



## County Council Meeting Beaufort County, SC

Council Chambers, Administration Building Beaufort County Government Robert Smalls  
Complex 100 Ribaut Road, Beaufort and virtually through zoom

**Monday, December 13, 2021**

**5:30 PM \*OR IMMEDIATELY FOLLOWING THE CAUCUS MEETING\***

### AGENDA

1. CALL TO ORDER
2. PLEDGE OF ALLEGIANCE AND INVOCATION - COUNCIL MEMBER LAWRENCE MCELYNN
3. PUBLIC NOTIFICATION OF THIS MEETING HAS BEEN PUBLISHED, POSTED, AND DISTRIBUTED IN COMPLIANCE WITH THE SOUTH CAROLINA FREEDOM OF INFORMATION ACT
4. APPROVAL OF AGENDA
5. BREAK FOR TREE LIGHTING CEREMONY
- [6.](#) APPROVAL OF MINUTES - SEPTEMBER 27, 2021 & OCTOBER 11, 2021
7. ADMINISTRATOR'S REPORT

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### CITIZEN COMMENTS

8. **CITIZEN COMMENTS - (ANYONE who wishes to speak during the Citizen Comment portion of the meeting will limit their comments to no longer than three (3) minutes ( a total of 15 minutes ) and will address Council in a respectful manner appropriate to the decorum of the meeting, refraining from the use of profane, abusive, or obscene language)**

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### COMMITTEE REPORTS

9. LIASION AND COMMITTEE REPORTS

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### PUBLIC HEARINGS AND ACTION ITEMS

10. APPROVAL OF CONSENT AGENDA
11. MATTERS ARISING OUT OF CAUCUS EXECUTIVE SESSION
- [12.](#) SECOND READING OF AN ORDINANCE AUTHORIZING THE COUNTY ADMINISTRATOR TO EXECUTE THE NECESSARY DOCUMENTS TO CONVEY A PORTION OF, ACCEPT A DEED FOR, AND CONVEY A PERPETUAL EASEMENT ON A PORTION OF PROPERTY OWNED BY BEAUFORT COUNTY WITH TMS NO. R600 021 000

0673 0000; EXECUTE AN AMENDMENT TO A DEED OF PERPETUAL EASEMENT ON A PORTION OF THE PROPERTY WITH TMS NO. R600 021 000 0007 0000; AND ACCEPT A DONATION TO THE RURAL AND CRITICAL LANDS PROGRAM

*Vote at First Reading on November 8, 2021 - 7:4*

13. FIRST READING BY TITLE ONLY OF AN ORDINANCE REDISTRICTING THE COUNTY COUNCIL OF BEAUFORT COUNTY
- [14.](#) FIRST READING BY TITLE ONLY OF AN ORDINANCE ALLOCATING \$166,397.00 TO THE BEAUFORT COUNTY PUBLIC DEFENDERS OFFICE TO COVER A COST OF LIVING INCREASE, COMPENSATION STUDY INCREASE, AND COST REQUIRED TO HIRE ANOTHER MAGISTRATE COURT ATTORNEY.
15. FIRST READING BY TITLE ONLY OF AN ORDINANCE AMENDING THE 2021-22 BUDGET ORDINANCE TO REFLECT THE RECEIPT OF AMERICAN RESCUE PLAN ACT ("ARPA") FUNDS FROM THE US GOVERNMENT
- [16.](#) RESOLUTION APPROVING AN INTERGOVERNMENTAL AGREEMENT WITH THE SC TRANSPORTATION INFRASTRUCTURE BANK
- [17.](#) RESOLUTION AUTHORIZING THE COUNTY ADMINISTRATOR TO REFUND THE \$3001.54 AMOUNT OF IMPACT FEES PAID BY BEAUFORT HOUSING AUTHORITY ON 2 RESIDENTIAL UNITS FRONTING RIBAUT ROAD.
- [18.](#) RESOLUTION AUTHORIZING THE COUNTY ADMINISTRATOR TO WAIVE OR REFUND THE \$17,768 TOTAL AMOUNT OF IMPACT FEES DUE OR PAID BY HILTON HEAD REGIONAL HABITAT FOR HUMANITY ON 8 RESIDENTIAL UNITS FRONTING ALEX PATTERSON ROAD.
- [19.](#) RESOLUTION AUTHORIZING THE COUNTY ADMINISTRATOR TO EXECUTE THE NECESSARY DOCUMENTS AND PROVIDE FUNDING FOR THE FEE SIMPLE PURCHASE OF REAL PROPERTY KNOWN AS TMS# R300 028 000 0016 0000 AND ALSO KNOWN AS BERMUDA BLUFF
- [20.](#) RESOLUTION AUTHORIZING THE COUNTY ADMINISTRATOR TO EXECUTE ANY AND ALL NECESSARY DOCUMENTS FOR THE ACCEPTANCE OF PROPERTIES ENCUMBERING THE ROAD RIGHT OF WAY FOR KLINE CIRCLE
- [21.](#) RESOLUTION SUPPORTING FEDERAL FLOOD MITIGATION ASSISTANCE REIMBURSABLE GRANT PROGRAMS
- [22.](#) A RESOLUTION TO ADOPT THE BEAUFORT COUNTY FLOOD MITIGATION ASSISTANCE POLICY
- [23.](#) ACCOMMODATIONS TAX (STATE 2%) BOARD RECOMMENDATIONS TO TOURISM-RELATED ORGANIZATIONS IN THE AMOUNT OF \$800,000.
- [24.](#) ACCEPTANCE OF COMMUNITY DEVELOPMENT BLOCK GRANT FOR THE STUART POINT ROAD PATHWAY PROJECT.
- [25.](#) APPROVAL OF PURCHASE OF TWO LOTS ADJACENT TO THE OLD COURTHOUSE FROM THE GG DOWLING FAMILY TRUST - FISCAL IMPACT WOULD BE IN THE AMOUNT OF \$1,900,000. A FUNDING SOURCE NEEDS TO BE IDENTIFIED.
- [26.](#) APPROVAL OF 2022 COUNCIL AND COMMITTEE MEETING SCHEDULES

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### **CITIZEN COMMENTS**

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27. **CITIZEN COMMENTS - (ANYONE who wishes to speak during the Citizen Comment portion of the meeting will limit their comments to no longer than three (3) minutes ( a total of 15 minutes ) and will address Council in a respectful manner appropriate to the decorum of the meeting, refraining from the use of profane, abusive, or obscene language)**
28. **ADJOURNMENT**

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## CONSENT AGENDA

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### Items Originating from the Executive Committee

1. REQUEST TO PURCHASE CAT MODEL 120 MOTORGRADER
2. APPOINTMENT TO THE BEAUFORT MEMORIAL HOSPITAL BOARD OF TRUSTEES FOR A PARTIAL TERM EXPIRING IN 2023.  
Applicants:  
CAROLYN M. BANNER, Ph.D.  
ANGELA D. SIMMONS Ph.D.

### Items Originating from the Finance Committee

3. THIRD READING OF AN ORDINANCE regarding a TEXT AMENDMENT TO BEAUFORT COUNTY CODE OF ORDINANCES: ARTICLE VII, DIVISION 4, SECTION 2-508; SECTION 2-509; SECTION 2-513; SECTION 2-517; AND SECTION 2-541 TO UPDATE ADMINISTRATIVE CHANGES, TO PROVIDE NECESSARY CONTRACT DOLLAR THRESHOLD CHANGES AND TO UPDATE EXEMPTION PROVISIONS AND PROCEDURES.

### Items Originating from the Natural Resources Committee

4. THIRD READING OF AN ORDINANCE AUTHORIZING THE EXECUTION AND DELIVERY OF AN ACCESS AND UTILITY EASEMENT FOR A PORTION OF A RIGHT OF WAY OWNED BY BEAUFORT COUNTY KNOWN AS CASSIDY DRIVE OFF BUCKWALTER PARKWAY IN BULFFTON TOWNSHIP SOUTH CAROLINA
5. THIRD READING OF AN ORDINANCE DECLARING CERTAIN COUNTY OWNED REAL PROPERTY AS SURPLUS PROPERTY AND AUTHORIZING THE COUNTY ADMINISTRATOR TO EXECUTE ANY AND ALL NECESSARY DOCUMENTS TO SELL REAL PROPERTY IDENTIFIED AS TMS NO. R700 036 000 13J 0000, R700 036 000 0112 0000, R700 036 000 0109 0000, R700 036 000 002C 0000 AND R600 036 000 001B 0000
6. SECOND READING OF AN ORDINANCE TO AMEND THE STORMWATER MANAGEMENT UTILITY ORDINANCE AS ADOPTED SEPTEMBER 26, 2016 TO PROVIDE FOR THE ADOPTION OF STORMWATER MANAGEMENT STANDARDS SET FORTH IN THE SOUTHERN LOWCOUNTRY DESIGN MANUAL TO MEET THE MUNICIPAL SEPARATE STORMSEWER SYSTEM (MS4) PERMIT REQUIREMENTS
7. SECOND READING OF AN ORDINANCE FOR A TEXT AMENDMENT TO THE STORMWATER MANAGEMENT UTILITY ORDINANCE AS ADOPTED SEPTEMBER 26TH, 2016 TO ADDRESS THE ADOPTION OF THE SOUTHERN LOWCOUNTRY DESIGN MANUAL
8. SECOND READING OF AN ORDINANCE FOR A TEXT AMENDMENT TO THE COMMUNITY DEVELOPMENT CODE (CDC): SECTION A.3.40 (PERMITTED ACTIVITIES) TO REVISE THE LADY'S ISLAND EXPANDED HOME BUSINESS DISTRICT TO INCLUDE SHORT-TERM RENTALS AS A SPECIAL USE.

### Items Originating from the Public Facilities Committee

9. SECOND READING OF AN ORDINANCE AMENDING BEAUFORT COUNTY ORDINANCE 2008/17 AND ADOPTING THE BUCKWALTER ACCESS MANAGEMENT PLAN
10. APPROVAL TO APPLY FOR THE AMERICAN RESCUE PLAN ACT 2021 FOR THE HILTON HEAD ISLAND AIRPORT – (*FISCAL IMPACT: INCOMING GRANT FUNDS - \$1,995,069*)
11. APPROVAL TO APPLY FOR THE AMERICAN RESCUE PLAN ACT 2021 FOR THE BEAUFORT EXECUTIVE AIRPORT – (*FISCAL IMPACT: INCOMING GRANT FUNDS - \$32,000*)
12. APPROVAL OF THE HILTON HEAD ISLAND AIRPORT (HXD) AND BEAUFORT EXECUTIVE AIRPORT (ARW) HANGAR RENT INCREASE APPROVAL.

13. CONTRACT AWARD TO BRANTLEY CONSTRUCTION SERVICES, LLC, FOR SUN CITY EMS/FIRE RENOVATIONS (\$1,234,000)

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**END OF CONSENT AGENDA**

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## Caucus Beaufort County, SC

This meeting was held both in person in Council Chambers at 100 Ribaut Road, Beaufort, and virtually through Zoom.

**Monday, September 27, 2021  
5:00 PM**

### MINUTES

1. **CALL TO ORDER**

Council Chairman Passiment called the meeting to order at 5:00 PM

**PRESENT**

Chairman Joseph F. Passiment  
Vice Chairman D. Paul Sommerville  
Council Member Logan Cunningham  
Council Member Gerald Dawson  
Council Member Brian Flewelling  
Council Member York Glover  
Council Member Stu Rodman  
Council Member Chris Hervochon  
Council Member Alice Howard  
Council Member Mark Lawson

**ABSENT**

Council Member Lawrence McElynn

2. **PLEDGE OF ALLEGIANCE**

Council Member Brian Flewelling led the Pledge of Allegiance.

3. **FOIA**

Committee Chairman Passiment noted that the Public Notification of this meeting has been published, posted, and distributed in compliance with the South Carolina Freedom of Information Act.

4. **APPROVAL OF THE AGENDA**

**Motion:** It was moved by Council Member Rodman, seconded by Council Member Glover to approve the County Caucus agenda. The motion was approved without objection.

## DISCUSSION ITEMS

### 5. AGENDA REVIEW

Chairman Passiment stated for the Committee Chair's to not go through the entire consent agenda just touch on the important points.

### 6. COUNCIL MEMBER DISCUSSION

Council Member Dawson stated he does not support item#13 Dale PDR.

Council Member Rodman stated the road on Highway 170 from 278 to 462 to fix the roads and have a talk with DOT about fixing the road since it is the worse section of road.

Council Member Cunningham stated an area that needs to be fixed is on 170 near Ashley Furniture.

## EXECUTIVE SESSION

7. **Motion:** It was moved by Council Member Rodman, seconded by Council Member Howard to go into Executive Session to receive legal advice where the legal advice relates to a pending, threatened, or potential claim or other matters covered by the attorney-client privilege (HHI litigation) (Auditor Litigation) (Possible Dale PDR transaction. The motion was approved without objection.

### 8. ADJOURNMENT

The meeting Adjourned at 6:06 PM.

## COUNTY COUNCIL OF BEAUFORT COUNTY

BY: \_\_\_\_\_  
Joseph F. Passiment, Jr., Chairman

ATTEST:

\_\_\_\_\_  
Sarah W. Brock, Clerk to Council  
Ratified:



## County Council Meeting Beaufort County, SC

This meeting was held both in person and virtually through zoom.

**Monday, September 27, 2021**

**6:00 PM**

### MINUTES

#### 1. **CALL TO ORDER**

Chairman Passiment called the meeting to order at 6:12 PM.

#### **PRESENT**

Chairman Joseph F. Passiment  
Vice Chairman D. Paul Sommerville  
Council Member York Glover  
Council Member Chris Hervochon  
Council Member Stu Rodman  
Council Member Alice Howard  
Council Member Mark Lawson  
Council Member Lawrence McElynn  
Council Member Gerald Dawson  
Council Member Brian Flewelling  
Council Member Logan Cunningham

#### 2. **PLEDGE OF ALLEGIANCE AND INVOCATION**

Council Member Brian Flewelling led the Pledge of Allegiance and gave the invocation.

#### 3. **FOIA**

Chairman Passiment stated public notice of this meeting had been published, posted, and distributed in compliance with the SC FOIA Act.

#### 4. **APPROVAL OF AGENDA**

**Motion:** It was moved by Vice Chairman Sommerville, seconded by Council Member Rodman to approve the agenda. The motion was approved without objection.

#### 5. **ADMINISTRATOR'S REPORT**

To see County Administrator, Eric Greenway's report please click the link below.

<https://beaufortcountysc.new.swagit.com/videos/140694>

6. **THE 2021 CASHVEST NATIONAL LEADERSHIP AWARD PRESENTATION FOR MARIA WALLS, BEAUFORT COUNTY TREASURER**

Beaufort County Treasurer, Maria Walls, received the Cashvest National Leadership Award.

**Discussion:** To see the full discussion click the link below.

<https://beaufortcountysc.new.swagit.com/videos/140694>

7. **CITIZEN COMMENTS**

David Trail stated concerns regarding the Dale PDR Conservation Easement agenda item.

Mike McShane stated concerns regarding the Dale PDR Conservation Easement agenda item.

John Trask III spoke regarding concerns he has regarding the Campground Standards agenda item.

Cynthia Jenkins spoke in favor of the Community Foundation of the Lowcountry's 2021 local Atax Grant Award.

Richard Campbell stated concerns the Friends of Historic Point have regarding the Marcie Smalls House being designated as a historic landmark.

Alexander McBride, Pastor of the First African Baptist Church, spoke in favor the Marcie Smalls House and it's important place in our community aiding in telling the story Mr. Smalls heritage.

Billy Keyserling requested that council approve the funds requested in order to restore the Marcie Smalls house and place it on the historic register.

Steve Amorrow, President of the Friends of Historic Point Association spoke about the concerns his organization has regarding the Marcie Smalls House.

8. **LIASION AND COMMITTEE REPORTS**

Council Member Alice Howard recognized the county administrator and staff for their efforts in getting pickleball established in Beaufort County.

Council Member Mark Lawson reviewed the Finance committee consent agenda items

Council Member Alice Howard reviewed the Natural Resources Committee consent agenda items.

Council Member Stu Rodman reviewed the Public Facilities Committee consent agenda items.

9. **APPROVAL OF CONSENT AGENDA**

**Motion:** It was moved by Vice-Chairman Sommerville, seconded by Council Member Dawson to approve the consent agenda. The motion was approved without objection.

10. **MATTERS ARISING OUT OF THE CAUCUS EXECUTIVE SESSION**

The Chairman stated this would be taken up during Item# 13 on the main agenda.

11. **SECOND READING OF A TEXT AMENDMENT TO BEAUFORT COUNTY CODE OF ORDINANCES, CHAPTER 42, ARTICLE II, DIVISION 3, SECTION 42.-81 TO UPDATE BOUNDARIES (SHELDON FIRE DISTRICT)**

**Motion:** It was moved by Council Member Dawson, seconded by Council Member Flewelling to approve public hearing and second reading of a text amendment to Beaufort County Code of Ordinances, Chapter 42, Article II, Division 3, Section 42.-81 to update Boundaries (Sheldon Fire District).

The Chairman opened the floor for a public hearing.

No one came forward.

The Chairman closed the public hearing.

**Discussion:** To see the full discussion click the link below.

<https://beaufortcountysc.new.swagit.com/videos/140694>

**The Vote** - The motion was approved without objection.

12. **PUBLIC HEARING AND SECOND READING OF AN ORDINANCE REGARDING A TEXT AMENDMENT TO THE COMMUNITY DEVELOPMENT CODE (CDC): SECTION 3.1.60 (CONSOLIDATED USE TABLE) AND SECTION 4.1.190 (RECREATION FACILITY: CAMPGROUNDS) TO REVISE THE CAMPGROUND STANDARDS**

**Motion:** It was moved by Council Member Howard, seconded by Council Member Rodman to approve public hearing and second reading of an Ordinance regarding a Text Amendment to the Community Development Code (CDC): Section 3.1.60 (Consolidated Use Table) and Section 4.1.190 (Recreation Facility: Campgrounds) to revise the Campground Standards. The motion is approved without objection.

The Chairman opened the floor for a public hearing.

No one came forward.

The Chairman closed the public hearing.

**Discussion:** To see the full discussion click the link below.

<https://beaufortcountysc.new.swagit.com/videos/140694>

**Motion to Amend:** It was moved by Council Member Sommerville, seconded by Council Member Cunningham to allow staff to consider extending the time permitted to 30 to 82.

**Motion Rescinded**

**The Vote** - The motion was approved without objection.

13. **PUBLIC HEARING OF A RESOLUTION AUTHORIZING THE COUNTY ADMINISTRATOR TO EXECUTE THE NECESSARY DOCUMENTS AND PROVIDE FUNDING FOR THE PURCHASE OF A CONSERVATION EASEMENT ON REAL PROPERTY KNOWN AS TMS# R700 040 000 0001 0000 AND R700 030 000 0004 0000 AND ALSO KNOWN AS DALE**

**Motion:** It was moved by Vice-Chairman Sommerville, seconded by Council Member Cunningham to execute the necessary documents, and provide funding for the purchase of a Conservation Easement on real property known as TMS# R700 040 000 0001 0000 And R700 030 000 0004 0000 and also known as Dale.

The Chairman opened the floor for a public hearing.

Linda Hills stated concerns she has about the lack of monthly communication between council and their constituents regarding policies and procedures being passed.

The Chairman closed the public hearing.

**Discussion:** To see the full discussion click the link below.

<https://beaufortcountysc.new.swagit.com/videos/140694>

**Motion to Amend:** It was moved by Vice-Chairman Sommerville, seconded by Council Member Cunningham to include the deletion of the whereas clause that allows the easement to be given back to the Department of Defense or the US Government and the final acreage be determined by the survey that has been done.



**The Vote** - Voting Yea: Chairman Passiment, Vice Chairman Sommerville, Council Member Glover, Council Member Rodman, Council Member Howard, Council Member McElynn, Council Member Flewelling, Council Member Cunningham. Voting Nay: Council Member Hervochon, Council Member Lawson, Council Member Dawson. The motion passed 8:3.

14. **FIRST READING OF AN ORDINANCE TO REPURPOSE COMMUNITY FOUNDATION OF THE LOWCOUNTRY'S 2021 LOCAL ATAX GRANT AWARD**

**Motion:** It was moved by Council Member Dawson, seconded by Council Member Rodman to approve first reading of an Ordinance to Repurpose Community Foundation of the Lowcountry's 2021 Local ATAX Grant Award.

**Discussion:** To see the full discussion click the link below.

<https://beaufortcountysc.new.swagit.com/videos/140694>

**The Vote** - Voting Yea: Council Member Rodman, Council Member Lawson, Council Member McElynn, Council Member Dawson. Voting Nay: Chairman Passiment, Vice Chairman Sommerville, Council Member Glover, Council Member Hervochon, Council Member Howard, Council Member Flewelling, Council Member Cunningham. The motion failed 4:7.

15. **FIRST READING OF AN ORDINANCE AUTHORIZING THE COUNTY ADMINISTRATOR TO EXECUTE A MODIFICATION OF DRAINAGE EASEMENT ASSOCIATED WITH PARCEL #R112-031-000-0628-0000**

**Motion:** It was moved by Council Member Flewelling, Seconded by Vice-Chairman Sommerville to approve first reading of an ordinance authorizing the County Administrator to execute a modification of drainage easement associated with parcel #R112-031-000-0628-0000.

**Discussion:** To see the full discussion click the link below.

<https://beaufortcountysc.new.swagit.com/videos/140694>

**The Vote** - The motion was approved without objection.

**EXTEND PAST 8 O'CLOCK**

**Motion:** It was moved by Council Member Flewelling, seconded by Vice-Chairman Sommerville to go past 8'Clock.

**The Vote** - Voting Yea: Chairman Passiment, Vice Chairman Sommerville, Council Member Glover, Council Member Rodman, Council Member Howard, Council Member Lawson, Council Member McElynn, Council Member Flewelling, Council Member Cunningham. Voting Nay: Council Member Hervochon, Council Member Dawson. The motion passed 8:2.

16. **APPROVAL OF A RESOLUTION REGARDING IMPLEMENTATION OF A COVID-19 INPATIENT EMPLOYEE LEAVE DONATION PROGRAM AS DETAILED IN EXHIBIT "A"**

**Motion:** It was moved by Council Member Howard, Seconded by Council Member Glover to approve the resolution regarding implementation of a COVID-19 Inpatient Employee Leave Donation Program as detailed in Exhibit "A".

**Discussion:** To see the full discussion click the link below.

<https://beaufortcountysc.new.swagit.com/videos/140694>

**The Vote** - The motion was approved without objection.

17. **Resolution to accept Federal Grant: Award # 1H79TI084543-01 in the amount of \$1.9 million**

**Motion:** It was moved by Vice-Chairman Sommerville, Seconded by Council Member Rodman to approve the Resolution to accept Federal Grant: Award # 1H79TI084543-01 in the amount of \$1.9 million.

**Discussion:** To see the full discussion click the link below.

<https://beaufortcountysc.new.swagit.com/videos/140694>

**The Vote** - The motion was approved without objection.

18. **CITIZEN COMMENTS**

Billy Keyserling stated he will withdraw the request on item#14

19. **ADJOURNMENT**

The meeting adjourned 8 PM

COUNTY COUNCIL OF BEAUFORT COUNTY

BY: \_\_\_\_\_  
Joseph F. Passiment, Jr., Chairman

ATTEST:

\_\_\_\_\_  
Sarah W. Brock, Clerk to Council  
Ratified:



## Caucus Beaufort County, SC

This meeting will be held both in person in Council Chambers at 100 Ribaut Road, Beaufort, and virtually through Zoom. Please be aware that there is limited seating available for the in-person meeting and attendees must practice social distancing

**Monday, October 11, 2021  
5:00 PM**

### MINUTES

1. **CALL TO ORDER**

Council Chairman Passiment called the meeting to order at 5:00 PM

**PRESENT**

Chairman Joseph F. Passiment  
Vice-Chairman D. Paul Sommerville  
Council Member Logan Cunningham  
Council Member Gerald Dawson  
Council Member Brian Flewelling  
Council Member York Glover  
Council Member Stu Rodman  
Council Member Chris Hervochon  
Council Member Alice Howard  
Council Member Mark Lawson  
Council Member Lawrence McElynn

2. **PLEDGE OF ALLEGIANCE**

Chairman Passiment led the Pledge of Allegiance.

3. **FOIA**

Chairman Passiment noted that the Public Notification of this meeting has been published, posted, and distributed in compliance with the South Carolina Freedom of Information Act.

4. **APPROVAL OF THE AGENDA**

**Motion to Amend:** It was moved by Council Member Rodman, seconded by Vice-Chairman Sommerville to amend the agenda to remove legal issues related to HWY-278 Project from Executive Session. The motion was approved without objection.

## DISCUSSION ITEMS

### 5. **AGENDA REVIEW**

Chairman Passiment asked that Committee Chairman only summarize their consent agenda items

### 6. **COUNCIL MEMBER DISCUSSION**

Chairman Passiment stated there is a Special Council Meeting that will be held on October 27, 2021, at 6 PM at the USCB Theater to discuss the redistricting areas of Beaufort County that will be a hybrid meeting.

## EXECUTIVE SESSION

### 7. **PURSUANT TO S.C. CODE SEC. 30-4-70(A)(2) RECEIPT OF LEGAL ADVICE WHERE THE LEGAL ADVICE RELATES TO A PENDING, THREATENED, OR POTENTIAL CLAIM OR OTHER MATTERS COVERED BY THE ATTORNEY-CLIENT PRIVILEGE (LEGAL ISSUES RELATED TO HWY-278 PROJECT) (LEGAL ISSUES RELATED TO SCHOOL IMPACT FEE IGAS WITH MUNICIPALITIES) (STATUS OF EMPLOYMENT RELATED CLAIMS) (STATUS OF FOIA LITIGATION)**

#### **Executive Session**

**Motion:** It was moved by Vice-Chairman Sommerville, seconded by Council Member McElynn to go into Executive Session. The motion was approved without objection.

### 8. **ADJOURNMENT**

The meeting adjourned at 5:57 PM

## COUNTY COUNCIL OF BEAUFORT COUNTY

BY: \_\_\_\_\_  
Joseph F. Passiment, Jr., Chairman

ATTEST:

\_\_\_\_\_  
Sarah W. Brock, Clerk to Council  
Ratified:



## County Council Meeting Beaufort County, SC

This meeting was held both in person in Council Chambers at 100 Ribaut Road, Beaufort, and virtually through Zoom.

**Monday, October 11, 2021  
6:00 PM**

### MINUTES

1. **CALL TO ORDER**

Council Chairman Passiment called the meeting to order at 6 PM

**PRESENT**

Chairman Joseph F. Passiment  
Vice-Chairman D. Paul Sommerville  
Council Member York Glover  
Council Member Chris Hervochon  
Council Member Stu Rodman  
Council Member Alice Howard  
Council Member Mark Lawson  
Council Member Lawrence McElynn  
Council Member Gerald Dawson  
Council Member Brian Flewelling  
Council Member Logan Cunningham

2. **PLEDGE OF ALLEGIANCE AND INVOCATION**

Council Member Mark Lawson led the Pledge of Allegiance and Invocation.

3. **FOIA**

Chairman Passiment noted that the Public Notification of this meeting has been published, posted, and distributed in compliance with the South Carolina Freedom of Information Act.

4. **APPROVAL OF AGENDA**

**Motion:** It was moved by Council Member Rodman, seconded by Council Member Cunningham to approve the agenda. The motion was approved without objection.

5. **APPROVAL OF MINUTES**

**Motion:** It was moved by Council Member Howard, seconded by Vice-Chairman Sommerville to approve the minutes from June 28, 2021, June 30, 2021, and July 26, 2021. The motion was approved without

objection.

6. **ADMINISTRATOR'S REPORT**

To see County Administrator, Eric Greenway's report please click the link below.

<https://beaufortcountysc.new.swagit.com/videos/141433>

7. **PROCLAMATION PRESENTATION TO THE YOUNG MARINES IN OBSERVANCE OF RED RIBBON WEEK**

Council Member Larry McElynn read and presented a proclamation honoring The Young Marines in observance of Red Ribbon Week

8. **PRESENTATION OF A PROCLAMATION RECOGNIZING THE BEAUFORT COUNTY ALCOHOL AND DRUG ABUSE PREVENTION DEPARTMENT IN OBSERVANCE OF RED RIBBON WEEK – COUNCIL MEMBER MCELYNN**

Council Member McElynn read and presented a proclamation to Beaufort County's Alcohol and Drug Abuse Department honoring Red Ribbon Week.

9. **CITIZEN COMMENTS**

Tony Cristela commented regarding a conservation easement.

Chuck Newton commented regarding the 2021 Comprehensive Plan.

10. **LIASION AND COMMITTEE REPORTS**

Council Member Cunningham reviewed and explained items on the consent agenda from Community Services.

Council Member Howard reviewed and explained items on the consent agenda from Natural Resources.

Council Member Rodman reviewed and explained items on the consent agenda from Public Facilities.

Chairman Passiment stated the Special Meeting will be held at USCB Theater on October 27, 2021, at 6 PM for redistricting the county.

11. **APPROVAL OF CONSENT AGENDA**

**Motion:** It was moved by Council Member Howard, seconded by Council Member Cunningham to approve the consent agenda. The motion was approved without objection.

12. **MATTERS ARISING OUT OF THE CAUCUS EXECUTIVE SESSION**

No formal motion

13. **THIRD READING OF AN ORDINANCE REGARDING A TEXT AMENDMENT TO THE COMMUNITY DEVELOPMENT CODE (CDC): SECTION 3.1.60 (CONSOLIDATED USE TABLE) AND SECTION 4.1.190 (RECREATION FACILITY: CAMPGROUNDS) TO REVISE THE CAMPGROUND STANDARDS**

**Motion to Amend:** It was moved by Vice-Chairman Sommerville, seconded by Council Member Howard to amend Community Development Code (CDC): Section 3.1.60 (Consolidated Use Table) and Section 4.1.190 (Recreation Facility: Campgrounds) to revise the Campground Standards with the following revisions, the primitive campgrounds maximum length of stay is revised from 14 days in any 30 day period to 60 days in any given 90 day period, primitive campgrounds are limited to 15 sites must have a minimum site area of 3 acres that have no restrictions on trailer or RV length. For semi developed land and

developed campgrounds maximum length of stay is revised from 30 days in any 60 day period to 60 days in any 90 day period.

**Discussion:** To see the full discussion click the link below:

<https://beaufortcountysc.new.swagit.com/videos/141433>

**The Vote** - The motion was approved without objection

14. **FIRST READING OF AN ORDINANCE ADOPTING THE “ENVISION BEAUFORT COUNTY 2040 COMPREHENSIVE PLAN” AND “BEAUFORT COUNTY CONNECTS BICYCLE AND PEDESTRIAN PLAN 2021” AS AN APPENDIX TO THE PLAN.**

**Motion:** It was moved by Council Member Howard, seconded by Council Member Rodman to approve first reading of an ordinance adopting the “Envision Beaufort County 2040 Comprehensive Plan” and “Beaufort County Connects Bicycle and Pedestrian Plan 2021” as an appendix to the Plan. The motion was approved without objection.

**Discussion:** To see the full discussion click the link below:

<https://beaufortcountysc.new.swagit.com/videos/141433>

**The Vote** - The motion was approved without objection

15. **APPROVAL TO APPLY – PALMETTO PRIDE 2022 GRANTS: KEEP SOUTH CAROLINA BEAUTIFUL, LITTER PREVENTION, LITTER CREW AND LITTER ENFORCEMENT**

**Motion:** It was moved by Vince-Chairman Sommerville, seconded by Council Member Lawson approved to Apply – Palmetto Pride 2022 Grants: Keep South Carolina Beautiful, Litter Prevention, Litter Crew and Litter Enforcement. The motion was approved without objection.

**Discussion:** To see the full discussion click the link below:

<https://beaufortcountysc.new.swagit.com/videos/141433>

**The Vote** - The motion was approved without objection

16. **CITIZEN COMMENTS**

No citizens comment

17. **ADJOURNMENT**

The meeting adjourned at 6:44 PM

COUNTY COUNCIL OF BEAUFORT COUNTY

BY: \_\_\_\_\_

Joseph F. Passiment, Jr., Chairman

ATTEST:

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Sarah W. Brock, Clerk to Council

Ratified:





## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 12.

<b>ITEM TITLE:</b>
AN ORDINANCE AUTHORIZING THE COUNTY ADMINISTRATOR TO EXECUTE THE NECESSARY DOCUMENTS TO CONVEY A PORTION OF, ACCEPT A DEED FOR, AND CONVEY A PERPETUAL EASEMENT ON A PORTION OF PROPERTY OWNED BY BEAUFORT COUNTY WITH TMS NO. R600 021 000 0673 0000; EXECUTE AN AMENDMENT TO A DEED OF PERPETUAL EASEMENT ON A PORTION OF THE PROPERTY WITH TMS NO. R600 021 000 0007 0000; AND ACCEPT A DONATION TO THE RURAL AND CRITICAL LANDS PROGRAM
<b>MEETING NAME AND DATE:</b>
County Council November 8, 2021 (1 <sup>st</sup> reading) December 13, 2021 (2 <sup>nd</sup> reading and Public Hearing) January 10, 2022 (3 <sup>rd</sup> reading)
<b>PRESENTER INFORMATION:</b>
Stefanie M. Nagid, Passive Parks Manager and Brittany Ward, Deputy County Attorney (10 minutes)
<b>ITEM BACKGROUND:</b>
On October 25, 2021, County Council approved a motion (7:4) to move the ordinance forward
<b>PROJECT / ITEM NARRATIVE:</b>
Execute the necessary documents to convey Parcel A by way of a quit claim deed to James E. Crosby, Michael S. Crosby, and Geoffrey S. Crosby.  Execute the necessary documents and accept the conveyance of any and all interest in Parcel B from James E. Crosby, Michael S. Crosby, and Geoffrey S. Crosby.  Execute the necessary documents to convey a perpetual easement on Parcel B for the continued existing use of the real property to James E. Crosby, Michael S. Crosby, and Geoffrey S. Crosby.  Accept from Robert L. Graves a donation of Twenty-Five Thousand (\$25,000) Dollars to the Rural and Critical Lands Program.
<b>FISCAL IMPACT:</b>
Possible survey costs Acceptance of \$25,000 donation
<b>STAFF RECOMMENDATIONS TO COUNCIL:</b>
Approve the ordinance
<b>OPTIONS FOR COUNCIL MOTION:</b>
Motion to approve the ordinance as written. Motion to amend the ordinance. Motion to deny the ordinance.

**AN ORDINANCE AUTHORIZING THE COUNTY ADMINISTRATOR TO EXECUTE THE NECESSARY DOCUMENTS TO CONVEY A PORTION OF, ACCEPT A DEED FOR, AND CONVEY A PERPETUAL EASEMENT ON A PORTION OF PROPERTY OWNED BY BEAUFORT COUNTY WITH TMS NO. R600 021 000 0673 0000; EXECUTE AN AMENDMENT TO A DEED OF PERPETUAL EASEMENT ON A PORTION OF THE PROPERTY WITH TMS NO. R600 021 000 0007 0000; AND ACCEPT A DONATION TO THE RURAL AND CRITICAL LANDS PROGRAM**

**WHEREAS**, Beaufort County (“County”) purchased real property from Robert L. Graves, and is the current fee simple owner of the real property known as Okatie River Park with TMS No. R600 021 000 0673 0000 and being recorded in the Office of the Register of Deeds for Beaufort County, South Carolina on December 20, 2013, in Book 3293 Pages 2884-2893; hereinafter referred to as the “Public Park”; and

**WHEREAS**, the County purchased the Public Park through the Rural and Critical Lands Program and intends to develop a public passive park on the real property; and

**WHEREAS**, the County desires to provide the citizens and visitors of Beaufort County with public access to the Public Park in the most direct and accessible manner possible; and

**WHEREAS**, adjacent to the Public Park is the real property with TMS No. R600 021 000 0007 0000 which was previously owned by Verna G. Crosby, and is currently owned by James E. Crosby, Michael S. Crosby, and Geoffrey S. Crosby; hereinafter the “Adjacent Property”; and

**WHEREAS**, Verna Crosby previously provided Robert L. Graves a Deed of Perpetual Easement of ingress and egress over a portion of the Adjacent Property for livestock, farm equipment and human foot traffic; whereby the easement was executed on January 30, 1996, and recorded in the Beaufort County Register of Deeds in Book 432 Page 5389; hereinafter the “Access Easement”; and

**WHEREAS**, the land survey dated January 18, 1996 and being recorded in the Office of the Register of Deeds for Beaufort County, South Carolina in Book 55 Page 82 identifies Parcel A as a “Disputed Area”, Parcel B which abuts the Adjacent Property, and Parcel C with an Access Easement located on the Adjacent Property; the aforementioned survey is shown in Exhibit A attached hereto and incorporated herein by reference; and

**WHEREAS**, the County desires to convey Parcel A by way of a quit claim deed to James E. Crosby, Michael S. Crosby, and Geoffrey S. Crosby; and

**WHEREAS**, the owners of the Adjacent Property desire to convey any and all potential interest in Parcel B to the County; and

**WHEREAS**, the County desires to convey a perpetual easement on Parcel B for the continued existing use of the real property to James E. Crosby, Michael S. Crosby, and Geoffrey S. Crosby; and

**WHEREAS**, the County and owners of the Adjacent Property desire to amend the Access Easement on Parcel C, including but not limited to, permitting the County to further develop the already existing dirt pathway and establish a permeable road; to permit public vehicular access to the Public Park; to require the County to maintain vegetation along the road abutting the Adjacent Property; and to permit a gated access to the Adjacent Property from the Access Easement; and

**WHEREAS**, in support of providing the citizens and visitors of Beaufort County vehicular access to the Public Park, Robert L. Graves desires to provide a Twenty-Five Thousand (\$25,000) Dollar donation to the Rural and Critical Lands Program.

**NOW, THEREFORE BE IT ORDAINED BY BEAUFORT COUNTY COUNCIL**, duly assembled, does hereby authorize the County Administrator as follows:

1. Execute the necessary documents to convey Parcel A, as shown in Exhibit A, by way of a quit claim deed to James E. Crosby, Michael S. Crosby, and Geoffrey S. Crosby; and
2. Execute the necessary documents and accept the conveyance of any and all interest in Parcel B, as shown in Exhibit A, from the owners of the Adjacent Property; and
3. Execute the necessary documents to convey a perpetual easement on Parcel B, as shown in Exhibit A, for the continued existing use of the real property to James E. Crosby, Michael S. Crosby, and Geoffrey S. Crosby; and
4. Accept from Robert L. Graves a donation of Twenty-Five Thousand (\$25,000) Dollars to the Rural and Critical Lands Program.

Adopted this \_\_\_\_ day of \_\_\_\_\_, 2022.

COUNTY COUNCIL OF BEAUFORT COUNTY

By: \_\_\_\_\_  
Joseph Passiment, Chairman

ATTEST:

\_\_\_\_\_  
Sarah Brock, Clerk to Council

JOHN A. SULLIVAN, JR.  
 FILED 3150  
 DEPT. OF REVENUE  
 DIVISION OF LANDS  
 FOLDER #

PLAT BOOK 35  
 PAGE 238  
 DATE 3-28-86

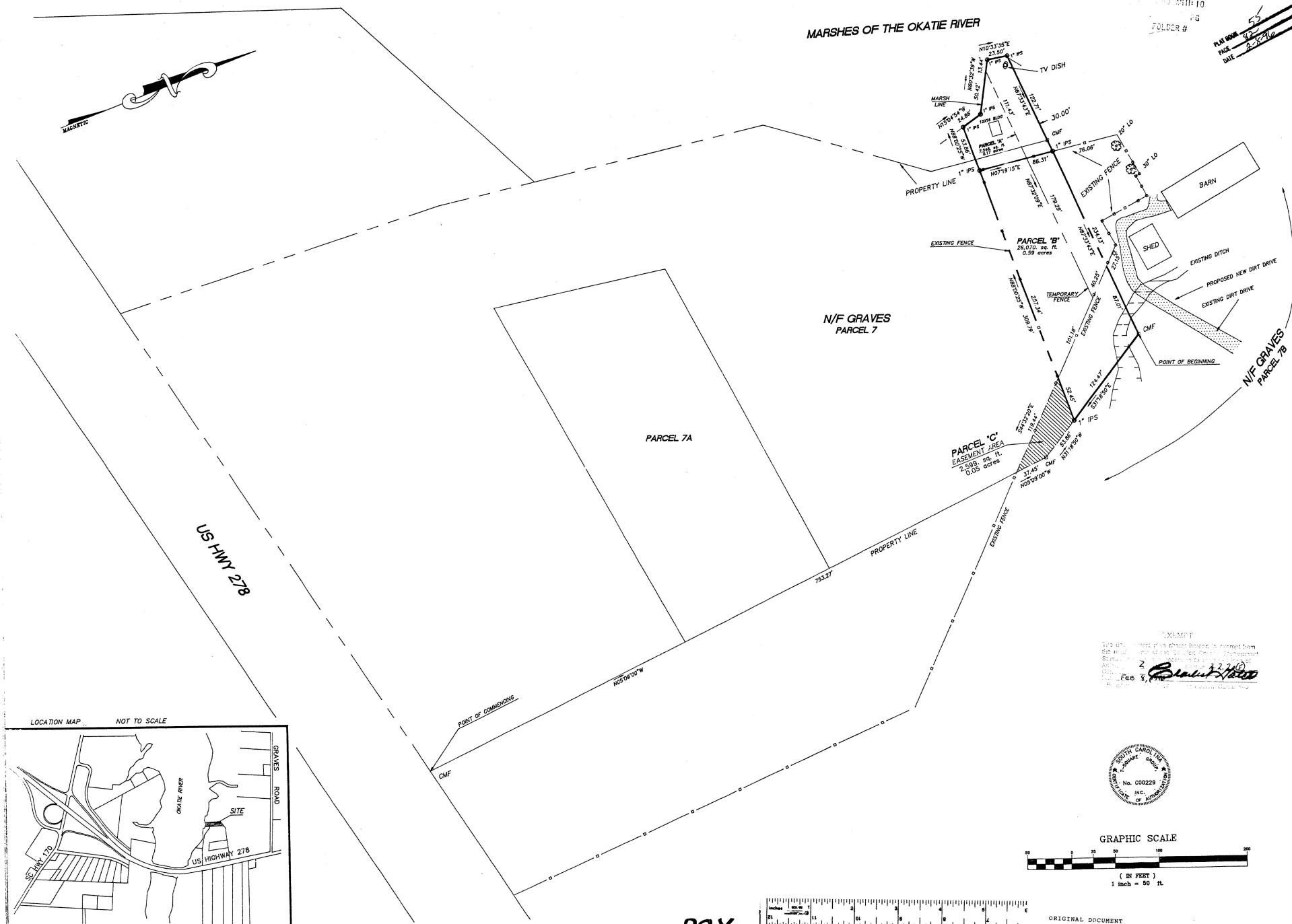
NOTE: This Lot, Laid in A Federal Flood Plain Zone C  
 DIST 600, TAX MAP 21, A PORTION OF PARCEL 7 & 7B  
 REFERENCE PLAT  
 A PORTION OF THE ESTATE OF L. W. TON GRAVES, JR.  
 LAST RECORDED 8-21-1989

THE ABOVE PLAT PREPARED BY ME AT THE REQUEST OF  
 SAID P. GRAVES, IRENA G. GRAVES & ROBERT L. GRAVES  
 A DIVISION OF A PORTION OF THE ESTATE OF L. W. TON GRAVES, JR.  
 BLOFTON TOWNSHIP, BEaufORT COUNTY, SOUTH CAROLINA

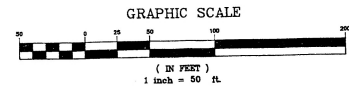


I HEREBY CERTIFY TO THE BEST OF MY KNOWLEDGE  
 INFORMATION & BELIEF, THE SURVEY SHOWN HEREON  
 WAS MADE IN ACCORDANCE WITH THE STANDARDS  
 OF LAND SURVEYING IN SOUTH CAROLINA, AND I  
 AS SWORN, THEREIN.  
 ALSO NOW, I AM NOT PROVIDING ANY OTHER  
 PROJECTIONS EXCEEDING THE PROPERTY OTHER THAN  
 THAT SHOWN HEREON.

T-SQUARE GROUP, INC.  
 PROFESSIONAL LAND SURVEYORS  
 811 Peachtree St.  
 Suite 200  
 Atlanta, GA 30308



22X



ORIGINAL DOCUMENT  
 POOR CONDITION OR CONTRAST

**Office of the Public Defender**  
**Fourteenth Judicial Circuit**  
**Stephanie Smart-Gittings, Circuit Defender**

Item 14.

**BEAUFORT COUNTY**  
Human Services Building  
1905 Duke Street, Room 210  
Post Office Box 525  
Beaufort, SC 29902  
(843) 255-5805 (Phone)  
(843) 255-9494 (Fax)

**ALLENDALE, HAMPTON & JASPER COUNTIES**  
1 Courthouse Square  
80 Elm Street, Room 133  
Post Office Box 506  
Hampton, SC 29924  
(803) 914-2240 (Phone)

**COLLETON COUNTY**  
319 N. Lucas Street  
Walterboro, SC 29488  
(843) 549-1633 (Phone)  
(843) 549-2912 (Fax)

November 12, 2021

Beaufort County Finance Council  
100 Ribaut Road  
Post Office Drawer 1228  
Beaufort, SC 29901

RE: FY 2021/2022

Dear Council Members,

The current Beaufort County allocation for the Beaufort County Public Defender's Office stands at \$1,498,131.00. I am making a mid-year request for additional funding of \$166,397.00 in order to maintain staff for the Beaufort County Public Defender's Office.

Currently I have four (4) open previously funded attorney positions with the Beaufort County Public Defender's Office. Based on research of neighboring agencies and other Public Defender's Offices' throughout our state, I am proposing the following chart for Public Defenders in Beaufort County:

Tier 1 Attorney:	65,000 – 85,000
Tier 2 Attorney:	86,000 – 130,000

This is an increase from the funding you provided in 2020 wherein I predicted to hire Tier 1 attorneys at \$56,000 and Tier 2 attorneys at \$80,000.

Like many agencies and courts around the state, Covid-19 and the closures that followed increased the case load for the Beaufort County Public Defender's Office. This was especially prevalent in the Beaufort County Magistrate Court. The single attorney assigned to Magistrate Court became overwhelmed in 2021 with the pending case load, and ultimately, I was required to use any available funds to hire another attorney to assist in magistrate court. The Beaufort County Public Defender's Office now has two attorneys in Magistrate Court; one (1) attorney handling Beaufort Magistrate Court and one (1) attorney handling Bluffton Magistrate Court.

While this addressed the unyielding issue in Magistrate Court in Beaufort County, I was unable to give needed salary increases to Beaufort County attorneys and staff members. The Beaufort County Public Defender's Office did not receive the previous cost of living increase or the compensation study increase last year. In order to recruit and retain employees in the Beaufort County Public Defender's Office, I am requesting \$166,397.00 to cover this cost of

living increase, compensation study increase, and cost required to hire another Magistrate Court attorney.

At this time, I am not requesting additional attorneys for the Beaufort County Public Defender's Office. My current immediate need is to compensate the valuable staff members currently employed with my office, and recruit and retain attorneys for the four (4) available attorney positions with my office.

I am happy to answer any questions that council may have, and respectfully request to be heard at your next available council meeting on November 15, 2021.

With kind regards, I am,

*Stephanie Smart- Gittings*

Stephanie Smart-Gittings  
14<sup>th</sup> Circuit Public Defender

## NEW HIGHLIGHTS OF BEAUFORT COUNTY PUBLIC DEFENDER'S OFFICE:

### 1. MITIGATION TEAM CREATED IN 2020:

In 2020, the Beaufort County Public Defender's Office received funding from the Beaufort County Council which enabled our office to be able to form the Mitigation Division of the Public Defender's Office.

This team consist of a Mitigation Attorney, a Sentencing/ Mitigation Specialist, and an Administrative Assistant.

This elite team places a holistic approach to the criminal justice system and handles a variety of tasks including:

- Assisting attorneys in investigating, analyzing, developing, and presenting mitigation evidence to the court,
- Develops relationships with clients, their families, local service providers, treatment centers, substance abuse networks, mental health agencies, and vocational programs aimed at addressing substance abuse, mental illness, homelessness, or other issues that many clients maybe facing, and
- Addresses the collateral consequences associated with General Sessions cases.

### 2. BOND COURT DIVISION:

Likewise in 2021, the Beaufort County Public Defender's Office created the Bond Court Division. This Division handles Bond Hearings twice a day at the Beaufort County Detention Center. A dedicated Administrate Assistant assists our attorneys in bond court.

### 3. MAGISTRATE COURT:

Two Public Defenders now handle Magistrate Court in Beaufort County; one for Beaufort Magistrate and one for Bluffton Magistrate.

Previously one attorney rotated between the two courts: causing scheduling issues, and a growing case load.

## UPCOMING GENERAL SESSIONS COURT DATES:

November 8 - 12, 2021

November 15 -19, 2021

December 6 -10, 2021

December 13 -17, 2021

January 10 -14, 2021

January 18 -21, 2021

January 31 - February 4, 2021

February 14 - 18, 2021

February 21 – 25, 2021

March 14 – 18, 2021

March 21 – 25, 2021

April 11 – 15, 2021

April 18 – 22, 2021

May 9 – 13, 2021

May 16 – 20, 2021

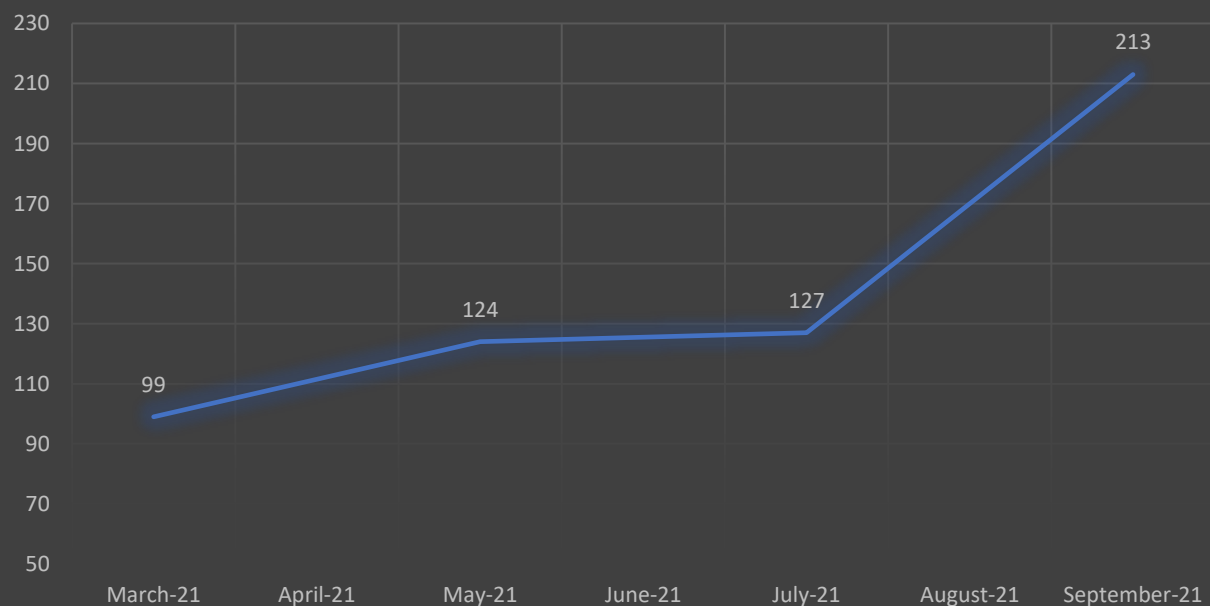
## Did you know?

*The Beaufort County Public Defender's Office Mitigation Division assisted 43 individuals with placement in substance abuse treatment centers, homeless shelters, or half-way housing since August 2020.*

Beaufort County  
Public Defender's  
Office Current  
Numbers (as of  
November 10, 2021):

Court Type	Clients (People)	Cases (Incidents)	Charges (Warrants/Tickets)
General Sessions	1371	1805	3164
Magistrate Court	524	583	970
Municipal Court	231	261	516
Juvenile	49		
<b>Total</b>	<b>2175</b>	<b>2649</b>	<b>4650</b>

**DISPOSED CASE COUNT: BEAUFORT COUNTY MAGISTRATE  
 COURT AND BEAUFORT COUNTY GENERAL SESSIONS COURT**





**BEAUFORT COUNTY PUBLIC DEFENDER'S OFFICE REQUEST:****STAFF MEMBERS COST OF LIVING INCREASES \$23,397.00**

- Investigators, Administrative Assistants, Mitigation Specialist
- This would be a 5.9% cost of living/ retention increase for current staff members.
- Rate at 5.9% which is consistent with the Social Security Administrations 2022 cost of living increase.

**ATTORNEYS RETENTION AND RECRUITING ADJUSTMENT \$143,000.00**

Tier 1 Attorney: 65,000 – 85,000  
Tier 2 Attorney: 86,000 – 130,000

**TOTAL REQUEST: \$166,397.00**



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 16.

<b>ITEM TITLE:</b>
Resolution approving an Intergovernmental Agreement with the SC Transportation Infrastructure Bank
<b>MEETING NAME AND DATE:</b>
Council, December 13, 2021
<b>PRESENTER INFORMATION:</b>
Kurt Taylor, County Attorney Time Needed for Item Discussion 3 min.
<b>ITEM BACKGROUND:</b>
<b>PROJECT / ITEM NARRATIVE:</b>
The SCTIB requires council approval for the funding agreement for the Hwy 278 project
<b>FISCAL IMPACT:</b>
(Discuss Funding and Liability Factors- this enables the receipt of the funds from the SCTIB (List Dollar Amount Requested/Needed)
<b>STAFF RECOMMENDATIONS TO COUNCIL:</b>
Approve the Resolution
<b>OPTIONS FOR COUNCIL MOTION:</b>
Motion to approve/deny Resolution

## RESOLUTION 2021/\_\_\_\_\_

**WHEREAS**, on or about July 24, 2019 (and supplemented thereafter), Beaufort County (the “County”) submitted an application for financial assistance (the “Application”) to the South Carolina Transportation Infrastructure Bank (the “Bank”) for the purpose of receiving funds for improvements to certain portions of US Highway 278 from Moss Creek Drive to Spanish Wells Road in the county (the “Project”); and

**WHEREAS**, subsequently, the Application received approval from the Bank on July 16, 2020; and

**WHEREAS**, the SC Department of Transportation Commission approved the financial assistance at its meeting of July 16, 2020; and

**WHEREAS**, the financial assistance was approved by the Joint Bond Review Committee of the SC General Assembly on August 11, 2020; and

**WHEREAS**, the Bank and the County now wish to enter into the Intergovernmental Agreement provided by the Bank setting forth the respective responsibilities and obligations of the parties for financial assistance for the Project (the “Intergovernmental Agreement”), as revised.

**NOW, THEREFORE, BE IT RESOLVED**, by the County Council of Beaufort County, South Carolina, that:

1. County Council hereby approves entering into the Intergovernmental Agreement with the Bank for the Bank’s financial assistance for the Project.

2. The County Administrator is authorized to execute and deliver the Intergovernmental Agreement to the Bank, and is authorized to execute and enter into any supplements or amendments to the Intergovernmental Agreement as may be necessary or helpful from time to time.

Adopted this 13th day of December, 2021.

COUNTY COUNCIL OF BEAUFORT COUNTY

By: \_\_\_\_\_  
Joseph Passiment  
Chairman

ATTEST:

\_\_\_\_\_  
Sarah Brock, Clerk to Council

## PROJECT &amp; CAPACITY FEE QUOTE

Beaufort Jasper Water & Sewer Authority  
 Engineering Department  
 6 Snake Road  
 Okatie, SC 29909  
 843- 987-8064

Date: May 22, 2019  
 REVISED: December 3, 2019

<b>To:</b> Andrew Klosterman Andrews Engineering 2712 Bull Street Beaufort, SC 29902	<b>Project Information</b> Project Name: Beaufort Housing Authority 4-Plex Project No.: 2019-093 Location: Beaufort
--	--

## Comments or Special Instructions:

1. All fees are subject to change without notice.
2. Please return a copy of this invoice with your payment.
3. BJWSA will not schedule a pre-construction meeting until the balance due has been paid.

## FEES DUE:

Description	Quantity	Units	Unit Cost	Total
<b>Wastewater Capacity Fee:</b>				
One BR per unit = 150 GPD x 8 Units = 1,200 GPD	1,200	GPD	\$ 10.27	\$12,324.00
WW Capacity Fee as of 1/1/2020 = \$13,608.00	1,200	GPD	\$ 11.34	
<b>Water Capacity Fee:</b>				
1,200 GPD x 1.3 = 1,560 GPD	1,560	GPD	\$ 3.30	\$5,148.00
Water Capacity Fee as of 1/1/2020 = \$5,616.00	1,560	GPD	\$ 3.60	
<b>Plan Review Fee:</b>	1	EA.	\$ 300.00	\$300.00
<b>Construction Phase Review Fee:</b>	1,560	GPD	\$ 0.10	\$156.00
<b>Record Drawing Conversion Fee:</b>	1	EA.	\$ 500.00	\$500.00
<b>Pump Station Recording Fee:</b>	0	EA.	\$ 350.00	\$0.00
<b>Blanket Easement Document Recording Fee:</b>	0	EA.	\$ 150.00	\$0.00
<b>Total Due</b>				<b>\$18,428.00</b>

Total Due After 12/31/2019 = \$20,180.00

OK JC  
 12-3-19



Fees Quoted By: *Sarah Santana* Engineering Administrative Coordinator- Development Projects

Development Name  
Location  
**Road Impact Fee Schedule - Northern Beaufort County Service Area**

ITE Code	Land-Use	Enter No. of Dwellings 1,000 sq. ft., VFP, etc.	Unit	Daily Trip Generation per Unit	Primary Trips Factor	Primary Trips
<b>Residential</b>						
210	Single-Family		Dwelling	9.57	100%	
220	Apartment (Multi-Family)		Dwelling	6.72	100%	27
230	Condominiums/Townhouse		Dwelling	5.86	100%	
251-252	Senior Adult Housing		Dwelling	3.48	100%	
254-255	Assisted Living/Continuing Care Retirement Community		Beds	2.81	100%	
<b>Lodging</b>						
310-320	Hotel/Motel		Rooms	8.17	100%	
<b>Retail/Commercial/Services</b>						
412	County Park		Acres	2.28	100%	
430	Golf Course		Holes	35.74	90%	
445	Multiplex Movie Theater		Screens	146.3	90%	
491	Racquet/Tennis Club		1000 sq. ft.	14.03	90%	
492	Health/Fitness Club and/or Bowling Alley		1000 sq. ft. or lanes	32.93	56%	
820	Shopping Center/General Retail		1000 sq. ft.	42.94	56%	
841	New Car Sales		1000 sq. ft.	33.34	90%	
851	Convenience Market (no gas pumps)		1000 sq. ft.	460.05	26%	
853	Convenience Market w/ Gasoline Pumps		VFP	179.8	26%	
862	Home Improvement/Paint/Garden Store		1000 sq. ft.	29.8	50%	
881	Pharmacy/Drugstore		1000 sq. ft.	88.16	40%	
890	Furniture Store		1000 sq. ft.	5.06	90%	
912	Bank		1000 sq. ft.	148.15	40%	
931	Quality Restaurant		1000 sq. ft.	69.95	41%	
932	High-Turnover Restaurant		1000 sq. ft.	127.15	42%	
934	Fast Food Restaurant		1000 sq. ft.	496.12	31%	
941	Quick Lubrication Vehicle Shop		Service Bays	40	85%	
942	Automobile Care Center		Service Bays	12.48	85%	
947	Self-Service Car Wash		Service Bays	108	70%	
<b>Office</b>						
710	General Office Building		1000 sq. ft.	11.01	90%	
720	Medical-Dentist Office Building		1000 sq. ft.	36.13	90%	
733	Government Office Complex		1000 sq. ft.	27.92	90%	
<b>Institutional/Medical</b>						
520	Elementary School		Students	1.29	85%	
522	Middle/High School		Students	1.62	85%	
540-550	College		Students	1.2	100%	
560-561	Church/Synagogue		1000 sq. ft.	9.11	100%	
565	Day Care		1000 sq. ft.	79.26	15%	
590	Library		Employees	52.52	90%	
610	Hospital		1000 sq. ft.	17.57	100%	
620	Nursing Home		Beds	2.37	100%	
630	Clinic		1000 sq. ft.	31.45	100%	
<b>Industrial</b>						
110	General Light Industrial		1000 sq. ft.	6.97	100%	
120-140	General Heavy Industrial/Manufacturing		1000 sq. ft.	1.5	100%	
150	Warehousing		1000 sq. ft.	3.56	100%	
151	Mini-Warehouse		1000 sq. ft.	1.76	100%	

Total Vehicle Trips per Day

27

Cost per VT/D:

\$81.00

Total Road Impact Fee:

\$2,177.28

Source: ITE, Trip Generation, 7th ed., 2003; percent primary trips from ITE, Trip Generation Handbook, 2004.

Average trip rate used for daily trip generation

Sq.Ft. = Gross Square Footage

D.U. = Dwelling Units

Bays = Service Bays

V.F.P. = Vehicle Fueling Positions

+ 324.00 (Park Fee)  
2501.28 4 units  
pourt X 81.00)

\$5002.50  
PL 4/26  
5002.50

**RESOLUTION NO. 2021 / \_\_****A RESOLUTION AUTHORIZING THE COUNTY ADMINISTRATOR TO APPROVE AFFORDABLE HOUSING IMPACT FEE REDUCTIONS**

**WHEREAS**, Beaufort County Code Sec. 82-33. Provides for the Imposition, Calculation and Collection of impact fees, and

**WHEREAS**, Section 82-33 makes a provision for the waiver/reduction of impact fees that comply with certain Annual Median Income criteria, and

**WHEREAS**, The Beaufort Housing Authority has constructed certain housing which qualifies for the impact fee reductions, and

**WHEREAS**, therefore, a request has been received for a 60% reduction in the impact fees due as provided in Section 82-83, and

**WHEREAS**, The Transportation Fee to be waived/refunded will be \$2612.74. The Parks and Recreation fee to be waived/refunded will be \$388.80. This will require approximately \$3001.54 to be paid from the Affordable Housing Impact Fee allocation approved by the Council in 2019. These fees are estimates only, and Council specifically delegates to the Building and Codes Division the authority to confirm the fees when collected; and

**NOW, THEREFORE**, County Council hereby RESOLVES TO approve the waivers as specified above, and authorizes the County Administrator to undertake the fee reductions/waivers/refunds and do all things necessary or helpful for implementing same.

**IT IS SO ORDERED!**

COUNTY COUNCIL OF BEAUFORT COUNTY

By: \_\_\_\_\_  
Joe Passiment, Chairman

ATTEST:

\_\_\_\_\_  
Sarah Brock, Clerk to Council

**RESOLUTION NO. 2021 / \_\_****A RESOLUTION AUTHORIZING THE COUNTY ADMINISTRATOR TO APPROVE AFFORDABLE HOUSING IMPACT FEE REDUCTIONS**

**WHEREAS**, Beaufort County Code Sec. 82-33. Provides for the Imposition, Calculation and Collection of impact fees, and

**WHEREAS**, Section 82-33 makes a provision for the waiver/reduction of impact fees that comply with certain Annual Median Income criteria, and

**WHEREAS**, Hilton Head Regional Habitat for Humanity has constructed certain housing which qualifies for the impact fee reductions, and

**WHEREAS**, therefore, a request has been received for a 100% reduction in the impact fees due as provided in Section 82-83, and

**WHEREAS**, the Transportation Fee to be waived/refunded will be \$9008.00. The Library Fee to be waived/refunded will be \$3,744.00. The Parks and Recreation fee to be waived/refunded will be \$5,016.00. This will require approximately \$17,768.00 to be paid from the Affordable Housing Impact Fee allocation approved by the Council in 2019. These fees are estimates only, and Council specifically delegates to the Building and Codes Division the authority to confirm the fees when collected; and

**NOW, THEREFORE**, County Council hereby **RESOLVES TO** approve the waivers/reductions/refunds as specified above, and authorizes the County Administrator to undertake the fee reductions and do all things necessary or helpful for implementing the reductions.

**IT IS SO ORDERED!**

COUNTY COUNCIL OF BEAUFORT COUNTY

By: \_\_\_\_\_  
Joe Passiment, Chairman

ATTEST:

\_\_\_\_\_  
Sarah Brock, Clerk to Council



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 20.

<b>ITEM TITLE:</b>
<b>A RESOLUTION AUTHORIZING THE COUNTY ADMINISTRATOR TO EXECUTE ANY AND ALL NECESSARY DOCUMENTS FOR THE ACCEPTANCE OF PROPERTIES ENCUMBERING THE ROAD RIGHT OF WAY FOR KLINE CIRCLE</b>
<b>MEETING NAME AND DATE:</b>
Public Facilities Committee Meeting 11-15-2021
<b>PRESENTER INFORMATION:</b>
Jared Fralix, P.E., Assistant County Administrator, Engineering (5 Minutes)
<b>ITEM BACKGROUND:</b>
The County has been maintaining many roads for over 20 years with an assumed prescriptive right of way referred to as “legacy roads”. Right of Way staff have been working with property owners to perfect the right of way on “legacy roads” by requesting formal conveyance of ROW from associated property owners.
<b>PROJECT / ITEM NARRATIVE:</b>
Kline Circle is (~1700 LF) located off Keans Neck Road in Sheldon. Property owners associated with this road have requested to donate ROW to the County. This ROW conveyance will help perfect County ownership of legacy roads.
<b>FISCAL IMPACT:</b>
N/A
<b>STAFF RECOMMENDATIONS TO COUNCIL:</b>
Staff recommends acceptance of ROW associated with Kline Circle
<b>OPTIONS FOR COUNCIL MOTION:</b>
Motion to either accept/deny ROW associated with Kline Circle <i>Next Step – Public hearing for Resolution at County Council Meeting</i>



**A RESOLUTION AUTHORIZING THE COUNTY ADMINISTRATOR TO EXECUTE ANY AND ALL NECESSARY DOCUMENTS FOR THE ACCEPTANCE OF PROPERTIES ENCUMBERING THE ROAD RIGHT OF WAY FOR KLINE CIRCLE**

**WHEREAS**, the property owners abutting and encumbering all or a portion of the right of way shown and described as Kline Circle, more particularly described on Exhibit A attached hereto and incorporated herein ("ROW"); and

**WHEREAS**, the aforementioned property owners have requested to have the ROW conveyed to Beaufort County ("County"); and

**WHEREAS**, the County desires to accept the ROW in order to perfect right of way on County maintained roads for current road maintenance and future improvements such as rocking or paving; and

**WHEREAS**, it is in the best interest of the Kline Circle community and the County to accept the properties from the property owners and perfect the right of way.

**NOW, THEREFORE, BE IT RESOLVED** that Beaufort County Council hereby authorizes the County Administrator to execute any and all necessary documents for the acceptance of properties encumbering the road right of way for Kline Circle.

**ADOPTED** this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_.

COUNTY COUNCIL OF BEAUFORT COUNTY

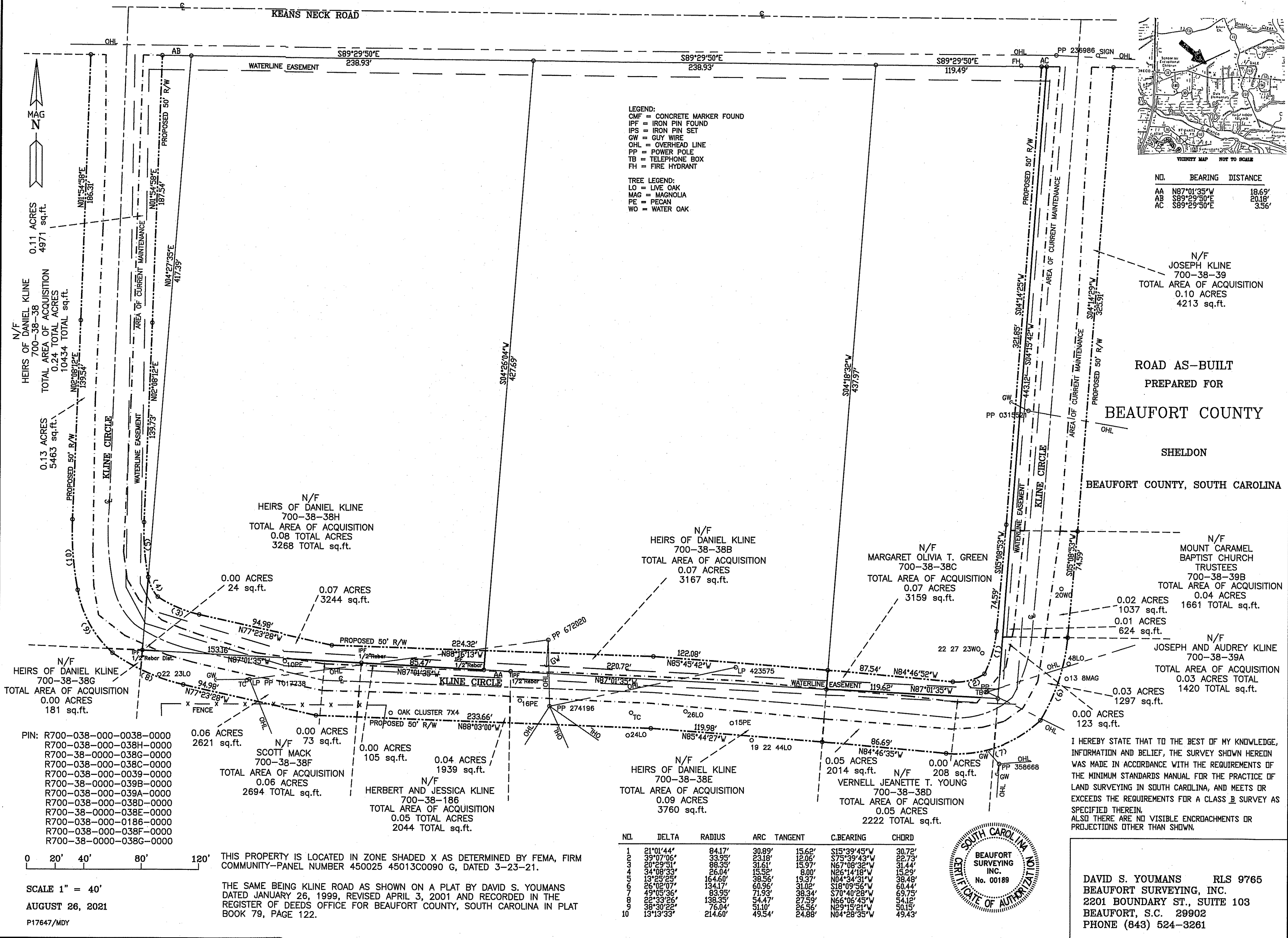
By: \_\_\_\_\_  
Joseph Passiment, Chairman

ATTEST:

\_\_\_\_\_  
Sarah W. Brock, Clerk to Council

Exhibit A

Item 20.



I HEREBY STATE THAT TO THE BEST OF MY KNOWLEDGE, INFORMATION AND BELIEF, THE SURVEY SHOWN HEREON WAS MADE IN ACCORDANCE WITH THE REQUIREMENTS OF THE MINIMUM STANDARDS MANUAL FOR THE PRACTICE OF LAND SURVEYING IN SOUTH CAROLINA, AND MEETS OR EXCEEDS THE REQUIREMENTS FOR A CLASS B SURVEY AS SPECIFIED THEREIN. ALSO THERE ARE NO VISIBLE ENCROACHMENTS OR PROJECTIONS OTHER THAN SHOWN.

DAVID S. YOUMANS RLS 9765  
BEAUFORT SURVEYING, INC.  
2201 BOUNDARY ST., SUITE 103  
BEAUFORT, S.C. 29902  
PHONE (843) 524-3261





## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 21.

<b>ITEM TITLE:</b>
A RESOLUTION SUPPORTING FEDERAL FLOOD MITIGATION ASSISTANCE REIMBURSABLE GRANT PROGRAMS
<b>MEETING NAME AND DATE:</b>
Executive Committee – December 6, 2021
<b>Presenter Information:</b>
Pamela Cobb, Disaster Recovery Coordinator – Alternate Neil Desai, Public Works Director (5 Minutes)
<b>ITEM BACKGROUND:</b>
Beaufort County recognizes the need to assist Beaufort County residents with the opportunity to federal/state mitigation programs that will assist in mitigating repetitive loss properties in unincorporated Beaufort County. Mitigation Grant Programs are provided to authorized applicants to assist in the elevation of a residence located in the jurisdiction of unincorporated Beaufort County to reduce or eliminate the risk of repetitive flood damage to buildings and structures insurable under the Nation Flood Insurance Program (NFIP).
<b>PROJECT / ITEM NARRATIVE:</b>
Beaufort County desires to promote citizen participation by creating a Flood Mitigation Assistance Program and permitting grant funds to be reimbursed through this program.
<b>FISCAL IMPACT:</b>
The funding source for this program will come from the general fund. This program requires \$750,000 to be available in order to initially cover the costs of the citizen's project, whereby the costs of the project will ultimately be reimbursed by the Federal or State entity.
<b>STAFF RECOMMENDATIONS TO COUNCIL:</b>
Staff recommends approval of the Resolution to fund the Flood Mitigation Assistance Program.
<b>OPTIONS FOR COUNCIL MOTION:</b>
Motion to approve the recommendation of the Resolution to fund the Flood Mitigation Assistance Program. Motion to deny the recommendation of the Resolution to fund the Flood Mitigation Assistance Program. <i>(Next Steps – Go before full council for determination on Resolution December 13, 2021)</i>

**A RESOLUTION SUPPORTING FEDERAL FLOOD MITIGATION ASSISTANCE  
REIMBURSABLE GRANT PROGRAMS**

**WHEREAS**, Beaufort County (“County”) recognizes the need to provide for and to assist with the applications for and distribution of funds from federal programs (“Federal Funding”) for the purpose of assisting with the cost to elevate certain structures above the base flood elevation which are located in the Special Flood Hazard Area; and

**WHEREAS**, the Federal Funding is for the purpose of Flood Mitigation, Hazard Mitigation or Building Resilient Infrastructure and Communities to assist in the South Carolina’s efforts to reduce or eliminate the risk of repetitive flood damage to buildings and structures insurable under the National Flood Insurance Program; and

**WHEREAS**, when a resident is the fee simple owner of a home in the unincorporated area of the County (“Recipient”) and has a need for assistance in the elevation of their home located in the Special Flood Hazard Area, then Recipient may be eligible to receive assistance from Federal Funding; and

**WHEREAS**, when the Federal Funding entity approves Recipient to receive assistance, the Federal Funding entity requires that Grant Funds be reimbursed through a government entity; and

**WHEREAS**, the County is a government entity and desires to promote Recipient participation by creating a Flood Mitigation Assistance Program and allocating General Fund dollars for the purpose of reimbursing Grant Funds in an amount not to exceed \$750,000 at any one time; and

**NOW, THEREFORE, BE IT RESOLVED**, by Beaufort County Council agrees to support federal flood mitigation assistance reimbursable grant programs and allocating General Fund dollars in an amount not to exceed \$750,000.

ADOPTED this \_\_\_\_ day of \_\_\_\_\_ 2021.

COUNTY COUNCIL OF BEAUFORT COUNTY

By: \_\_\_\_\_  
Joseph Passiment, Chairman

ATTEST:

By: \_\_\_\_\_  
Sarah Brock, Clerk to Council



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

<b>ITEM TITLE:</b>
A RESOLUTION TO ADOPT THE BEAUFORT COUNTY FLOOD MITIGATION ASSISTANCE POLICY
<b>MEETING NAME AND DATE:</b>
Executive Committee – December 13, 2021
<b>Presenter Information:</b>
Jared Fralix, Assistant County Administrator – Engineering Pamela Cobb, Disaster Recovery Coordinator – Alternate (5 Minutes)
<b>ITEM BACKGROUND:</b>
Beaufort County recognizes the need to provide for and to assist with the applications for and distribution of funds from federal mitigation programs for the purpose of assisting with the cost to elevate certain structures above the base flood elevation who have incurred repetitive loss due to flooding.
<b>PROJECT / ITEM NARRATIVE:</b>
County staff to oversee the implementation of applications from homeowners, who have been awarded by a mitigation grant program, meet the requirements per the Beaufort County Flood Mitigation Policy, and the reimbursement process of the project.
<b>FISCAL IMPACT:</b>
No fiscal impact.
<b>STAFF RECOMMENDATIONS TO COUNCIL:</b>
Staff recommends approval of the resolution to adopt the Beaufort County Flood Mitigation Assistance Policy.
<b>OPTIONS FOR COUNCIL MOTION:</b>
Motion to approve a resolution to adopt the Beaufort County Flood Mitigation Assistance Policy. Motion to deny a resolution to adopt the Beaufort County Flood Mitigation Assistance Policy. <i>(Next Steps – Go before full council for determination on Resolution, December 13, 2021.)</i>

## RESOLUTION 2021/\_\_\_\_\_

### A RESOLUTION TO ADOPT THE BEAUFORT COUNTY FLOOD MITIGATION ASSISTANCE POLICY

**WHEREAS**, Beaufort County (“County”) recognizes the need to provide for and to assist with the applications for and distribution of funds from federal programs (“Federal Funding”) for the purpose of assisting with the cost to elevate certain structures above the base flood elevation which are located in the Special Flood Hazard Area of unincorporated Beaufort County; and

**WHEREAS**, the Federal Funding is for the purpose of Flood Mitigation, Hazard Mitigation or Building Resilient Infrastructure and Communities to assist in South Carolina’s efforts to reduce or eliminate the risk of repetitive flood damage to buildings and structures insurable under the National Flood Insurance Program; and

**WHEREAS**, when a resident is the fee simple owner of a home in the unincorporated area of the County (“Recipient”) and has a need for assistance in the elevation of their home located in the Special Flood Hazard Area, then Recipient may be eligible to receive assistance from Federal Funding; and

**WHEREAS**, when the Federal Funding entity approves Recipient to receive assistance, the Federal Funding entity requires that Grant Funds to be reimbursed through a government entity; and

**WHEREAS**, the County, a government entity, desires to adopt a Flood Mitigation Assistance Policy, as provided in “Exhibit A” attached hereto and incorporated herein by reference, to establish the policies and procedures in order to promote citizens to take proactive and preventive actions to avoid future flooding of their homes by being the government entity in which the Grant Funds can be reimbursed through as required by the Federal Funding entity.

**NOW THEREFORE, BE IT RESOLVED**, that the County Council of Beaufort County adopts the Flood Mitigation Assistance Policy as provided in Exhibit A attached hereto.

Adopted this \_\_\_\_\_ day of \_\_\_\_\_, 2021.

COUNTY COUNCIL OF BEAUFORT COUNTY

\_\_\_\_\_  
Joseph F. Passiment

Attest:

\_\_\_\_\_  
Sarah W. Brock

**BEAUFORT COUNTY  
FLOOD MITIGATION ASSISTANCE POLICY**

The purpose of this Flood Mitigation Assistance Policy (“Policy”) is to assist citizens in being able to mitigate or significantly reduce repetitive loss to their fee simple owned property.

**1. DEFINITIONS.** The following terms are defined as follows:

- (A) “*County*”. A government entity, Beaufort County, a subdivision of the State of South Carolina.
- (B) “*Effective Date*”. The date the County and Authorized Entity have approved as the date the Recipient may begin the Project.
- (C) “*Authorized Entity*”. The federal or state entity providing Grant Funds including, but not limited to, the Federal Emergency Management Agency as an agency of the United States Department of Homeland Security, South Carolina Emergency Management Division, or Department of Natural Resources of the State of South Carolina.
- (D) “*Grant Funds*”. The funds granted by the Authorized Entity to be reimbursed to Recipient for the sole purpose of completing the Project.
- (E) “*Recipient*”. A citizen of Beaufort County, and the fee simple owner of the Property, pursuing the assistance of the Authorized Entity in order to obtain Grant Funds through a mitigation grant program.
- (F) “*Project*”. The construction, reconstruction, repair, or remodel of the Recipient’s Property as approved by the Authorized Entity.
- (G) “*Project Cost*”. The costs and fees required to complete the project in its totality, whereby such fees and cost have been approved by FEMA.
- (H) “*Property*”. The dwelling and the real property located in unincorporated Beaufort County owned fee simple by Recipient, said dwelling shall be occupied by Recipient and is considered Recipient’s primary residency.

**2. APPLICABILITY.** This Policy applies to all Projects which have been submitted by Recipient to Authorizing Entity and have received written approval from Authorized Entity that the Project meets Authorized Entity’s terms and conditions of the mitigation grant program. A Recipient shall adhere to all of the terms, conditions and requirements of this Policy.

**3. REQUIRED DOCUMENTS.** In addition to any and all documents required by Authorized Entity, the Recipient shall execute a “County Grant Fund Agreement” consistent with and similar to “Exhibit A” attached hereto and incorporated herein by reference. The County Grant Fund Agreement may be amended from time to time to meet the requirements of County Administration, state laws or federal laws. The Recipient shall provide or execute any and all documents as required by this Policy and the County Grant Fund Agreement.

**4. PROJECT COST.** The Recipient is solely responsible for the payment of any cost or fees associated with the Project that exceeds the Grant Funds amount, regardless if the excess fees or costs are

unforeseeable or unexpected. The County shall not be responsible for, or be requested to pay, any costs associated with or required in order to complete the Project.

**5. REQUIRED FINANCIAL VERIFICATION.** Prior to initiating any portion of the Project or expending any monies in preparation to initiate the Project, the Recipient shall submit to the County proof of financing in an amount equal to, or greater than, the Project Cost. Any and all contractors shall be required to secure a General Contractor Bond valued at one hundred (100%) percent of the Project Cost. The Recipient shall adhere to all financial verification requirements as agreed to in the County Grant Fund Agreement.

**6. PERIOD OF PERFORMANCE.** The period of performance shall start on the Effective Date and end on the designated date as determined by the Authorized Entity ("Performance Period"). All costs must be incurred during the Performance Period. Any costs incurred prior to or after the Performance Period shall not be reimbursable and shall be at the sole expense of the Recipient, regardless of whether said cost would have been reimbursable during the Performance Period.

**7. PROGRESS REPORTS.** The Recipient shall submit a written progress report to the County every sixty (60) days, starting on the Effective Date ("Progress Report"). The Progress Report shall describe the status of Recipient's performance since the preceding report and the progress expected to be made in the next successive period. Each report shall describe Recipient's activities by reference to the work that has been initiated or completed, shall include a statement of expenses incurred, and a financial statement from a bank or lending service. A Progress Report is required even if there has been no activity.

**8. COSTS DURING PERFORMANCE PERIOD.** Recipient shall be solely responsible for making all payments to contractors and subcontractors, and any other fees or costs associated with the Project during the Performance Period. The fees and costs subject to this Section include any and all unforeseeable or unexpected fees or costs that may occur.

**9. DISTRIBUTION OF GRANT FUNDS.** The County shall only distribute Grant Funds to Recipient after the requirements established in this Policy have been fulfilled and all of the terms and conditions of the County Grant Fund Agreement have been completed, including but not limited to, the construction of the building is complete, and a Certificate of Occupancy is provided to the County. Distribution of Grant Funds shall only occur one (1) time, any costs or fees not included in the one-time distribution shall be at the Recipient's cost.

(A) *Invoice Review.* The Recipient shall submit to the Provider a summary of invoices, actual copies of invoices, proof of payment, and an affirmation statement from the contractor or subcontractor at the time of submittal. The County shall review the aforementioned documents and communicate in writing to Recipient any discrepancies, concerns, or unapproved items.

(B) *Distribution of Grant Funds.* Following the invoice review process, Grant Funds shall be submitted by County to the Authorized Entity in order to obtain the Grant Funds. Upon receipt of Grant Funds from the Authorized Entity, the County shall remit the Grant Funds to the Recipient.

(C) *Non-Appropriation.* Notwithstanding any provision of this Policy or any agreement, the Recipient shall agree that in the event sufficient appropriations, grants, or monies are not granted by Beaufort County Council to fund the Flood Mitigation Assistance Program, any and all obligations of the County would terminate without further obligation of County.



## EXHIBIT A

COUNTY OF BEAUFORT	)	
	)	
STATE OF SOUTH CAROLINA	)	GRANT FUND AGREEMENT

**THIS GRANT FUND AGREEMENT** (“Agreement”) is made and entered into this \_\_\_\_ day of \_\_\_\_\_, 2021 (“Effective Date”) by and between **Beaufort County, a political subdivision of the State of South Carolina**, (“Provider”) and \_\_\_\_\_ (“Recipient”). The Provider and Recipient hereinafter will collectively be referred to as the “Parties”.

**WHEREAS**, the Provider applied to a Federal Emergency Management Agency’s (“FEMA”) Flood Mitigation Assistance Grant (“FMA Grant”) program pursuant to the Congressional appropriation for Fiscal year 2017; and

**WHEREAS**, the purpose of FMA Grant is to assist in the State of South Carolina’s efforts to reduce or eliminate the risk of repetitive flood damage to buildings and structures insurable under the National Flood Insurance Program (“NFIP”); and

**WHEREAS**, the Recipient desires to eliminate the risk of repetitive flood damage by renovating, or demolishing and rebuilding a home owned by Recipient and located at (*insert address of Property*); and

**WHEREAS**, Recipient received FMA Grant approval and FEMA has confirmed a federal share in the amount of (*insert dollar amount of Grant Funds*) (\$\_\_\_\_\_) (“Grant Funds”) is being granted to demolish and rebuild the home on the Property (“Project”); and

**WHEREAS**, FEMA requires that Grant Funds be reimbursed through a government entity; and

**WHEREAS**, the Provider, a government entity, desires to promote citizens to take all proactive and preventive actions available to avoid future flooding of their homes.

**NOW, THEREFORE**, the Parties agree to abide by the terms and conditions as follows:

**10. PROPERTY.** Subject to terms and conditions herein, Recipient is the fee simple owner of the real property located at (*insert address of Property*) and further described in “Exhibit B” attached hereto and incorporated herein by reference, collectively the “Property”.

**11. PROJECT.** The Recipient during the application process has provided specific plans for construction, reconstruction, repair or remodel of the Property. The plans as shown and further described in “Exhibit C”, attached hereto and incorporated herein by reference, have been reviewed and approved by FEMA, and all actions required to complete the plans are collectively hereinafter referred to as the “Project”.

**12. PROJECT COST.** The Recipient submitted the required documents to FEMA pursuant to the FMA Grant program. The approved Project’s total cost is in the amount of (*insert dollar amount of Project*) (\$\_\_\_\_\_) (“Project Cost”), and FEMA has agreed to reimburse the Grant Funds to the Recipient.

(A) *Associated Costs.* The Recipient is solely responsible for the payment of any cost associated with the Project that exceed the Grant Funds amount, regardless if the excess costs are unforeseeable or unexpected. The Provider shall not be responsible for, or be requested to pay, any costs associated with or required in order to complete the Project.

**13. REQUIRED FINANCIAL VERIFICATION.** Prior to initiating any portion of the Project or expending any monies in preparation to initiate the Project, the Recipient shall submit to the Provider proof of financing in an amount equal to the Project Cost. Acceptable documents for proof of financing include:

- i. A Letter of Credit from a lender; or
- ii. Proof of Funds letter from the bank showing the Recipient possesses monies equal to the Project Cost. The cash funds must be held in a single escrow account.

The Provider reserves the right to request any documents, certifications, or reports from the Recipient in order to verify the Recipient's financial stability.

(A) *Contractors.* Recipient shall require that a general contractor, or if no general contractor than any contractors associated with the Project, secure a General Contractor Bond valued at one hundred percent (100%) of the Project Cost. A copy of the aforementioned bond shall be delivered to the Provider prior to the initiation of the Project.

**14. PERIOD OF PERFORMANCE.** The period of performance shall start on the Effective Date and end on (*Insert Date*), hereinafter the "Performance Period". All costs must be incurred during the Performance Period. Any costs incurred prior to the Effective Date shall not be reimbursable, and shall be at the sole expense of the Recipient.

**15. PROGRESS REPORTS.** The recipient shall submit a written progress report to the Provider every sixty (60) days, starting on the Effective Date of this Agreement ("Progress Report"). The Progress Report shall describe the status of Recipient's performance since the preceding report and the progress expected to be made in the next successive period. Each report shall describe Recipient's activities by reference to the work that has been initiated or completed, shall include a statement of expenses incurred, and a financial statement from a bank or lending service.

A Progress Report is required even if there has been no activity. Insufficient Progress Reports may be rejected by the Provider, and Provider can request an updated Progress Report immediately.

**16. COMPLIANCE WITH FEMA and FMA.** The Recipient shall follow all guidelines, conditions, terms, and regulations set forth in the agreement between the County and federal entity attached hereto and incorporated by reference as "Exhibit C".

**17. DISTRIBUTION OF GRANT FUNDS.** The Recipient shall be solely responsible for making all payments to contractors and subcontractors associated with this project. The Parties agree that the distribution of Grant Funds shall occur only after all terms and conditions have been satisfied, following the requirements established in this Section have been fulfilled, the construction of the building is complete, and a Certificate of Occupancy is provided to the Provider. The Parties agree that the distribution of Grant Funds shall only occur one (1) time after all requirements established in this Section have been fulfilled.

(A) *Submittal of Invoices for Approval.* The Recipient shall submit to the Provider a complete summary of invoices, actual copies of invoices, proof of payment, and an affirmation statement from the contractor or subcontractor at the time of submittal; hereinafter collectively the "Submittal Packet". The Submittal Packet shall be submitted with the following items completed:

- i. Summary of Invoices. The summary shall be submitted in a table format and contain the following: (1) date the cost incurred; (2) name of the vendor or contractor; (3) the amount owed; (4) amount paid; and (5) date of payment. The Recipient shall sign the Summary of Invoices and acknowledge that all items being submitted have been paid in full.

- ii. Invoices. A copy of any and all invoices associated with the costs stated on the Summary of Invoices. Each invoice shall be signed by the contractor and Recipient.
- iii. Proof of Payment. The Recipient shall provide a copy of the cleared check written to the Contractor for the costs as shown on the Invoice or receipt when a credit or debit card is used as payment.
- iv. Affirmation Statement. Attached to any individual Invoice shall be a notarized statement from the Contractor affirming the following: (1) the work described in the invoice has been performed; (2) the charges are accurate as provided; and (3) the invoice has been paid in full by the Recipient.

(B) *Approval for Distribution of Grant Funds*. The Provider shall review the Submittal Packet within thirty (30) days of receipt. If there are discrepancies, concerns, or unapproved items; then the Provider shall provide written notice to the Recipient immediately. The Provider shall not be responsible in any manner for any delay or failure to obtain Grant Funds due to failure by Recipient to comply with any request of Provider during the approval for distribution of Grant Funds process.

(C) *Distribution of Grant Funds*. Following the invoice approval process set forth in this Section and Pursuant to (“*Name of Exhibit C Agreement to be inserted*”), Grant Funds shall be submitted by the Provider to FEMA in order to obtain the Grant Funds. Upon receipt of Grant Funds from FEMA, the Provider shall remit the Grant Funds by way of check, mailed to the address stated in Section 9 of this Agreement, and in the name of the Recipient.

**18. RISK OF LOSS OR DAMAGE.** In case the Property is destroyed wholly or partially by fire or other casualty prior to completion of the Project the Provider shall be released of any and all terms and obligations established in this Agreement.

**19. DEFAULT.** If Recipient or Provider fails to perform any provision of this Agreement, the other party may elect to seek any remedy provided in equity as a result of such failure to perform, including an action for specific performance of Recipient’s obligations under this Agreement, or terminate this Agreement with a five (5) day written notice.

(A) *Termination*. The Provider reserves the right to terminate this Agreement without cause at any time. Provider reserves the right to terminate if funding is not approved.

**20. NON-APPROPRIATION.** Notwithstanding any provision of this Agreement, the Parties hereto agree that in the event sufficient appropriations, grants, or monies are not granted by Beaufort County Council to fund the Flood Mitigation Assistance Program, this Agreement shall terminate without further obligation of County.

**21. INDEMNIFICATION.** Recipient hereby agrees to indemnify and hold harmless Provider against and from any and all claims or property damage, or personal injury, arising out of or with respect to the Project or from any activity, work, or thing done, permitted or suffered by Recipient, contractor, subcontractor, or other third party in, on or about the Property.

**22. NOTICES.** All notices, requests, demands or other communications required or permitted to be given hereunder shall be in writing and shall be addressed and delivered by electronic mail, by certified mail, return receipt requested, or by Federal Express, or by hand delivery by reputable courier, to each party

at the addresses set forth below. Any such notice, request, demand, or other communication shall be considered given or delivered, as the case may be, on the date of receipt. Rejection or other refusal to accept or inability to deliver because of changed address of which proper notice was not given shall be deemed to be receipt of the notice, request, demand, or other communication. By giving prior written notice thereof, any party may from time to time and at any time change its address for notices hereunder. Legal counsel for the respective parties may send to the other party any notices, requests, demands, or other communications required or permitted to be given hereunder by such party.

To Provider:  
Beaufort County  
Attn: \_\_\_\_\_  
Post Office Box 1228  
Beaufort, SC 29901-1228

To Recipient:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

### 23. OTHER PROVISIONS.

- (A) ***Time of Essence.*** Time is and shall be of the essence in this Agreement.
- (B) ***Mutual Cooperation.*** The Parties shall cooperate with each other, and will use all reasonable efforts to cause the fulfillment of the terms and conditions of this Agreement.
- (C) ***Independent Parties.*** It is mutually agreed that Provider is independent of Recipient, and as such Recipient shall exercise complete control over the actions performed by contractors or subcontractors. Additionally, the Parties mutually agree that this Agreement is for the sole purpose as set forth in this Agreement and does not establish an agency or employment relationship.
- (D) ***Disputes.*** All claims, disputes, and controversies arising out of or in relation to the performance, interpretation, application, or enforcement of this Agreement, including but not limited to breach thereof, shall be first submitted to an agreed upon mediator. The disputing party shall be responsible for cost of mediation.
- (E) ***Entire Agreement.*** This Agreement contains the entire agreement between the Parties pertaining to the subject matter contained herein.
- (F) ***Amendment or Modification.*** This Agreement cannot be amended or modified orally or by a single party. No amendment or modification to this Agreement shall be valid unless in writing and signed by both Parties to this Agreement.
- (G) ***Binding Nature and Assignment.*** This Agreement shall bind the Parties and their respective successors in interest as may be permitted by law. Neither party to this Agreement may assign their rights or obligations arising under this Agreement without the prior written consent of the other party.
- (H) ***No Third Party Beneficiaries.*** This Agreement is intended solely for the benefit of the Parties and not for the benefit of any other person or entity.
- (I) ***Counterparts.*** This Agreement may be executed in multiple counterparts, and all such executed counterparts shall constitute the same agreement. The Parties agree that this Agreement may be communicated by use of a fax or other electronic means, such as electronic mail and the internet, and that the signatures, initials and handwritten or typewritten modifications to any of the foregoing shall be deemed

valid and binding upon the Parties as if the original signatures, initials and handwritten or typewritten modifications were present on the documents.

(J) **Captions.** The section headings appearing in this Agreement are for convenience of reference only and are not intended to any extent for the purpose, to limit or define the test of any section or any subsection hereof.

(K) **Severability.** If any provision of this Agreement is determined by a court of competent jurisdiction to be invalid or unenforceable, the remainder of this Agreement shall nonetheless remain in full force and effect.

(L) **Waiver.** No waiver of any provision of this Agreement shall be effective unless in writing and signed by the party waiving its rights. No delay or omission by either party to exercise any right or remedy it has under this Agreement shall impair or be construed as a waiver of such right or remedy. A waiver by either party of any covenant or breach of this Agreement shall not constitute or operate as a waiver of any succeeding breach of the covenant or of any other covenant.

(M) **Applicable Law.** This Agreement is enforceable in the State of South Carolina and shall in all respects be governed by, and construed in accordance with, the substantive Federal laws of the United States and the laws of the State of South Carolina. Any claims for default, non-performance or other breach shall be filed in Beaufort County, South Carolina.

**THIS IS A LEGALLY BINDING AGREEMENT. BOTH RECIPIENT AND PROVIDER SHALL SEEK FURTHER ASSISTANCE IF THE CONTENTS ARE NOT UNDERSTOOD. BOTH RECIPIENT AND PROVIDER ACKNOWLEDGE RECEIPT OF A COPY OF THIS AGREEMENT.**

**IN WITNESS WHEREOF**, and in acknowledgement that the parties hereto have read and understood each and every provision hereof, the Parties have caused this Agreement to be executed on the date first written above.

**WITNESSES:**

\_\_\_\_\_  
 \_\_\_\_\_

**PROVIDER:**

\_\_\_\_\_  
 \_\_\_\_\_  
*Beaufort County Administrator*

**WITNESSES:**

\_\_\_\_\_  
 \_\_\_\_\_

**RECIPIENT:**

\_\_\_\_\_  
 \_\_\_\_\_  
 (Print Recipient's Name)

**EXHIBIT A**

*(Insert Grant Fund Approval)*

**EXHIBIT B**

***Legal Description as provided for in the Warranty Deed recorded in the Beaufort County Register of Deeds in Book \_\_\_\_ at Page \_\_\_\_.***

*(Insert legal description)*

Beaufort County Tax Reference: *(Insert Tax ID Number)*

**EXHIBIT C**

*(Insert Agreement between Federal Funding Entity and County)*

Organization		Event/Project	Amount Requested	Received Last Year	Amount Received	% of Ask	Name	Notes
1	Greater Beaufort-Port Royal CVB	Tourism Marketing FY 2021-2022	\$ 175,000	\$ 229,300	\$ 175,000	100.0%	Robb Wells	Fully Funded; Budget is for Marketing Only
2	Lean Ensemble Theater	Tourism marketing 2020-2021	\$ 6,000	\$ 1,500	\$ 850	14.2%	Blake White	Funds for Chamber Dues
4	Friends of the Spanish Moss Trail	Spanish Moss Trail Visitor Marketing Video Phase 2	\$ 3,950	\$ 2,000	\$ 3,950	100.0%	Sissy Perryman	Fully Funded; Budget is to Complete Video that was partially funded in 2020
5	Daufuskie Island Historical Foundation	Brochure printing	\$ 6,000	\$ -	\$ 4,000	66.7%	Nancy Ludtke	Funds for Brochure Printing
6	HHI Concourse d'Elegance	Motoring Festival	\$ 40,000	\$ -	\$ 24,755	61.9%	Lindsey Harrell	Funding for Social Media and Chamber Digital Ads
7	Arts Center of Coastal Carolina	Tourism Marketing of the Unincorporated Areas of Beaufort County	\$ 6,000	\$ 4,000	\$ 3,050	50.8%	Andrea Gannon	Funds for Print Ads in Experience Charleston, The Post and Courier and Footlight Payers in Charleston
8	Friends of Port Royal Cypress Wetlands*	Rack cards/Guided tours/Birthday for the birds	\$ 5,600	\$ -	\$ 2,400	42.9%	Bernadette Clayton	Funds for Marketing the Guided Naturalist Tours
9	HHI Land Trust	Fort Howell Historical Tourism marketing	\$ 20,000	\$ -	\$ 3,600	18.0%	Linda Hyslop	Funds for Hiring PR Firm to assist with Marketing
10	Beaufort Area Sports Council	Beaufort area sports marketing and sales	\$ 40,000	\$ -	\$ 40,000	100.0%	Christian Kata	Fully Funded; Budget is for Marketing Only
11	HHI Symphony Orchestra	HHSO Marketing	\$ 20,000	\$ -	\$ 5,250	26.3%	Alan Jordan	Funds for Airport Kiosk, Radio Advertising and Social Media
12	Hilton Head Hospitality Association	Hilton Head Wine and Food Festival	\$ 10,000	\$ 10,000	\$ 10,000	100.0%	Jeff Gerber	Fully Funded; Budget is for Marketing Only
13	Beaufort Festivals & Events Advertising	Gullah Fest/Shrimp Fest/Taste of Beaufort	\$ 48,500	\$ -	\$ 48,500	100.0%	Thomas Hicks	Fully Funded due to Large Number of Room Nights Produced by Events
14	HHI Sea Turtle Patrol*	Sea Turtle GREEN carpet event	\$ 7,800	\$ -	\$ -	0.0%	Heather Malia Rath	Not Funded; No Tourism Production Impact
15	Beaufort County Black Chamber of Commerce	Cultural Tourism Marketing/Events	\$ 155,000	\$ 32,000	\$ 32,000	20.6%	Larry Holman	Allocated what County Council Awarded during Last Cycle
16	Beaufort Film Society	Beaufort International Film Festival (16th)	\$ 30,000	\$ 20,000	\$ 30,000	100.0%	Ron Tucker	Fully Funded due to Large Number of Room Nights Produced by Event
17	Hilton Head Choral Society	Marketing for Tourist/Visitor Development	\$ 4,000	\$ -	\$ -	0.0%	Margie Lechowicz	Not Funded; All Marketing/Advertising Proposed is Local
18	Beaufort County Parks and Rec*	Burton Wells Pickleball complex	\$ 617,400	\$ -	\$ 140,000	22.7%	Shannon Loper	Partially Funded to Assist with Development of Pickleball
19	SC Lowcountry & Resort Islands	Promotion of Beaufort Country & the Lowcountry	\$ 49,400	\$ 40,000	\$ 49,400	100.0%	Peach Morrison	Fully Funded; Budget is for Marketing Only
20	Port Royal Sound Foundation	Family field trip marketing campaign/Fleet of kayaks	\$ 52,380	\$ 50,250	\$ 52,380	100.0%	Kat Armstrong	Fully Funded due to Large Number of Room Nights Produced by Programs
21	Historic Bluffton Foundation	Heyward House summer kitchen roof	\$ 31,044	\$ 17,000	\$ 31,044	100.0%	Kelly Graham	Fully Funded to Replace Roof on Welcome Center
22	Native Island Business and Community Affairs Association (NIBCAA)	HHI Gullah Celebration	\$ 41,800	\$ 20,000	\$ 37,326	89.3%	Courtney Young	Funding for TV Advertising, Billboards and Social Media
23	Historic Mitchelville Freedom Park	Holiday Tree Lighting, Freedom Day, Marketing and Site Prep / Design for Juneteenth Celebration	\$ 35,000	\$ 20,000	\$ 35,000	100.0%	Ahmed Ward	Fully Funded; Budget is for Marketing Only
24	HHI Airport*	HHI Inbound Awareness Campaign	\$ 60,000	\$ -	\$ -	0.0%	Jon Rembold	Not Funded due to No Tourism Impact
25	Gullah Traveling Theater	A Gullah Kinfolk Christmas Wish	\$ 30,990	\$ -	\$ 19,795	63.9%	Anita Singleton-Prather	Funding for Facility Rental, Equipment Rental for Video and Video Production
26	Penn Center	Heritage Festival; Operations & Marketing	\$ 60,000	\$ 24,800	\$ 19,500	32.5%	Annette Sumpter	Funding for Video Production, Equipment Rental for Video and Print Ads
28	Lowcountry Golf Course Owners Association	Golf Tourism Broadcast Golf Channel TV Campaign	\$ 20,000	\$ 7,500	\$ 10,000	50.0%	Barry Fleming	Funding for Golf Channel Ads
3	Coastal Discovery Museum	Cultural & EcoTourism Program	\$ 34,500	\$ 15,000	\$ 22,200	64.3%	Natalie Hefter / Rex Garniewicz	Funding for Web Site, Exhibits and Special Event Marketing
Total Applications: 27			\$ 1,610,364	\$ 379,000	\$ 800,000	49.7%		
AMOUNT AVAILABLE:			\$ 800,000					
Amount Remaining:			\$ -					

\*First Time Applicants



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 24.

**ITEM TITLE:**

Acceptance of Community Development Block Grant for the Stuart Point Road Pathway Project

**MEETING NAME AND DATE:**

County Council – December 13, 2021

**PRESENTER INFORMATION:**

Jared Fralix, Assistant County Administrator - Engineering

(2 mins)

**ITEM BACKGROUND:**

On September 13, 2021, County Council approved the application to the Department of Commerce for a Community Development Block Grant in the amount of \$200,000 for the Stuart Point Road Pathway project as a match to the 2018 One Cent Sales Tax.

**PROJECT / ITEM NARRATIVE:**

The Department of Commerce has granted a Community Development Block Grant award to Beaufort County in the amount of \$200,000 for the Stuart Point Road Pathway project.

**FISCAL IMPACT:**

Revenue of \$200,000 for the Stuart Point Road Pathway project associated with the 2018 One Cent Sales Tax Program. Revenue will be distributed in fund 4705.

**STAFF RECOMMENDATIONS TO COUNCIL:**

Staff recommends acceptance of the Community Development Block Grant for the Stuart Point Road Pathway Project in the amount of \$200,000.

**OPTIONS FOR COUNCIL MOTION:**

Motion to approve/deny the acceptance of the Community Development Block Grant for the Stuart Point Road Pathway Project in the amount of \$200,000.



Department of Commerce  
Grants Administration  
1201 Main Street, Suite 1600  
Columbia, South Carolina 29201

**GRANT AWARD**

Grantee: Beaufort County

Date of Award: November 22, 2021

Grant Title: Stuart Point Pathway

Category: Special Projects

Grant Period: 11/2021– 11/2023

Award Amount: \$200,000

Grant Number: 4-SP-21-001

In accordance with the provisions of Title I of the Housing and Community Development Act of 1974 (P.L. 93-383), as amended and on the basis of the grant application submitted, Grants Administration hereby awards funds to the above named Grantee, in the amount shown above, for the activities specified in the application and within the purposes and categories authorized. The acceptance of this award creates a contract between the State of South Carolina and the Grantee legally binding the Grantee to carry out the activities set forth in the approved grant application in accordance with the terms and conditions of the Grant Agreement. Contracts to be paid in whole or in part with funds from this grant must be submitted to Grants Administration for approval prior to execution. The special conditions for this grant, if any, are as follows:

**See attached Special Condition(s) for Community Development Block Grant (CDBG) # 4-SP-21-001.**

This contract shall become effective, as of the date of award, upon return of two copies of this grant award which have been signed in the space provided below. Both copies must have original signatures and must be returned within 15 days from the date above.



Lisa Kalsbeck  
Assistant Director, Federal Programs

**ACCEPTANCE FOR THE GRANTEE:**



Signature of Official with authority to execute this contract

December 1, 2021  
Date

Eric H. Greenway  
Typed or Printed Name and Title of Authorized Official

ATTEST:



Signature of Elected City or County Council Member

Alice G. Howard  
Signature of Elected City or County Council Member

CFDA: 14.228

**Community Development Block Grant (CDBG) Special Conditions**  
**Grantee: Beaufort County - Grant #4-SP-21-001**

- 1) The Grantee must provide a written certification from the engineer/architect that all applicable federal accessibility requirements have been met prior to grant closeout.
- 2) A technical assistance visit must be conducted with the grant administrator, local government officials, and subrecipient (if applicable) within 120 days of grant award.
- 3) The CDBG Program Start-up Checklist must be completed and submitted to Grants Administration within 120 days.
- 4) The project must be substantially underway within 6 months of grant award. The Grantee must take appropriate administrative actions to implement the project in a timely manner to insure that the project is programmatically closed within 24 months of grant award. Failure to begin the project or implement it in a timely manner may result in grant termination.
- 5) The Grantee must take appropriate actions to ensure that the local matching funds are documented as expended prior to or prorata with the drawdown of CDBG funds, unless otherwise approved by Grants Administration. CDBG funds may be held if all of the match cannot be documented prior to the final 10% of CDBG funds being drawn.
- 6) Cost savings should be prorated among the funding sources, unless otherwise approved. Cost overruns will be a local responsibility.
- 7) Grants Administration recommends sending the CDBG administrator, rehabilitation inspector or other appropriate personnel to CDBG Implementation and Compliance training sponsored by Grants Administration.

Unless otherwise specified, the Grantee must submit all required information set forth above to Grants Administration within 120 days of grant award.

**STATE OF SOUTH CAROLINA  
COMMUNITY DEVELOPMENT BLOCK GRANT PROGRAM**



**GRANT AGREEMENT**

The Grant Award serves as the signature page for this Community Development Block Grant (CDBG) Program Grant Agreement for Beaufort County - CDBG #4-SP-21-001. Three identical Grant Award pages have been included for signature by appropriate representatives of the Grantee. Two of the Grant Award pages, with the required original signatures, must be returned **within 15 days**. The third Grant Award page with original signatures should be maintained in the Grantee's files along with this Grant Agreement.

**STATE OF SOUTH CAROLINA  
COMMUNITY DEVELOPMENT BLOCK GRANT PROGRAM**

**GRANT AGREEMENT**

Upon receipt by the State of the appropriately signed Grant Award, the State agrees to provide to the Grantee the Federal Assistance under Title I of the Housing and Community Development Act of 1974, as amended, subject to the terms and conditions of this Grant Agreement, applicable laws, regulations and all other Federal and State requirements now or hereafter in effect. This Grant Agreement is effective with respect to such Assistance as of the date of the Grant Award and consists of the Grant Award hereto attached, together with the State approved Application, including any Assurances, certifications, maps, schedules or other submissions made, or to be made, with respect thereto.

1. **Definitions:** Except to the extent modified or supplemented by this Grant Agreement, any term defined in Title I of the Housing and Community Development Act of 1974, as amended, shall have the same meaning when used herein. The following terms are specifically used in this Grant Agreement:
  - (a) Act means Title I of the Housing and Community Development Act of 1974, as amended.
  - (b) Agreement means this Grant Agreement, as described herein and in any amendments or supplements hereto.
  - (c) Application means the application for the Assistance which has been approved by the State and is incorporated as part of this Agreement.
  - (d) Assistance means the CDBG grant funds provided, or to be provided, to the Grantee by the State, pursuant to this Agreement.
  - (e) Assurances when capitalized, means the certifications and assurances submitted pursuant to the Act and other requirements of the State.
  - (f) CDBG means Community Development Block Grant.
  - (g) Grantee means each entity designated as the recipient of the Assistance in the Grant Award and signing the acceptance provision of the Grant Award.
  - (h) HUD means U.S. Department of Housing and Urban Development.
  - (i) Program means the community development program, project, or other activities, including the administration thereof, funded in whole or in part, under this Agreement.
  - (j) State means the State of South Carolina, or that agency, agency division, or Office of State government which has been delegated the responsibility for administering the Community Development Block Grant program for the State of South Carolina, as appropriate.
2. **CDBG Program Requirements:** Grantees must comply with the requirements of Title I of the Housing and Community Development Act of 1974, as amended; with 24 CFR Part 570, Subpart I Community Development Block Grant State Program Regulations, and Subpart C, Eligible Activities; as well as the policies and procedures of the South Carolina CDBG program as

included in the CDBG Program Implementation Manual or other State program documents applicable to the Assistance.

3. Federal and State Laws: This Agreement renders the Grantee responsible for compliance with all Federal or State laws, Executive Orders, and regulations applicable to the receipt and administration of Assistance provided under this Agreement. Such laws, Executive Orders, and regulations include, but are not limited to, the following:
  - (a) Financial Management Requirements: The Grantee must comply with the applicable requirements of the Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards found in 2 CFR Part 200. The Grantee must make available to the State or Federal government, or their representatives, all records related to the matters and activities of the Program for the purposes of audit and inspection.
  - (b) Environmental Review: The Grantee is required to assume responsibility for environmental review decision making in accordance with Section 104(f) of the Act; 24 CFR Part 58, Environmental Review Procedures for Title I CDBG Programs; and 40 CFR Parts 1500-1508, National Environmental Policy Act regulations.
  - (c) Equal Employment Opportunity: In accordance with Executive Order 11246 and other applicable Federal and State laws, Executive Orders and regulations, the Grantee cannot discriminate on the basis of race, color, religion, sex, national origin, familial status, or disability in the admission of or access to, treatment in or employment in, the Program.
  - (d) Non-Discrimination Under Title VI of the Civil Rights Act of 1964: This Agreement is subject to the requirements of Title VI of the Civil Rights Act of 1964 (P.L.88-352), as amended, and HUD regulations with respect thereto, including the regulations under 24 CFR Parts 100 - 180.
  - (e) Ineligible Contractors Under Executive Order 11246 and State Regulations: The Grantee agrees that it will refrain from entering into any contract or modification subject to Executive Order 11246 of September 24, 1965, with a contractor debarred from, or who has not demonstrated eligibility for, government contracts and federally assisted construction contracts pursuant to the Executive Order. The Grantee will carry out such sanctions and penalties for violation of the equal opportunity clause as may be imposed upon contractors and subcontractors by the State pursuant to Part II, Subpart D of the Executive Order. In addition, the Grantee may not award contracts to any contractors who are ineligible to receive contracts under any applicable regulations of the State.
  - (f) "Section 3" Compliance in the Provision of Training, Employment and Business Opportunities: This Agreement is subject to the requirements of Section 3 of the Housing and Urban Development Act of 1968 (12 USC 1701u), as amended, the implementing regulations found in 24 CFR Part 135, State regulations issued pursuant thereto, and any applicable rules and orders of the State issued thereunder prior to the State authorization of the Grant Award.
  - (g) South Carolina Illegal Immigration Reform Act: The Grantee is required to comply with the South Carolina Illegal Immigration Reform Act (signed June 4, 2008) requiring verification of lawful presence in the United States of any alien eighteen years of age or older who has applied for State or local public benefits, as defined in 8 U.S.C. Section 1621, or for Federal public benefits, as defined in 8 U.S.C. Section 1611.

- (h) Federal Labor Standards Provisions: Except with respect to the rehabilitation of residential property designed for residential use for less than eight units, the Grantee and all contractors engaged under contracts in excess of \$2,000 for the construction, completion or repair of any building or work financed in whole or in part with Assistance provided under this Agreement, shall comply with Federal requirements pertaining to such contracts and the applicable requirements of the regulations of the State, governing the payment of wages and the ratio of apprentices and trainees to journeymen, provided, that if wage rates higher than those required under such regulations are imposed by the State or local law, nothing hereunder is intended to relieve the Grantee of its obligation, if any, to require payment of the higher rates. The Grantee shall cause or require to be inserted in full, in all such contracts subject to such regulations, provisions meeting the requirements of 29 CFR Part 5.5.
- (i) Subcontracting with Small and Minority Firms, Women's Business Enterprise and Labor Surplus Areas: It is national policy to award a fair share of contracts to disadvantaged business enterprises (DBEs), small business enterprises (SBEs), minority business enterprises (MBEs) and women's business enterprises (WBEs). Accordingly, affirmative steps must be taken to assure that DBEs, SBEs, MBEs and WBEs are utilized when possible as sources of supplies, equipment, construction and services. Affirmative steps shall include the following:
- (1) Including qualified DBEs, SBEs, MBEs and WBEs on solicitation lists;
  - (2) Assuring that DBEs, SBEs, MBEs and WBEs are solicited whenever they are potential sources;
  - (3) Whenever economically feasible, dividing total requirements into smaller tasks or quantities so as to permit maximum participation by DBEs, SBEs, MBEs and WBEs;
  - (4) Where the requirement permits, establishing delivery schedules which will encourage participation by DBEs, SBEs, MBEs and WBEs;
  - (5) Using the services and assistance of the Small Business Administration, Minority Business Development Agency, the State Office of Small and Minority Business Assistance, the U.S. Department of Commerce and the Community Services Administration as required; and
  - (6) Requiring the subcontractor, if any, to take the affirmative actions outlined in (1) – (5) above.
- (j) Fair Housing: The Grantee is prohibited from taking any action that in any way makes unavailable or denies a dwelling to any person because of race, color, religion, sex, national origin, familial status or disability. The Grantee must comply with Title VIII of the Civil Rights Act of 1968, as amended, Executive Order 11063, and the South Carolina Fair Housing Law.
- (k) Fair Housing Plans: The Grantee will provide the State with a Fair Housing Plan which includes a written description of the action(s) the Grantee will undertake to affirmatively further fair housing. The State reserves the right to withhold all or a portion of the Assistance until such plan has been received and approved.
- (l) Age Discrimination Act of 1975: The Grantee shall ensure that no person shall be excluded from participation, be denied program benefits, or be subject to discrimination, on the basis of age under any part of the Program.
- (m) Section 504 of the Rehabilitation Act of 1973: Every recipient of Federal funds, including subgrantees, must comply with Section 504 of the Rehabilitation Act of 1973, as amended.

The Grantee agrees that no otherwise qualified individual with disabilities shall, solely by reason of his disability, be denied the benefits, or be subjected to discrimination under any part of the Program.

- (n) Acquisition and Relocation: In carrying out the Program, the Grantee is required to comply with the requirements of the Uniform Relocation Assistance and Real Property Acquisition Act of 1970, as amended, and the implementing HUD regulations at 49 CFR Part 24 and 24 CFR Part 570.
  - (o) Lead Based Paint Hazards: The construction or rehabilitation of residential structures with the Assistance is subject to the HUD Lead-Based Paint regulations at 24 CFR Part 35.
  - (p) Compliance with Air and Water Acts: (Applicable to construction contracts and related subcontracts exceeding \$100,000) The Program is subject to the requirements of the Clean Air Act, as amended; 42 USC §7401 et seq.; the Federal Water Pollution Control Act, as amended; 33 USC §1251 et seq.; and the regulations of the Environmental Protection Agency with respect thereto at 40 CFR Part 15, as amended from time to time, and the South Carolina Stormwater Management and Sediment Reduction Act.
4. Personnel: The Grantee agrees that it has the necessary personnel, or will hire the necessary personnel, to carry-out the activities described in the Application. All persons employed must be fully qualified and authorized to carry out such activities under such Federal, State and local laws, as may be applicable.
  5. Amendments: Any changes to this Agreement, including changes in activities and budgets of the Application, must be approved in writing by the State and shall be incorporated in written amendment(s) to this Agreement, except as may be provided in the following section "Budget Changes."
  6. Budget Changes: Any change in a line item of the budget must have prior written approval by the State. This applies to the collective total of the line item, regardless of the source of funds. However, no increase for the budget item *General Administration* is allowed without prior written approval by the State, regardless of the amount or percentage of increase or the source of funds. Without written approval from the State, the maximum amount which may be budgeted for general administration from the Assistance is ten (10%) of the total activity costs, excluding administration costs.
  7. Funding Overruns/Underruns: The Grantee must meet its funding commitment. In the event there are cost underruns in the Program, the savings will be prorated among all funding sources unless otherwise approved by the State, a regulatory requirement by another Federal funding agency supersedes, or the savings could be accrued to another grant program funded by the State. In the event there are cost overruns in the Program, this Agreement creates no obligation on the part of the State to provide funds for the cost overruns.
  8. Incurrence of Costs and Release of Funds: The Grantee may not obligate or expend the Assistance on any activities described in the Application, except those exempted under 24 CFR Part 58, until the State has approved the Grantee's Request for Release of Funds and related certifications. In no case, without prior written approval by the State, may the Grantee incur costs or expend funds to be paid or reimbursed with the Assistance. Funds obligated or expended without the State's written approval shall be considered ineligible costs and are not eligible for payment with the Assistance.

9. Reporting Requirements: The Grantee agrees to complete and submit all reports, in such form and according to such schedule, as may be required by the State. Further, the Grantee agrees to require any subrecipients or contractors to submit reports that may be required and to incorporate such language in its agreements.
10. Program Progress: Significant activity must be underway within six months of the date of this Agreement unless otherwise approved by the State. If, within six months of the date of this Agreement, substantial progress is not being made, the State reserves the right to terminate this Agreement and require the repayment of any of the Assistance provided to the Grantee under this Agreement. Determination of substantial progress will be based on the Grantee's compliance with the Grantee's Target Plan or Implementation Schedule, as approved by the State.
11. Project Completion: The Program is expected to be completed within 24 months of the date of Grant Award. Unless otherwise defined by the State, completion is the final documentation of funds expended, accomplishment of CDBG National Objectives, and receipt by the State of the Grantee's Close-out Report. Future funding may be contingent upon timely and acceptable compliance with this Agreement. Extensions to Program periods may be made at the discretion of the State.
12. Change of the Use of Real Property: Unless the Grantee obtains prior written approval from the State, there may be no change in the use or planned use of any real property acquired in whole or in part or improved in whole or in part using CDBG funds in excess of \$150,000. This requirement shall apply from the date the CDBG funds are first spent for the property or the improvement until five years after final close-out of the CDBG grant from which the Assistance was provided.
13. Copyright: Except as otherwise provided in this Agreement, the Grantee or any third party or contractor paid through the Assistance is free to copyright any books, publications, or other copyright able materials developed in the course of or under the Program. However, HUD and the State reserve a royalty-free, non-exclusive, and irrevocable license to reproduce, publish or otherwise use, and to authorize others to use for Federal government and State purposes: the copyright in any work developed under the Program or through a contract under this Agreement; and any rights of copyright to which a subgrantee or contractor purchases ownership with Assistance support. The Federal government's rights and the State's rights identified above must be conveyed to the publisher, and the language of the publisher's release form must ensure the preservation of these rights.
14. Prohibition Against Payments of Bonus or Commission: The Assistance provided under this Agreement shall not be used in the payment of any bonus or commission for the purpose of obtaining State approval of the Application for such Assistance, or State approval of applications for additional assistance, or any other approval or concurrence of the State required under this Agreement, the Act or HUD regulations with respect thereto. However, reasonable fees for bona fide technical, consultational, managerial or other such services, other than actual solicitation, are not hereby prohibited if otherwise eligible as Program costs.



15. Ownership: Title to property acquired in whole or in part with the Assistance shall be vested in the Grantee, subject to divestment by the State, where its use for approved community development activities is discontinued. The Grantee should exercise caution in the use, maintenance, protection, and preservation of such property. The Grantee must submit, in the form prescribed by the State, a list of all non-expendable property acquired with the Assistance pursuant to this Agreement at the time of the final close-out of the CDBG grant from which the Assistance was provided, and the Grantee must agree to be subject to audit by the State or its duly authorized representatives for verification of the information. A physical inventory must be conducted every two years for the life of the property.
16. Maintenance of Records: Records for non-expendable property purchased totally or partially with Assistance provided under the Agreement and all other pertinent grant records including financial records, supporting documents, and statistical records must be retained for three years after Grants Administration closes the State Program Year's allocation with HUD. However, if any litigation, claim, or audit is started before the expiration of the maintenance period, then all records must be retained for five years after the litigation, claim, or audit is resolved.
17. Access: All records with respect to all matters covered by this Agreement shall be made available at any time for audit and inspection by HUD, the State, or their representatives, upon request.
18. Freedom of Information: The Grantee acknowledges and agrees that this Agreement and certain other information related to the CDBG award are or may be subject to public disclosure to the South Carolina Freedom of Information Act and that the Grantee and the State are required to comply with the provisions of that Act.
19. Confidential Information: Any reports, information, data, etc., given to, prepared by, or assembled by the Grantee under this Agreement, which the State requests to be kept confidential, shall not be made available to any individual or organization by the Grantee without prior written approval of the State.
20. Obligations of Grantee with Respect to Certain Third Party Relationships: The Grantee shall remain fully obligated under the provisions of the Agreement notwithstanding the Grantee's designation of, or contract with, any third party or parties for the undertaking of all or any part of this Agreement. The Grantee shall require that any such third party comply with all applicable requirements of this Agreement.
21. Conflict of Interest: The Grantee shall comply with the more restrictive provisions of 2 CFR Part 200.112, and 200.113, 24 CFR Part 570.611, or Section 8-13-100 et. seq. of the Code of Laws of South Carolina, 1976, as applicable.
22. Personal Information: The Grantee shall comply with the SC Financial Identity Fraud and Identity Protection Act in protecting any personally identifiable information.
23. Sanctions: If the Grantee does not comply with the provisions of this Agreement, the State may take any or all of the following actions: require repayment of all or a portion of any Assistance provided; require the Grantee to take corrective actions to comply with this Agreement; cancel, terminate, or suspend, in whole or in part, the Assistance in this Agreement; or, refrain from extending any further assistance to the Grantee until such time as the Grantee is in full compliance.

24. Liability: The Grantee understands that the Department of Commerce accepts no liability for the Project nor any responsibility other than its agreement to provide the Grantee the Grant funds for the Project as approved in the original application, insofar as such funds are expended in accordance with the terms and conditions of this Agreement. During the term of the Grant, the Grantee should maintain tort liability insurance or shall have a self-funded and excess liability program with coverage amounts sufficient to meet the limits set forth under the SC Torts Claims Act in Section 15-78-120, as may be amended.

The Grantee agrees to repay to the State, upon demand by the State, monies equal to the amount of the Assistance provided to the Grantee pursuant to this Agreement which the State has determined that the Grantee, its agents or assigns, have caused to be advanced and/or expended in violation of this Agreement or in violation of any Federal, State, or local laws or policies governing the use of CDBG funds.

This provision also applies to any monies determined by the State to be income generated by funds provided to the Grantee pursuant to this Agreement. The State is the sole arbiter in all matters concerning the eligibility of costs and the interpretation of the provisions of law, statute and policy, as well as the terms and conditions of this Agreement, except to the extent that the State's prerogative may be superseded by the Federal government or by a court of law having jurisdiction over such matters.

25. Termination of the Agreement: The State may, upon written notification to the Grantee, terminate all or part of the Assistance to be provided pursuant to this Agreement for failure to comply with the terms and conditions of this Agreement. This Agreement may also be terminated, in whole or in part, with the mutual consent of the State and the Grantee, upon written notification.
26. Terms and Conditions: The State reserves the right to add or delete terms and conditions of this Agreement as may be required by revisions and additions to changes in the Federal regulations and laws governing the State's CDBG Program.
27. Severability: If any provision of this Agreement is or becomes illegal, invalid, or unenforceable in any respect, the legality, validity, and enforceability of the other provisions of this Agreement shall not in any way be affected or impaired thereby.
28. Venue: In addition to the previously cited Federal laws and regulations, this Grant Agreement is also made under and shall be construed in accordance with the laws of the State. By executing this Agreement, the Grantee also agrees to submit to the jurisdiction of the courts of the State or the appropriate Federal courts for all matters arising or to arise hereunder.



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 25.

<b>ITEM TITLE:</b>
Approval of purchase of two lots adjacent to the old courthouse from the GG Dowling Family Trust
<b>MEETING NAME AND DATE:</b>
Council, December 13, 2021, 5:30 P.M.
<b>PRESENTER INFORMATION:</b>
Kurt Taylor, County Attorney <i>5 mins</i>
<b>ITEM BACKGROUND:</b>
Council previously authorized entering into mediation to reach an agreeable purchase price for the lots
<b>PROJECT / ITEM NARRATIVE:</b>
The County Administrator and County Attorney's Office participated in a mediation on December 7, resulting in an agreed upon purchase price of \$1.9 million, plus a letter of acknowledgement of a charitable contribution of equity of approximately \$400,000.
<b>FISCAL IMPACT:</b>
Funding source needs to be identified, general fund surplus s recommended. <i>\$1,900,000.00 requested</i>
<b>STAFF RECOMMENDATIONS TO COUNCIL:</b>
Approval
<b>OPTIONS FOR COUNCIL MOTION:</b>
(Motion to approve/deny purchase of two lots adjacent to the old courthouse from the GG Dowling Family Trust

**Beaufort County Council  
2022 Committee Meeting Schedule**

**Executive Committee**

<i>Date</i>	<i>Time</i>	<i>Location</i>
January 3, 2022	1:00 p.m.	Council Chambers
February 7, 2022	1:00 p.m.	Council Chambers
March 7, 2022	1:00 p.m.	Council Chambers
April 4, 2022	1:00 p.m.	Council Chambers
May 2, 2022	1:00 p.m.	Council Chambers
June 6, 2022	1:00 p.m.	Council Chambers
No Meeting in July		
August 1, 2022	1:00 p.m.	Council Chambers
September 6, 2022 *	1:00 p.m.	Council Chambers
October 3, 2022	1:00 p.m.	Council Chambers
November 7, 2022	1:00 p.m.	Council Chambers
No Meeting in December		

**Community Services Committee**

<i>Date</i>	<i>Time</i>	<i>Location</i>
January 3, 2022	2:00 p.m.	Council Chambers
February 7, 2022	2:00 p.m.	Council Chambers
March 7, 2022	2:00 p.m.	Council Chambers
April 4, 2022	2:00 p.m.	Council Chambers
May 2, 2022	2:00 p.m.	Council Chambers
June 6, 2022	2:00 p.m.	Council Chambers
No Meeting in July		
August 1, 2022	2:00 p.m.	Council Chambers
September 6, 2022 *	2:00 p.m.	Council Chambers
October 3, 2022	2:00 p.m.	Council Chambers
November 7, 2022	2:00 p.m.	Council Chambers
No Meeting in December		

**Natural Resources Committee**

<i>Date</i>	<i>Time</i>	<i>Location</i>
January 3, 2022	3:00 p.m.	Council Chambers
February 7, 2022	3:00 p.m.	Council Chambers
March 7, 2022	3:00 p.m.	Council Chambers
April 4, 2022	3:00 p.m.	Council Chambers
May 2, 2022	3:00 p.m.	Council Chambers
June 6, 2022	3:00 p.m.	Council Chambers
No Meeting in July		
August 1, 2022	3:00 p.m.	Council Chambers
September 6, 2022	3:00 p.m.	Council Chambers
October 3, 2022	3:00 p.m.	Council Chambers
November 7, 2022	3:00 p.m.	Council Chambers
No Meeting in December		

**Finance Committee**

<i>Date</i>	<i>Time</i>	<i>Location</i>
January 18, 2022 *	2:00 p.m.	Council Chambers
February 22, 2022 *	2:00 p.m.	Council Chambers
March 21, 2022	2:00 p.m.	Council Chambers
April 18, 2022	2:00 p.m.	Council Chambers
May 16, 2022	2:00 p.m.	Council Chambers
June 20, 2022	2:00 p.m.	Council Chambers
No Meeting in July		
August 22, 2022	2:00 p.m.	Council Chambers
September 19, 2022	2:00 p.m.	Council Chambers
October 17, 2022	2:00 p.m.	Council Chambers
November 21, 2022	2:00 p.m.	Council Chambers
No Meeting in December		

**Public Facilities Committee**

<i>Date</i>	<i>Time</i>	<i>Location</i>
January 18, 2022 *	3:00 p.m.	Council Chambers
February 22, 2022 *	3:00 p.m.	Council Chambers
March 21, 2022	3:00 p.m.	Council Chambers
April 18, 2022	3:00 p.m.	Council Chambers
May 16, 2022	3:00 p.m.	Council Chambers
June 20, 2022	3:00 p.m.	Council Chambers
No Meeting in July		
August 22, 2022	3:00 p.m.	Council Chambers
September 19, 2022	3:00 p.m.	Council Chambers
October 17, 2022	3:00 p.m.	Council Chambers
November 21, 2022	3:00 p.m.	Council Chambers
No Meeting in December		

**Agenda Item Deadlines:** Items are due no later than the Tuesday before the scheduled meeting.

\* Tuesday in lieu of Monday.

Effective:

## County Council of Beaufort County 2022 Meeting Schedule

Date	Location	CAUCUS	REGULAR SESSION
		Time	Time
January 10, 2022	Council Chambers	5:00 p.m.	6:00 p.m.
January 24, 2022	Council Chambers	5:00 p.m.	6:00 p.m.
February 14, 2022	Council Chambers	5:00 p.m.	6:00 p.m.
February 28, 2022	Hilton Head Island Auditorium	5:00 p.m.	6:00 p.m.
March 14, 2022	Council Chambers	5:00 p.m.	6:00 p.m.
March 28, 2022	St. Helena Elementary School	5:00 p.m.	6:00 p.m.
April 11, 2022	Council Chambers	5:00 p.m.	6:00 p.m.
April 25, 2022	Buckwalter Rec Center	5:00 p.m.	6:00 p.m.
May 9, 2022	Council Chambers	5:00 p.m.	6:00 p.m.
May 23, 2022	Whale Branch Early College	5:00 p.m.	6:00 p.m.
June 13, 2022	Council Chambers	5:00 p.m.	6:00 p.m.
June 27, 2022	Hilton Head Island Auditorium	5:00 p.m.	6:00 p.m.
July 11, 2022	Council Chambers	5:00 p.m.	6:00 p.m.
August 15, 2022	Council Chambers	5:00 p.m.	6:00 p.m.
September 12, 2022	Council Chambers	5:00 p.m.	6:00 p.m.
September 26, 2022	St. Helena Elementary School	5:00 p.m.	6:00 p.m.
October 10, 2022	Council Chambers	5:00 p.m.	6:00 p.m.
October 24, 2022	Council Chambers	5:00 p.m.	6:00 p.m.
November 14, 2022	Buckwalter Rec Center	5:00 p.m.	6:00 p.m.
December 12, 2022	Council Chambers	5:00 p.m.	6:00 p.m.

Hilton Head High Auditorium, 70 Wilborn Road, Hilton Head Island, SC 29926  
 St. Helena Elm., 1025 Sea Island Parkway, St. Helena Island, SC 29920  
 Whale Branch Early College, 169 State Hwy S 7-549, Seabrook, SC 29940  
 Buckwalter Rec., 905 Buckwalter Pkwy, Bluffton, SC 29910



BEAUFORT COUNTY GOVERNMENT-  
PUBLIC WORKS & MAINTENANC  
84 SHANKLIN RD  
BEAUFORT, SC 29901

November 5, 2021

Attention: NEIL DESAI

Dear Neil,

We would like to thank you for your interest in our company and our products and are pleased to quote the following for your consideration.

**One (1) New Cat Model: 120 Motorgraders with all standard equipment in addition to the additional specifications listed below:**

**STOCK NUMBER:** M26500      **SERIAL NUMBER:** 0Y9A00857      **YEAR:** 2021      **SMU:** 22

We wish to thank you for the opportunity of quoting on your equipment needs. This quotation is valid for 30 days, after which time we reserve the right to re-quote. If there are any questions, please do not hesitate to contact me.

Sincerely,

Wiley Murph  
Machine Sales Representative

#### STANDARD EQUIPMENT

**POWERTRAIN** -Air cleaner, dual stage dry type radial -seal with service indicator through -messenger and automatic dust ejector  
-Air-to-air after cooler (ATAAC) -Brakes, oil disc, four-wheel, hydraulic -Demand fan, hydraulic -Differential, lock/unlock, auto -Drain, engine oil, ecology -Engine: --C7.1 diesel, with automatic -engine derate, and idle control. --Optimized VHP Plus --Engine ECO mode  
--Fuel-water separator -Parking brake, multi-disc, sealed -and oil cooled -Priming pump, fuel -Transmission, 8 speed forward and 6  
-speed reverse, power shift, direct -drive

**ELECTRICAL** -Alarm, back-up -Alternator, -Batteries, maintenance free -Electrical system, 24V

**OPERATOR ENVIRONMENT** -Display, digital speed and gear -Gauge, machine level -Gauges (analog) inside the cab -(includes fuel, articulation, engine -coolant temp, engine RPM, and -hydraulic oil temp) -Ladders, cab, left and right side -Message operator information display, -meter, hour, digital -ISO 6394 (70% fan speed) -Throttle control, electronic -

**SAFETY AND SECURITY** -Clutch, circle drive slip -Doors, engine compartment, -Ground level engine shutdown -Seat belt, retractable 76.2 (3")

**TIRES, RIMS, AND WHEELS** -A partial allowance for tires -on 254mm x 609mm (10"x24") multi- piece rims is included in the base -machine weight and price

**OTHER STANDARD EQUIPMENT** -CD ROM parts book -Doors, service compartment, -locking -SOS ports, engine, hydraulic, -transmission, coolant, fuel -Tool box -Fuel tank, 225 liters (59 gallon) -Radiator, cleanout access

MACHINE SPECIFICATIONS

Description	Reference No	List
120 14B MOTOR GRADER	468-2237	\$279,590.00
HVAC, BASIC,W/O AIR COMPRESSOR	510-8447	\$5,900.00
CAMERA, REAR VISION, LVR	492-0617	\$2,665.00
SEAT COMFORT, SUSPENSION, LVR	461-3554	\$2,140.00
HITCH, TOWING	416-6892	\$570.00
LIGHTS,BRAKE&BKP,TURN,LED	563-2423	\$428.00
ROLL ON-ROLL OFF	0P-2265	\$320.00
DECALS, ENGLISH (U.S)	472-5087	\$0.00
JUMP START STUDS	506-4262	\$0.00
ALTERNATOR, 145 AMP	438-5768	\$0.00
MIRRORS, EXTERNAL, BASE, LVR	483-9353	\$0.00
ANTIFREEZE WINDSHIELD WASHER	0P-1939	\$0.00
FUEL ANTIFREEZE, -25C (-13F)	0P-3978	\$0.00
LANGUAGE, ENGLISH	462-6595	\$0.00
PRODUCT LINK, CELLULAR PLE742	491-5100	\$0.00
NO GRADE CONTROL TECHNOLOGY	543-0221	\$0.00
REAR PANEL W/O ACCESS DOOR	518-1195	\$0.00
STARTER, STANDARD DUTY	462-6512	\$0.00
ENGINE, STAGE V AND T4 FINAL	590-7345	\$0.00
DRAIN, GRAVITY, ENGINE OIL	422-6603	\$0.00
NO LOCK OUT	461-3545	\$0.00
GLOBAL ARRANGEMENT LVR	561-9459	\$0.00
MOLDBOARD, 12' BASIC	320-9924	\$0.00
WEATHER, STANDARD TND	467-7404	\$0.00
NO ACCUMULATORS, NO ARO, LVR	465-4422	\$0.00
FUEL FILTER, NEXT GEN	574-8803	\$0.00
GROUND LEVEL, FUELING	577-8014	\$0.00
FAN, STANDARD TND	575-7683	\$0.00
SEAT BELT	594-6359	(\$214.00)
DRAWBAR, STANDARD,HYD TIP, LVR	579-6849	(\$1,630.00)
CAB, ROPS, BASE, LVR, TND	461-3561	\$19,300.00
TIRES,14.0R24 MX XGLA2 * G2 SP	254-7904	\$7,600.00
COMFORT PACKAGE, PREMIUM, LVR	471-5352	\$3,005.00
BASE + 2 (TIP, MMS) LVR	468-2247	\$2,970.00
LIGHTS, WORKING,BASIC HAL,LVR	468-7618	\$805.00
HIGH BAR, HALOGEN, LVR, TND	573-6437	\$675.00
TOTAL LIST PRICE		\$324,124.00
SELL PRICE		\$240,994.00
STATE CONTRACT 4400025395 SELL PRICE		\$194,274.23
EXT WARRANTY		Included
NET BALANCE DUE		\$194,274.23
SC SALES TAX		\$500.00
AFTER TAX BALANCE		\$194,774.23

WARRANTY

Standard Warranty:	12 MONTHS UNLIMITED
Extended Warranty:	120-60 MO/5000 HR POWERTRAIN

Accepted by \_\_\_\_\_ on \_\_\_\_\_

\_\_\_\_\_  
Signature





SALES AGREEMENT

DATE \_\_\_\_\_ 

Item 1.

 021

Blanchard Machinery Co., 3151 Charleston Highway, Columbia, SC29202-7517 Phone: (803) 791-7100

PURCHASER	BEAUFORT COUNTY GOVERNMENT-				
STREET ADDRESS	84 SHANKLIN RD PO DRAWER 1228			<SAME>	
CITY/STATE	BEAUFORT, SC	COUNTY	BEAUFORT		
POSTAL CODE	29901	PHONE NO.	843 255 2801		
EQUIPMENT	Neil Desai				
CUSTOMER CONTACT:	PRODUCT SUPPORT Neil Desai				
INDUSTRY CODE:	COUNTY GOVERNMENT (PS92)		PRINCIPAL WORK CODE	F.O.B. AT:	
CUSTOMER NUMBER	0486000		Sales Tax Exemption # (if applicable)	N/A	
				CUSTOMER PO NUMBER	
PAYMENT TERMS: (All terms and payments are subject to Finance Company - OAC approval)					
NET PAYMENT ON RECEIPT OF INVOICE	<input type="checkbox"/>	NET ON DELIVERY	<input checked="" type="checkbox"/>	FINANCIAL SERVICES	<input type="checkbox"/> CSC <input type="checkbox"/> LEASE
CASH WITH ORDER	\$0.00	BALANCE TO FINANCE	0.00	CONTRACT INTEREST RATE	0.00
PAYMENT PERIOD		PAYMENT AMOUNT	0.00	NUMBER OF PAYMENTS	0
OPTIONAL BUY-OUT					
DESCRIPTION OF EQUIPMENT ORDERED / PURCHASED					
MAKE: CAT	MODEL: 120		YEAR: 2021		
STOCK NUMBER: M26500	SERIAL NUMBER: 0Y9A00857				
120 14B MOTOR GRADER	468-2237	ALTERNATOR, 145 AMP	438-5768	ENGINE, STAGE V AND T4 FINAL	590-7345
HVAC, BASIC,W/O AIR COMPRESSOR	510-8447	MIRRORS, EXTERNAL, BASE, LVR	483-9353	DRAIN, GRAVITY, ENGINE OIL	422-6603
CAMERA, REAR VISION, LVR	492-0617	ANTIFREEZE WINDSHIELD WASHER	0P-1939	NO LOCK OUT	461-3545
SEAT COMFORT, SUSPENSION, LVR	461-3554	FUEL ANTIFREEZE, -25C (-13F)	0P-3978	GLOBAL ARRANGEMENT LVR	561-9459
HITCH, TOWING	416-6892	LANGUAGE, ENGLISH	462-6595	MOLDBOARD, 12' BASIC	320-9924
LIGHTS,BRAKE&BKP,TURN,LED	563-2423	PRODUCT LINK, CELLULAR PLE742	491-5100	WEATHER, STANDARD TND	467-7404
ROLL ON-ROLL OFF	0P-2265	NO GRADE CONTROL TECHNOLOGY	543-0221	NO ACCUMULATORS, NO ARO, LVR	465-4422
DECALS, ENGLISH (U.S)	472-5087	REAR PANEL W/O ACCESS DOOR	518-1195	FUEL FILTER, NEXT GEN	574-8803
JUMP START STUDS	506-4262	STARTER, STANDARD DUTY	462-6512	GROUND LEVEL, FUELING	577-8014
TRADE-IN EQUIPMENT					
MODEL: _____	YEAR: _____	SN: _____	SELL PRICE		\$194,274.23
PAYOUT TO: _____	AMOUNT: _____	PAID BY: _____	EXT WARRANTY		Included
MODEL: _____	YEAR: _____	SN: _____	NET BALANCE DUE		\$194,274.23
PAYOUT TO: _____	AMOUNT: _____	PAID BY: _____	SC SALES TAX		\$500.00
MODEL: _____	YEAR: _____	SN: _____	AFTER TAX BALANCE		\$194,774.23
PAYOUT TO: _____	AMOUNT: _____	PAID BY: _____			
ALL TRADE-INS ARE SUBJECT TO EQUIPMENT BEING IN "AS INSPECTED CONDITION" BY VENDOR AT TIME OF DELIVERY OF REPLACEMENT MACHINE PURCHASE ABOVE.					
PURCHASER HEREBY SELLS THE TRADE-IN EQUIPMENT DESCRIBED ABOVE TO THE VENDOR AND WARRANTS IT TO BE FREE AND CLEAR OF ALL CLAIMS, LIENS, MORTGAGES AND SECURITY INTEREST EXCEPT AS SHOWN ABOVE.					
<input checked="" type="checkbox"/> CATERPILLAR EQUIPMENT WARRANTY			<input type="checkbox"/> USED EQUIPMENT WARRANTY		
INITIAL _____			INITIAL _____		
The customer acknowledges that he has received a copy of the Blanchard Machinery Company/Caterpillar Warranty and has read and understood said warranty. Scheduled oil sampling (S.O.S.) is mandatory with this warranty. The customer is responsible for taking oil samples at designated intervals from all power train components and failure to do so may result in voiding the warranty. Warranty applicable including expiration date where necessary: 12 MONTHS UNLIMITED 120-60 MO/5000 HR POWERTRAIN, 12 MONTH UNLIMITED			All used equipment is sold as is where is and no warranty is offered or implied except as specified here: Warranty applicable: _____ _____ _____		
CSA: _____					
NOTES: _____					

THIS AGREEMENT IS SUBJECT TO THE TERMS AND CONDITIONS ON THE REVERSE

BLANCHARD MACHINERY COMPANY		PURCHASER	
ORDER RECEIVED BY	Wiley Murph	APPROVED AND ACCEPTED ON	_____
REPRESENTATIVE		BEAUFORT COUNTY GOVERNMENT-	
		PURCHASER	
BY _____		SIGNATURE _____	
		TITLE _____	

# TERMS AND CONDITIONS

Item 1.

- 1. Binding Agreement.** By executing this Sales Agreement (the "Agreement"), Purchaser agrees to purchase from Blanchard Machinery the equipment and attachments described on the face hereof (collectively referred to herein as the "Equipment") pursuant to the terms and conditions specified in this Agreement.
- 2. Purchase of Equipment.** Blanchard Machinery Company ("Blanchard Machinery") shall have no obligation to fulfill timely orders for Equipment which are out-of-stock or otherwise unavailable, but Blanchard Machinery will promptly notify you of such unavailability or delay as soon as Blanchard Machinery becomes aware of it. Any terms and conditions contained in Purchaser's documents that are different or in addition to the terms and conditions herein, including but not limited to letters, purchase orders, or sales acknowledgements, are hereby rejected by Blanchard Machinery, are not a part of this Agreement, and shall be of no effect or binding upon Blanchard Machinery unless specifically agreed to in writing by an authorized officer of Blanchard Machinery. Failure by Blanchard Machinery specifically to object to provisions contained in such documents shall not in any way be deemed an alteration to or waiver of these terms and conditions.
- 3. Price and Other Expenses.** All prices set forth on the face of this Agreement are the purchase prices of the Equipment. Purchaser shall be responsible for all expenses relating to the Equipment purchased including but not limited to (a) any federal, state, local, foreign or provincial taxes or tariffs, now or hereafter enacted, applicable to the Equipment, as further set forth in Section 7, below; (b) standard shipping or other special transportation costs to the point of delivery specified by Purchaser; (c) all charges in the event payment from Purchaser is delinquent, including, without limitation, all costs and expenses, including attorneys' fees, of collecting any amount not paid when due hereunder; and (d) all other expenses, not included in the sale and delivery contemplated above, of whatever kind or nature, relating to special insurance requirements, the purchase, shipment, transportation, or delivery of Equipment.
- 4. Equipment Delivery.** Unless otherwise agreed, all shipments will be made by third-party carriers chosen by Blanchard Machinery or its designees, at costs, tariffs and other charges, and in accordance with terms and conditions established by Blanchard Machinery and its designees from time to time.
- 5. Risk of Loss.** The risk of loss associated with any Equipment and title passes to Purchaser upon delivery of the goods to the shipping point, FOB, subject to the reservation of a security interest to Blanchard Machinery in Section 6 of this Agreement. Blanchard Machinery shall have no liability of any kind or nature, whether for consequential or other damages for any reason whatsoever, relating to shipment of Equipment purchased by Purchaser, including but not limited to damage to the Equipment, taxes, duties, loss, theft or any illness of or personal injury to any person or property under any environmental, health or safety law.
- 6. Payment and Credit.** Purchaser shall pay for all Equipment in accordance with payment terms set forth on the face of this Agreement. Purchaser's right to purchase any Equipment is conditioned upon approval of Purchaser's credit and may be withdrawn or amended at any time by Blanchard Machinery in its sole discretion. Purchaser understands and agrees that the late fee is subject to adjustment by Blanchard Machinery. The late fee schedule is subject to change at discretion of Blanchard Machinery. The late fee schedule is as follows: \$5 fee for past due balances of \$350 to \$1,000; \$15 fee for \$1,001 to \$2,000; \$30 fee for \$2,001 to \$3,000; \$45 fee for \$3,001 to \$5,000; \$75 fee for \$5,001 to \$10,000; \$150 fee for \$10,001 to \$20,000; \$300 fee for \$20,001 to \$50,000; \$700 fee for \$50,001 to \$75,000; and \$1,100 fee for \$75,001 to \$100,000; \$1,500 fee for \$100,001 to \$200,000; \$3,000 fee for \$200,001 to \$300,000; \$4,500 fee for \$300,001 to \$500,000; \$7,500 fee for \$500,001 and above. In the event Purchaser is delinquent, Purchaser shall pay all costs of collection, including but not limited to reasonable attorneys' fees. Should Purchaser become delinquent in the payment of any sum due under this Agreement, all contractual or other obligations of Blanchard Machinery to Purchaser shall terminate without further notice to Purchaser. Blanchard Machinery retains, and Purchaser hereby grants Blanchard Machinery, a purchase money security interest in the Equipment, including all accessions to and replacements of them, to secure the payment of the purchase price of the Equipment, until Purchaser has made payment in full in accordance with the terms hereof, and Purchaser shall cooperate fully with Blanchard Machinery in executing such documents, including a Uniform Commercial Code financing statement, and accomplishing such filings and/or recordings thereof as Blanchard Machinery deems necessary for the perfection, protection and enforcement of such security interest.
- 7. Taxes and Other Charges.** Purchaser is responsible for the payment of all federal, state, local, foreign, or provincial taxes (now or hereafter enacted), fees, or charges which may be assessed or levied now or hereafter on or on account of materials sold hereunder to Purchaser. Published prices do not include such taxes, which may be added by Blanchard Machinery to the invoice where Blanchard Machinery has a legal obligation to collect them. When Purchaser claims that this transaction is not subject to any such tax, or that Purchaser is exempt, or that Blanchard Machinery is not required to collect such tax, Purchaser agrees to provide Blanchard Machinery with any documentation necessary to support such a claim and to allow Blanchard Machinery to document its decision not to collect tax(es).
- 8. Acceptance; Non-Conforming Equipment; Sole Remedy.** Purchaser agrees to accept all Equipment upon delivery to Purchaser where the Equipment is in material conformity with Blanchard Machinery's or the applicable manufacturer's published description or specifications of such Equipment. In any event, Equipment shall be deemed automatically, irrevocably and conclusively accepted without defects when Purchaser has had possession of the Equipment for five (5) days and has failed to notify Blanchard Machinery that the Equipment has been rejected and the reasons for such rejection. Purchaser's sole remedy hereunder for Blanchard Machinery's failure to deliver Equipment in material conformity with applicable published description or specifications of such Equipment shall be, at Blanchard Machinery's option, the replacement of such non-conforming Equipment with conforming Equipment, or refund of the applicable purchase price paid therefore.
- 9. Purchaser Representations and Covenants.** Purchaser shall be solely responsible for the use and disposition of the Equipment, including, without limitation, the obtaining of all permits, licenses or certificates required for the use thereof. Purchaser agrees to use the Equipment only in accordance with all laws, rules and regulations applicable thereto.
- 10. Indemnification.** Purchaser shall indemnify, defend, and hold Blanchard Machinery harmless from any and all liabilities, claims, demands, causes of action, or suits of whatever nature including, but not limited to, attorneys' fees and litigation expenses, arising from any: (a) breach by Purchaser of any representation or covenant made by Purchaser under this Agreement; (b) breach by Purchaser of any provision of this Agreement; (c) failure of Purchaser to comply with applicable environmental, health and safety laws; and (d) any use by Purchaser or third parties of the Equipment sold to Purchaser. Notwithstanding the foregoing, Purchaser shall not be liable to Blanchard Machinery for any portion of such liabilities that result from Blanchard Machinery's fraud, bad faith, or willful misconduct.
- 11. Equipment Warranties.** Some Equipment may come with limited warranties. Purchaser may obtain a copy of the applicable equipment warranty by contacting Blanchard Machinery. EXCEPT FOR THE FOREMENTIONED LIMITED WARRANTIES OF VARIOUS EQUIPMENT, TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, BLANCHARD MACHINERY DISCLAIMS ANY AND ALL REPRESENTATIONS AND WARRANTIES, WHETHER ORAL OR WRITTEN, EXPRESS OR IMPLIED, INCLUDING (WITHOUT LIMITATION) ANY IMPLIED WARRANTIES AS TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE EQUIPMENT.
- 12. Limitations on Liability.** IN NO EVENT SHALL BLANCHARD MACHINERY BE LIABLE FOR LOSS OF PROFITS, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES ARISING OUT OF ANY BREACH OF THIS AGREEMENT OR OBLIGATIONS UNDER THIS AGREEMENT, AND IN NO EVENT SHALL THE LIABILITY OF BLANCHARD MACHINERY EXCEED THE UNIT PRICE OF THE DEFECTIVE EQUIPMENT. ANY ACTION BY PURCHASER UNDER OR RELATING TO THIS AGREEMENT SHALL COMMENCE WITHIN TWELVE (12) MONTHS AFTER SUCH CAUSE OF ACTION ACCRUED. BLANCHARD MACHINERY'S LIABILITY SHALL BE LIMITED AS SET FORTH HEREIN AND OTHER PROVISIONS OF THIS AGREEMENT.
- 13. Force Majeure.** Blanchard Machinery shall not be responsible for any failure to perform the contract formed hereunder due to causes beyond its control, including, but not limited to, acts of God, pandemics, labor disputes or shortages, acts or omissions of buyer, government or judicial authorities, or military authorities, delays in transportation, or inability to obtain necessary materials or supplies, all whether foreseen or unforeseen.
- 14. Governing Law.** This Agreement shall be governed by and construed in accordance with the laws of the State of South Carolina, without regard to the choice of law provisions thereof. Any dispute or claim relating to or arising out of or in connection with this Agreement shall be finally settled by binding arbitration in Lexington County, South Carolina using the then current rules and procedures of the American Arbitration Association. Notwithstanding the foregoing, nothing herein shall preclude either party from seeking injunctive relief in any state or federal court of competent jurisdiction in Lexington County, South Carolina without first complying with the arbitration provisions of this Section, and each party hereby consents to the exclusive jurisdiction of state and federal courts in Lexington County, South Carolina for such purpose.
- 15. Product Link.** In the event any portion of the Equipment is equipped with Product Link, Customer understands data concerning this Equipment, its condition, and its operation is being transmitted by Product Link to Caterpillar and/or its dealers to better serve Customer and to improve upon Caterpillar products and services. The information transmitted may include: machine serial number, machine location, and operational data, including but not limited to: fault codes, emissions data, fuel usage, service meter hours, software and hardware version numbers, and installed attachments. Caterpillar will not sell or rent collected information to any other third party and will exercise reasonable efforts to keep the information secure. Caterpillar Inc. recognizes and respects customer privacy. Customer agrees to allow this data to be accessed by Caterpillar and/or its dealers.
- 16. Complete Agreement; Severability; Non-Waiver; No Third Party Beneficiaries.** This Agreement constitutes the entire understanding between Purchaser and Blanchard Machinery with respect to the purchase of Equipment, superseding all prior written and oral communications and understandings. If any provisions or portion of this Agreement is not given legal effect by a court of competent jurisdiction, such provisions or portions shall drop out of this Agreement and the remaining provisions and portions of this Agreement shall be construed and enforced. This Agreement shall not be interpreted or construed to confer any rights or remedies upon any third parties. Blanchard Machinery's failure to exercise any of its rights for any period shall not constitute or be deemed a waiver or forfeiture of such rights.

This instrument shall not become effective or binding upon Lessor until executed by an authorized representative of Lessor.



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 2.

<b>ITEM TITLE:</b>
APPROVAL OF APPOINTMENT
<b>MEETING NAME AND DATE:</b>
COUNTY COUNCIL MEETING <ul style="list-style-type: none"><li>DECEMBER 6, 2021</li></ul>
<b>PRESENTER INFORMATION:</b>
CHAIRMAN PASSIMENT
<b>ITEM BACKGROUND:</b>
APPOINTMENT OF CAROLYN M, BANNER Ph.D OR ANGELA SIMMONS, Ph.D <ul style="list-style-type: none"><li>PARTIAL (1st TERM) TO BEAUFORT MEMORIAL HOSPITAL BOARD OF TRUSTEES</li></ul>
<b>PROJECT / ITEM NARRATIVE:</b>
APPOINTMENT OF 1 of 2 INDIVIDUALS, CAROLYN M. BANNER, Ph.D. OR ANGELA D. SIMMONS Ph.D., TO THE BEAUFORT MEMORIAL HOSPITAL BOARD OF TRUSTEES FOR A PARTIAL TERM EXPIRING 2023.
<b>FISCAL IMPACT:</b>
N/A
<b>STAFF RECOMMENDATIONS TO COUNCIL:</b>
APPROVE, MODIFY OR REJECT
<b>OPTIONS FOR COUNCIL MOTION:</b>
MOTION TO (APPROVE, MODIFY, REJECT) APPOINTMENT OF 1 of 2 INDIVIDUALS, CAROLYN M. BANNER, Ph.D. OR ANGELA D. SIMMONS Ph.D., TO THE BEAUFORT MEMORIAL HOSPITAL BOARD OF TRUSTEES FOR A PARTIAL TERM EXPIRING 2023.



October 27, 2021

**Via United States Mail, with copy by E-Mail**

Beaufort County Council  
c/o Mr. Joseph Passiment, Chairman  
Post Office Drawer 1228  
Beaufort, South Carolina 29902

Dear Mr. Chairman and Members of Council:

In accordance with Sec. 46-27 of the Beaufort County Code of Ordinances, it is with great pleasure that the Board of Trustees for Beaufort Memorial Hospital present the following nominees for consideration by Beaufort County Council to fill the vacancy on our Board due to the resignation of Dr. Kathy McDonagh.

As part of this process, members of the Board of Trustees conducted interviews with a number of Beaufort County residents who had expressed an interest in serving. These candidates hailed from all corners of Beaufort County and all areas of industry. After substantial consideration and discussion of the Board's current weaknesses and strengths, we unanimously nominated the following two individuals for Beaufort County Council's appointment to the Beaufort Memorial Hospital Board of Trustees.

Both of these nominees (i) carry with them exceptional credentials and a documented commitment to serving those in Beaufort County, (ii) further the Board of Trustees' goal of greater racial and gender diversity on our Board, (iii) have experience in navigating the rapidly changing landscape of community health, and (iv) have expressed a dedication to identifying and addressing social disparities in healthcare. The two nominees we proudly are presenting for County Council consideration are as follows:

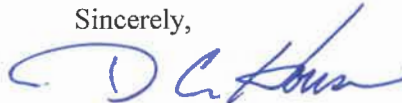
1. **Angela D. Simmons, Ph.D.** The current Vice Chancellor of Student Development at the University of South Carolina Beaufort, Angela is responsible for overseeing the health of the student body population, including academic advising, counseling and mental health services, career services, and housing and judicial affairs, as well as co-chairing the university's COVID-19 response. Further, over the last year, Angela has demonstrated her commitment to community by serving on both the Finance Committee and the Quality Improvement Committee of the Board of Trustees, during which time she has distinguished herself as an invaluable asset for Beaufort Memorial Hospital. Angela resides in the greater Bluffton area with her husband. We are honored to nominate Dr. Angela Simmons for consideration of appointment to the Beaufort Memorial Hospital Board of Trustees with such appointment to become effective upon approval by Beaufort County Council.
2. **Carolyn M. Banner, Ph.D.** Born at Beaufort Memorial Hospital and having largely resided in Beaufort County ever since, Carolyn has over twenty years of experience in higher education, counseling, program development and working with diverse populations and minority groups. An award-winning professor of community health at the University of South Carolina Salkehatchie, Carolyn has served our County and our State in various roles for the better of part of her professional life. Carolyn resides on Lady's Island, and her immediate and extended family remains connected and committed to Beaufort County. It is our true pleasure to nominate Dr. Carolyn Banner for consideration of appointment to the Beaufort Memorial Hospital Board of Trustees with such appointment to become effective upon approval by Beaufort County Council.

Mr. Joseph Passiment, Chairman  
Page 2  
October 27, 2021

Both of the above-listed nominees meet the qualifications necessary for consideration by the Beaufort County Council for appointment to the Beaufort Memorial Hospital Board of Trustees. On behalf of Beaufort Memorial, we are excited about the opportunity these nominees present to add a strong and accomplished voice to our Board.

Thank you in advance for your consideration.

Sincerely,



David House, Chairman  
Board of Trustees  
Beaufort Memorial Hospital

Cc: Eric Greenway, County Administrator (*e-mail only*)  
Sarah W. Brock, Clerk to Council (*e-mail only*)  
Russell Baxley, Beaufort Memorial Hospital CEO (*e-mail only*)  
E. Richardson LaBruce, BMH Governance Committee Chair (*e-mail only*)

# APPLICATION



COUNTY COUNCIL OF BEAUFORT COUNTY  
County Boards, Agencies, Commissions, Authorities and Committees



County Council of Beaufort County selects citizens for service on Council appointed Boards, Agencies, Commissions, Authorities and Committees from a roster of individuals who have either volunteered or have been recommended for appointment. The Clerk to Council uses this form to keep an up-to-date roster of volunteers and to provide Council basic information about each volunteer.

**Top Three Priorities:** Please indicate by placing a “1”, “2”, or “3” alongside your choices.

**BOARDS AND COMMISSIONS**

- \_\_\_ Accommodations Tax (2% State)
- \_\_\_ Airports
- \_\_\_ Alcohol and Drug Abuse
- \_\_\_ Assessment Appeals
- \_\_\_ Beaufort County Transportation
- \_\_\_ Beaufort-Jasper Economic Opportunity
- \_\_\_ Beaufort-Jasper Water & Sewer
- 1 Beaufort Memorial Hospital
- \_\_\_ Bluffton Township Fire
- \_\_\_ Burton Fire
- \_\_\_ Coastal Zone Management Appellate (inactive)
- \_\_\_ Construction Adjustments and Appeals
- \_\_\_ Daufuskie Island Fire
- \_\_\_ Design Review
- \_\_\_ Disabilities and Special Needs
- \_\_\_ Economic Development Corporation
- \_\_\_ Forestry (inactive)
- \_\_\_ Historic Preservation Review
- \_\_\_ Keep Beaufort County Beautiful
- \_\_\_ Lady's Island / St. Helena Island Fire
- 2 Library
- \_\_\_ Lowcountry Council of Governments
- \_\_\_ Lowcountry Regional Transportation Authority
- \_\_\_ Parks and Recreation
- \_\_\_ Planning \*
- \_\_\_ Rural and Critical Lands Preservation
- \_\_\_ Sheldon Fire
- \_\_\_ Social Services (inactive)
- \_\_\_ Solid Waste and Recycling
- \_\_\_ Southern Beaufort County Corridor Beautification
- \_\_\_ Stormwater Management Utility
- \_\_\_ Zoning

DATE: 10/27/21 NAME: Angela Denise Simmons

BEAUFORT COUNTY VOTER REGISTRATION NUMBER: \_\_\_\_\_

OCCUPATION: Higher Education Administration/Vice Chancellor at USCB

TELEPHONE: (Home) \_\_\_\_\_ (Office) \_\_\_\_\_ EMAIL: \_\_\_\_\_

HOME ADDRESS: \_\_\_\_\_ STATE: SC ZIP CODE: 29910

MAILING ADDRESS: \_\_\_\_\_ STATE: SC ZIP CODE: 29910

COUNTY COUNCIL DISTRICT: 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☒ 10 ☐ 11 ☐

ETHNICITY: Caucasian ☐ African American ☒ Other ☐

Are you presently serving on a Board, Agency, Commission, Authority or Committee? Yes ☐ No ☒

If “yes”, what is the name of the board and when does term expire? \_\_\_\_\_

- Please return completed form **and a brief resume'** either Email or U.S. Mail:
  - o Email: [boardsandcommissions@bcgov.net](mailto:boardsandcommissions@bcgov.net)
  - o U.S. Mail: Clerk to Council, County Council of Beaufort County, P.O. Drawer 1228, Beaufort, SC 29901
- Applications without a brief resume' cannot be considered.
- Applications will be held **three (3) years** for consideration.
- All information contained on this application is subject to public disclosure.

**YOU MUST BE A BEAUFORT COUNTY REGISTERED VOTER TO APPLY**  
**YOU MUST ATTACH YOUR RESUME' WITH THIS APPLICATION TO BE CONSIDERED**  
**An incomplete application will be returned**

**\* Anyone submitting an application to serve on the Planning Commission must fill out the questionnaire on page 2.**

Applicant's Signature: \_\_\_\_\_

**EDUCATION**

Doctor of Education, Higher Education

Florida State University

Dissertation: *The impact of long-term study abroad on the development of emotional-social intelligence in undergraduates*

Master of Science, Counselor Education

Concentration in Student Development in Higher Education

Mississippi State University

Bachelor of Science, Educational Psychology

Minor in Counselor Education

Mississippi State University

**ADMINISTRATIVE EXPERIENCE****Vice Chancellor for Student Development**

University of South Carolina Beaufort

December 2019 – Present

- Serve as a cabinet member reporting directly to the Chancellor at USCB, a public university with over 2,000 students, 30 academic programs and majors, and three campuses.
- Provide leadership and oversight for the Division of Student Development, which is charged with supporting the holistic well-being of students. These areas include: Academic Advising, Academic Support, Counseling & Accessibility Services, Career Service & Internships, Student Life, and Housing & Judicial Affairs.
- Provide direct supervision to the assistant vice chancellor of student development, a team of six department directors, and an administrative assistant.
- Oversee the retention efforts of the university, including using data and analysis to work with faculty and staff on the development and implementation of a retention plan that specifies effective retention and success initiatives.
- Partner with the Provost & Vice Chancellor for Academic Affairs to oversee the diversity, inclusion, and equity efforts of the university, including creating long-term strategies and collaborations designed to enhance the campus climate for historically marginalized students and employees.
- Co-chair the Public Health Team Committee charged with leading the university's COVID-19 response, including developing the Return to Work and Return to Campus plans and managing the daily quarantine/isolation and education efforts.

**Assistant Vice President for Student Affairs**

Virginia Polytechnic Institute and State University, Blacksburg, VA

August 2014 – November 2019

- Served as a senior administrator reporting directly to the Vice President for Student Affairs in a division with 24 departments and an annual budget of over \$150 million at a land grant university with a student population of approximately 31,000 undergraduate and graduate students.
- Provided leadership and oversight for areas charged with facilitating student learning through co-curricular engagement including: Cultural and Community Centers, First Generation Student Support, New Student and Family Programs, Student Engagement and Campus Life, and VT Engage: The Community Learning Collaborative with over 80 full and part-time employees and 200 student staff.
- Provided direct supervision for a team of four department directors, a program director, and an associate director for finance.



- Managed and allocated budgets in excess of \$16 million that were derived from multiple sources, including state appropriations, student fees, self-generated revenue, grant funding, and donor contributions.
- Provided direction and oversight in the management of four campus facilities with an annual visitor rate of approximately 1.5 million.

### **Key Accomplishments**

- Co-Chaired the New Student Transition Strategy Team charged with coordinating the collaborative efforts between the Division of Student Affairs, Undergraduate Academic Affairs, and Enrollment Management related to the transition of all new students.
- Served as the Division of Student Affairs representative on the University Strategic Planning Advisory Committee, including service as a member of the Vision and Mission Subcommittee.
- Served as the Division of Student Affairs representative on Inclusive VT, the university's senior representatives who serve as liaisons between colleges/management areas and the Office of Inclusion and Diversity.
- Chaired the Division of Student Affairs Inclusive VT Catalysts, a committee that supports progress on inclusion and diversity issues, sponsors programming, and recognizes significant contributions by faculty, staff, and students.
- Served as a member of the Beyond Boundaries university visioning committee on the Preparing Students for the World thematic area.
- Served on the Campus Master Plan Committee, including membership on the Student Life Stakeholder Committee.
- Co-Chaired the Student Engagement in the Arts research project aimed at understanding how and why students engage in curricular and co-curricular art's initiatives.
- Co-Chaired the Student Engagement in Athletic Events Committee charged with increasing student participation at non-ticketed athletic events.
- Co-Chaired the Student Affairs Diversity and Inclusion Strategic Plan Committee charged with creating a comprehensive student affairs strategic plan to support the university's ongoing efforts related to diversity and inclusion.
- Initiated and managed organizational change related to the consolidation of two departments; the Leadership Education Collaborative and VT Engage.
- Provided oversight for a major capital project; Commonwealth Ballroom renovation (\$3M) and numerous small-scale building renovation projects.
- Co-led a group of 15 students on a cultural exchange program to South Africa to study the connections between apartheid and racial segregation in America.
- Provided leadership and oversight in the creation and/or enhancement of learning-centered programs for students, including; Welcome Week, Student Engagement Ambassadors, the creation of additional cultural and community centers, and expanded international service opportunities for students.
- Coordinated and facilitated two international orientation programs in China for students and their family members.

### **Director of Student Conduct**

Virginia Polytechnic Institute and State University, Blacksburg, VA

August 2012 – August 2014

- Oversaw the general operation of the office and the adjudication of non-academic student misconduct.
- Represented the office of Student Conduct in departmental, divisional, and university wide meetings and committees.
- Interacted with parents, legal counsel, the news media, referral agents and charged students who are connected with student disciplinary matters on campus.
- Engaged students in intentional conversations that promote interpersonal awareness, purposeful actions, self-reflection, community commitment, and civility.
- Supervised four professional team members and oversaw the supervision of a full-time Office Manager, Case Manager, and graduate assistant.
- Counseled individual students (both respondents and complainants) regarding their procedural guarantees and responsibilities.

- Administered the management, creation and maintenance of conduct records in accordance with applicable university policies and state/federal laws.
- Created, implemented, and maintained the mission, purpose, strategic vision, and student learning outcomes for the office.
- Certified authorized disclosure of student's disciplinary histories to employers and professional schools within the applicable confines of Federal privacy laws.
- Fostered a positive working relationship with and served as liaison to on and off-campus units.
- Resolved student conduct violations through informal resolution or case adjudication, and issued sanctions ranging from formal warning through dismissal from the university.

#### **Key Accomplishments**

- Integrated adaptable conflict resolution into the Student Code of Conduct and facilitated the approval of the new policy through university governance, including the Board of Visitors.
- Served as a member of the university's Care Team and supported the Senior Associate Vice President for Student Affairs in the Threat Assessment Team's assessment, intervention, and monitoring efforts.
- Facilitated training sessions for Appellate Officers, Peer Advisors, Student Conduct Committees, Orientation Leaders, and other university community members.
- Participated in training sessions for Housing and Residence Life professional, graduate and undergraduate staff.
- Facilitated a memorandum of understanding for shared office space with the University Honor System.

#### **Director of the Center for Student Involvement & Leadership**

Millersville University, Millersville, Pennsylvania

September 2004 – August 2012

- Provided direct supervision for the following services and programs: Orientation, Greek Life, Leadership Development, Student Activities, and Student Organizations.
- Supervised a staff of 12 (two assistant directors, one coordinator, one administrative assistant, one graduate assistant and seven students).
- Directly managed and monitored university, auxiliary, and Student Senate allocated annual budgets totaling over \$750,000.
- Oversaw policy development, planning, and the overall coordination of over 130 student organizations through the implementation of organization registration, the creation of publications, and the development of training workshops.
- Assisted Student Senate with policies and procedures related to the recognition of student organizations.
- Oversaw the programming of annual campus events such as the Leadership Awards Banquet, SuperFest, Family Weekend, programming board spring concert, student organization fair, and the annual block party.

November 2006 – March 2008

- Assumed additional responsibilities during a period of transition within the Division of Student Affairs.
- Provided direct supervision for the Wellness and Women's Program.
- Coordinated the campus Community Service Program, which served as a clearinghouse for volunteer opportunities.
- Assisted work-study students in identifying community service work sites and securing employment outside of the university.

#### **Key Accomplishments**

- Chaired the university-wide Orientation Committee responsible for developing a new, comprehensive five day Fall Orientation Program, which was implemented Fall 2007.
- Partnered with the Assistant to the President for Social Equity and Diversity in the development and implementation of the Collegiate Leadership Development Program (CLDP), a program designed to assist students of color during their transition to the university.
- Responsible for the development and implementation of the Emerging and Seasoned Leaders Programs, which focused on a holistic approach to leadership development.

- Partnered with the Coordinator of the Women's Center in the creation of an annual Women's Leadership Retreat.
- Responsible for the creation and implementation of a diversity training program for students participating in Fall New Student Orientation.
- Partnered with the Associate Provost for Enrollment Management in the development of a leadership program for students participating in the Millersville Scholars Program, an initiative geared towards assisting at-risk students.
- Worked with the Director of Pre-Collegiate Programs in the development and implementation of Millersville Concerned Women, a program for female students of color.
- Served on the Student Memorial Center Renovation Committee, which provided input and made recommendations during the planning and design phases.
- Served on the President's Advisory Leadership Council, an assembly of key administrative, faculty, and staff leaders that fosters shared governance through its discussions of key issues on campus.
- Appointed by the Vice President of Student Affairs and the Provost to serve on the Steering Committee for the Middle States Accreditation Self-Study, a University-wide committee charged with providing leadership for the Self-Study design and implementation.

### **Assistant Dean of Students and Director of Greek Life**

Florida State University, Tallahassee, Florida

September 2001 – September 2004

- Supervised all operations of the University Greek community comprised of 49 organizations with over 3800 students.
- Hired, trained, supervised and evaluated Assistant Director and two Graduate Assistants.
- Advised daily operations, budget creation and management, programming, crisis management, and policy enforcement of the Interfraternity Council, National Pan-Hellenic Council, Panhellenic Council, Multicultural Council, and Greek Board.
- Served as the first responder to crisis situations within the Greek community.
- Provided training, education, development, and support services for chapter presidents, council executive board members, and chapter advisors.
- Served as a University liaison between alumni advisors, housing corporations, leadership consultants, and headquarters staff.
- Met regularly with individual chapter presidents to assist with assessment of organizational needs, goal setting, and program development.
- Selected, trained, and advised Interfraternity Council, National Pan-Hellenic Council, and Panhellenic Council Judicial Boards.
- Collaborated with the Office of Student Rights and Responsibilities on all fraternity and sorority judicial issues.
- Partnered with Environmental Health and Safety to coordinate annual fire inspections for fraternity and sorority chapter houses.
- Supervised all formal and informal recruitment processes for men's and women's fraternities.
- Negotiated various entertainment contracts and agreements for services on behalf on the governing councils.
- Oversaw implementation of campus-wide 32-hour Dance Marathon.

### **Key Accomplishments**

- Served as a member of the Dean of Students Leadership Team focused on providing leadership and vision for the department.
- Researched, created, implemented, and served as an instructor for Emerging Leaders; a program for new members of fraternities and sororities.
- Created a governing council for Multicultural fraternities and sororities.

### **Assistant Director of Greek Life**

Florida State University, Tallahassee, Florida

May 1999 – September 2001

- Planned and coordinated leadership training events such as Greek Leadership Conference and Greek Advance.

- Advised officers and members of Order of Omega, Greek Ambassadors, and GAMMA.
- Advised officers and members of Greek Board in the planning of Greek Week and the Greek Awards Banquet.
- Assisted fraternity and sorority scholarship chairs in developing long term goals.
- Tracked fraternity and sorority grades and member statistics.
- Supervised graduate interns.

### **Assistant Director of Student Activities**

University of West Georgia, Carrollton, Georgia

September 1994 - August 1997

- Advised the Black Student Alliance and actively provided professional leadership and guidance to officers and various committees.
- Coordinated Black History Month activities.
- Developed and maintained the Black Cultural Resource Center.
- Advised Panhellenic Council, Black Greek Council, and Gamma Sigma Alpha.
- Coordinated the registration process for student organizations.
- Served as a consultant to registered student organizations and their advisors.
- Assisted student organizations and University departments in creating and implementing leadership development programs for student leaders.
- Conducted "Diversity 101" workshops for student leaders.
- Developed, implemented, and maintained campus-wide community service program.
- Selected, trained, and supervised student workers in the production of identification cards.
- Developed and revised all office publications.

### **RELATED EXPERIENCE**

#### **University Judicial Hearing Officer**

Florida State University, Tallahassee, Florida

January 2000 – September 2004

#### **Instructor, First Year Experience**

Florida State University, Tallahassee, Florida

Fall – 1999, 2001, 2002, 2003 & Summer 2004

#### **Graduate Assistant, Hardee Center for Women in Higher Education**

Florida State University, Tallahassee, Florida

August 1997 – May 1999

### **SELECTED UNIVERSITY COMMITTEES**

- Co-Chair, Student Affairs Policy Review Committee, Virginia Tech
- Co-Chair, Curiosity Aspiration Committee, Virginia Tech
- Member, Creativity and Innovation Advisory Board, Virginia Tech
- Member, NPHC Vision and Planning Committee, Virginia Tech
- Chair, Student Affairs Professional Development Committee, Millersville University
- Member, President's Commission on the Status of Women, Millersville University
- Member, Council for Institutional Effectiveness & Accountability, Millersville University
- Member, Institutional Identity Committee, Millersville University
- Member, Alcohol and Other Drugs Steering Committee, Millersville University
- Member, Student Memorial Center Renovation Committee, Millersville University
- Chair, Dean of Students Professional Development Committee, Florida State University
- Member, University-Wide Public Safety Committee, Florida State University

# APPLICATION

## Beaufort County Boards/Commissions Application

Item 2.

Date

11/12/2021

Name

Carolyn Banner

Beaufort County Voter Registration Number

Occupation

Professor

Phone (Home)

Phone (Office)

Email

Home Address

City

BEAUFORT

State

SC

Zip Code

29907

Mailing Address

City

BEAUFORT

State

SC

Zip Code

29907

District

Ethnicity

African American

Presently Serving on a Board/Agency/Commission/Authority or Committee?

☒ Yes ☐ No

If Yes, what is the name of the board and when does term expire?

Beaufort Jasper Higher Education Commission---June 2022

### **BOARDS AND COMMISSIONS**

**Top Three Priorities:** Please indicate by placing a "1", "2", or "3" alongside your choices.

Accommodations Tax (2% State)

Airports

☐

Alcohol and Drug Abuse

☐

Assessment Appeals

☐

Beaufort County Transportation

☐

Beaufort -Jasper Economic Opportunity

☐

Beaufort -Jasper Water & Sewer

☒

Beaufort Memorial Hospital

☐

Bluffton Township Fire

☐

Burton Fire

☐

Coastal Zone Management Appellate (inactive)

☐

Construction Adjustments and Appeals

☐

Daufuskie Fire

☐

Design Review

☐

DSN

☐

Economic Development Corporation

☐

Forestry (inactive)

☐

Historic Preservation Review

☐

Keep Beaufort County Beautiful

☐

Lady's Island / St. Helena Island Fire

☐

Library

☐

2

Lowcountry Council of Governments

☐

Lowcountry Regional Transportation Authority

☐

3

Parks and Recreation

☐

Planning \*

☐

Rural and Critical Lands Preservation

☐

Sheldon Fire

☐

Social Services (inactive)

☐

Solid Waste and Recycling

☐

Southern Beaufort County Corridor Beautification

Stormwater Management Utility



Zoning

**Beaufort County Planning Commission  
Supplemental Application Questionnaire**

This questionnaire will assist the County Council in assessing your qualifications and experience for the Planning Commission vacancy.

Please explain why you want to serve on the Planning Commission.

What qualifications, experience and expertise make you a good candidate for the Planning Commission?

What role do you feel the Planning Commission plays in making Beaufort County a desirable community in which to live and work?

What do you believe are the most important planning issues facing the County during the next five years?

What previous experience have you had in serving on a Planning Commission? Give some examples of the items typically handled by the Planning Commission.

Item 2.

#### Attachments



Carolyn Mack Banner.resume.doc



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**SELECTED PROFESSIONAL & COMMUNITY INVOLVEMENT**

- Faculty Member, ACPA Mid-Level Management Institute
- Cluster Facilitator, LeaderShape, Allerton Conference Center
- Faculty Member, ASCA Gehring Academy for Student Conduct Administration
- Facilitator, Undergraduate Interfraternity Institute
- Planning Committee, Faculty Women of Color in the Academy Conference
- ACPA Institute for Aspiring Senior Student Affairs Officers
- ACPA Mid-Level Management Institute
- Introduction to Restorative Practices & Using Circles Effectively, International Institute for Restorative Practices
- StrengthsQuest Educator Seminar
- ACPA Cultural Study Tour, Ghana
- Management Academy, University Organizational and Professional Development, Virginia Tech
- Women's Leadership & Mentoring Program, Virginia Tech
- Member, ACPA Commission for Spirituality, Faith, Religion and Meaning
- Member, Student Affairs Administrators in Higher Education - NASPA
- Member, American College Personnel Association – ACPA
- Mentor, ACPA Coalition for Women's Identities
- Mentor, Women's Leadership & Mentoring Program, Virginia Tech
- Board of Directors, Women's Resource Center of the New River Valley
- Board or Directors, Urban League of Lancaster County

# Carolyn M. Banner

Work

## PROFESSIONAL PROFILE

- ◆ Over twenty years' experience in education: administration, counseling, teaching and program design.
- ◆ Extensive work with diverse population, minorities, non-traditional students and the academically challenged.
- ◆ Extensive background in counseling, instructing and program development.
- ◆ Self-motivated and ability to work independently and coordinate with others.

## EDUCATION

Walden University, Minneapolis, Minnesota  
**Ph.D., Education**

University of South Carolina, Columbia, SC  
**M.P.H., Health Education**

Voorhees College, Denmark, SC  
**B.S., Biology**

Harvard University, Cambridge, MA  
**Summer Institute**

## PROFESSIONAL SKILLS

### SUPERVISION AND ADMINISTRATION

- ◆ Coordinated, recruit and market the University of South Carolina-Columbia distance education graduate programs to district superintendents and businesses in Beaufort, Charleston, Walterboro and Myrtle Beach.
- ◆ Developed and negotiated contracts with school districts for undergraduate and graduate courses.
- ◆ Recruited and hired faculty for on site graduate courses.
- ◆ Directed the planning, development and supervision of the College Assessment and Testing Program, Job Placement, and off - campus student services.
- ◆ Administered career planning assessment instruments. (Myers Briggs, SDS, Kuder, Strong Campbell, CAPS)
- ◆ Coordinated and plan special activities and events for students (New Student Orientation, Career Fairs)
- ◆ Compiled and analyzed statistical data to document program performance.
- ◆ Wrote quarterly and final program evaluations reports.
- ◆ Developed and managed program budgets; monitor program expenditures for adherence to College and Federal guidelines; responsible for over \$200,000 annually.
- ◆ Assisted with Student Appeals cases.
- ◆ Directed the Single Parent/Homemaker Program and Gender Equity Program to include scheduling and coordinating all activities specified in the grant proposal.

## LEADERSHIP

- ◆ Represented USC Extended Campus at local and state meetings.
- ◆ Represented USC Extended Campus at corporate and colleges/universities career fairs.
- ◆ Conducted needs assessment to determine program need for program expansion.
- ◆ Coordinated and planned special activities and events for students (New Student Orientation, Career Fairs)
- ◆ Developed, planned and taught the first College Orientation course for new students
- ◆ Designed a career-planning program for middle and high school students entitled, "Careers and Choices;" program was implemented in 8 high schools.
- ◆ Directed the new service delivery system into one-stop concept; recognized by the National Council of Student Development as an exemplary program.
- ◆ Wrote annual grant proposals; successfully received funding each year.
- ◆ Planned and organized state conference for counselors in the SC Technical College system; over 100 individuals participated.

## COMMUNICATION

- ◆ Presented informational sessions to local groups on USC Extended Campus programs.
- ◆ Advised distance education students and assisted with online registration.
- ◆ Conducted over 100 workshops on career planning, study skills, and women health issues. Frequent guest speaker to various community agencies.
- ◆ Published articles in professional journal and newsletter.
- ◆ Taught on the college level for 8 years.
- ◆ Taught a graduate credit course for Coastal Carolina University.
- ◆ One of 6 instructors featured on CD-ROM's developed by the South Carolina Department of Education for statewide distribution on career planning issues.
- ◆ Coordinated professional training for Student Services staff.

## COUNSELING AND INTERVIEWING

- ◆ Provided crisis intervention and referral for college students.
- ◆ Conducted intake interviews and develop individual career plans for students.
- ◆ Provided academic, career, and personal counseling to new and continuing students.
- ◆ Faculty advisor for Career Development students.
- ◆ Administered career planning assessment instruments.
- ◆ Provided group-counseling activities, and test interpretation.
- ◆ Advised and register high school students for college courses.

## COMMUNITY RELATIONS AND TRAINING

- ◆ Served as agency liaison to high school schools and various community organizations.
- ◆ Organized and coordinate training sessions for staff and community members.
- ◆ Designed and conduct informational workshops on numerous career development issues.
- ◆ Managed, plan, develop and implement programs and services that guide new and enrolled students.
- ◆ Scheduled and coordinate retention activities.
- ◆ Coordinated and organize orientation program for new students.
- ◆ Scheduled and conduct career planning and employability skills workshops.

## EMPLOYMENT HISTORY

**Adjunct Faculty (2008-Current)**

**Director, Opportunity Scholars Program (2009- 2016)**

**Director/Adjunct Faculty (2004-2008)**

University of South Carolina-Extended Campus- Coastal Region  
Beaufort, SC

**Director of Student Services (1988 - 2004)**

Technical College of the Lowcountry, Beaufort, SC

**Director of Career Planning and Job Placement (1987 - 1988)**

Technical College of the Lowcountry, Beaufort, SC

**New Horizons Coordinator (1986 - 1987)**

Technical College of the Lowcountry, Beaufort, SC

**District Director of Health Education (1984 - 1986)**

Department of Health and Environmental Control, Orangeburg, SC

**Executive Director (1983 - 1984)**

Columbia Free Clinic, Columbia, SC

**Director of Counseling (1981 - 1983)**

Women's Medical Clinic, Washington, DC

**Health Educator (1979 - 1981)**

Urban Health Center, Savannah, GA

## CONSULTATION

Kennesaw State University, Instructor, 2001-2002

Options Resource Outplacement Services, Consultant, 1995-1996

South Carolina Alliance of Tech Prep/STW, 2003

## PROFESSIONAL AFFILIATIONS

National Council of Instructional Administrators

Leadership Beaufort

South Carolina Placement Association

South Carolina Counseling Association

South Carolina Women Work

National Council of Student Development

National Career Development Association

## HONORS & AWARDS

Leaders for Change, National Institute for Leadership Development

Educator of the Year-Administrator/Manager Category

Leadership Beaufort  
Chair, SC Technical College Counseling Peer Group  
Certified Career Development Facilitator Instructor  
Master Career Development Professional

## **TEACHING**

Personal and Community Health (HPEB 321)  
University 101-Student in the University  
Health Education for the Elementary School (HPEDA 331)

## **COMPUTER SKILLS**

Microsoft Word  
Microsoft Excel  
Microsoft PowerPoint  
Social Media



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 3.

### ITEM TITLE:

*Recommended Changes to Beaufort County Procurement Code, Division 4 concerning approval thresholds and to request additions to the current exemption section-approved by Finance Committee on October 18, 2021.*

### MEETING NAME AND DATE:

County Council Meeting October 25, 2021

### PRESENTER INFORMATION:

*Dave Thomas, CPPO, Purchasing Director and Kurt Taylor General Council*  
*(10 minutes)*

### ITEM BACKGROUND:

*The current Beaufort County Procurement Code, Division 4 was last updated in February 2014. The recommended threshold changes require an update to the current staff titles and their authority. The recommended increase to thresholds for staff approval takes into consideration the dramatic change in prices due to inflation, COVID 19, and the availability of Goods and Services requested by staff. The recommended additions to the exemption section is mainly due to the lack of qualified vendors and in most cases there is only one source available to provide the requested Goods or Services. Requesting quotes for these new exemptions is not the best procurement practice and is not practical.*

### PROJECT / ITEM NARRATIVE:

*The attached recommended procurement code changes will increase the approval thresholds for Department Heads, Purchasing Director, Budget Director, County Administrator, Committees and Council. Staff is also recommending adding additional Goods and Services exemptions to the Code. Some of the major justifications for requesting the code changes are due to the current market for Goods and Services (inflation, increased cost) and the outbreak of COVID 19. Note, COVID 19 has contributed to reducing the number of available vendors and their ability to provide/deliver some services and supplies to the County. Furthermore, changing our thresholds and adding exemptions as requested by staff will improve our processes and provide a code for staff to follow, which is more in-line with "Best Practices" used by similar organizations.*

### FISCAL IMPACT:

NA

### STAFF RECOMMENDATIONS TO COUNCIL:

Approve or Deny the recommended changes to the Procurement Code

### OPTIONS FOR COUNCIL MOTION:

*The Finance Committee approved the recommendation as stated in the attachments and request approval by County Council and possible First Reading.*



**ORDINANCE 2021/\_\_\_\_\_**

**TEXT AMENDMENT TO BEAUFORT COUNTY CODE OF ORDINANCES: ARTICLE VII, DIVISION 4, SECTION 2-508; SECTION 2-509; SECTION 2-513; SECTION 2-517; AND SECTION 2-541 TO UPDATE ADMINISTRATIVE CHANGES, TO PROVIDE NECESSARY CONTRACT DOLLAR THRESHOLD CHANGES AND TO UPDATE EXEMPTION PROVISIONS AND PROCEDURES.**

**WHEREAS**, added text is highlighted in yellow and underlined.

Adopted this \_\_ day of NOVEMBER 2021.

COUNTY COUNCIL OF BEAUFORT COUNTY

By: \_\_\_\_\_  
Joseph Passiment, Chairman

ATTEST:

\_\_\_\_\_  
Sarah W. Brock, JD, Clerk to Council

Chronology:

Third Reading: November 22, 2021 / Vote \_\_\_\_\_

Second Reading: November 8, 2021 / Vote \_\_\_\_\_

Public Hearing: November 8, 2021

First Reading: October 25, 2021 / Vote \_\_\_\_\_

**Sec. 2-508. - Establishment, appointment and qualifications of purchasing director.**

(a)

*Establishment of position.* There is created the position of purchasing director, who shall be the county's principal public procurement official. The purchasing director shall report to the Assistant County Administrator, Finance (ACA, Finance).

**Sec. 2-509. - Authority and duties of purchasing director.**

(a)

*Principal public procurement official.* The purchasing director shall serve as the principal public procurement official of the county and shall be responsible for the procurement of supplies, services, and construction in accordance with this division, as well as the management and disposal of supplies.

(b)

*Duties.* In accordance with this division, the purchasing director shall:

(1)

*Purchase.* Purchase all supplies, materials, equipment, and contractual services required by county agencies and perform the purchasing-related functions required of the purchasing director in this division.

(2)

*Negotiate contracts.* Negotiate contracts for personal services, submit them for approval, and award as provided in this division.

(3)

*Use standard specifications.* Use standard specifications wherever they are applicable to purchase orders and contracts, and ensure compliance with such specifications through adequate inspection of deliveries.

(4)

*Transfer between agencies.* Transfer between agencies supplies, materials, and equipment that are no longer needed by a holding agency but that can be used by the receiving agency.

(5)

*Exchange, trade in and sell.* Exchange, trade in or sell those supplies, materials and equipment which are surplus, obsolete or unused and which are found by the county administrator not to be required for public use.

(6)

*Develop standard forms and conditions.* Develop, with the approval of the county attorney as to legal sufficiency, standard forms and conditions of invitations to bid and purchase orders and contracts; develop and prescribe the use by agencies of other forms required in carrying out this division, and amend or eliminate any such forms.

(7)

*Acquire and dispose of real property.* Upon request of the county council and subject to its approval of each transaction, perform all delegable functions in connection with acquisition and disposal of real property.

(8)

*Perform other duties.* Perform other duties as assigned by the county administrator and ACA, Finance.

(c)

*Operational procedures.* Consistent with this division, the purchasing director shall adopt operational procedures relating to the execution of his duties.

(d)

*Dollar limitations.* Provided that funds have been preapproved by the county council as part of the budget process, an award is made to the lowest responsive and responsible bidder, the contracting authority for the county, except as otherwise provided in [section 2-512](#) pertaining to authority to contract for certain services, [section 2-513](#) pertaining to exemption and [section 2-514](#) pertaining to exemption for real property, shall be as follows:

(1)

Purchasing Director, Budget Director \$50,000.00 or less.

(2)

County administrator or his designee, over \$50,000.00, but less than \$150,000.00. The County Administrator may approve contract renewals and be exempt from the dollar limitations on expenditure authority identified in this Section 2-509-Authority and duties of purchasing director, paragraph (d-e) Dollar limitations in paragraphs (1-4) provided that the funds have been approved by the county council as part of the annual budget appropriation process, and that any expenditure of funds regardless of the amount will not result in a budget deficit.

(3)

Council committee, over \$150,000.00, but less than \$250,000.00.

(4)

The county council, \$250,000.00 and over.

(e)

*Elected and appointed officials.* Provided that funds have been approved by the county council as part of the annual budget appropriation process, and that any expenditure of funds regardless of the amount will not result in a budget deficit within any elected official's office, the sheriff, auditor, treasurer, clerk of court, coroner, solicitor, public defender, probate judge, and magistrates shall be exempt from the dollar limitations on expenditure authority identified above provided that they shall comply with all of [the] provisions of competitive purchasing as may be required by South Carolina law and the Beaufort County Purchasing Ordinance. The county council may request such reports and information, as it deems necessary and prudent on the purchasing activities of these offices to ensure compliance with these provisions.

(Code 1982, § 12-10; Ord. No. 99-14, 5-24-1999; *Ord. No. 2014/4, 2-10-2014*)

**Sec. 2-513. - Exemption from procedures.**

The County Council may, by resolution, exempt specific supplies or services from the purchasing procedures required in this Code. The following supplies and services shall be exempt from the purchasing procedures required in this division; however, the purchasing director for just cause may limit or withdraw any exemptions provided for in this section:

(1)

Works of art for museum and public display.

(2)

Published books, library books, maps, periodicals, technical pamphlets.

(3)

Copyrighted educational films, filmstrips, slides and transparencies.

(4)

Postage stamps, postal fees, and U.S. Post Office box rentals.

(5)

Professional dues, membership fees, seminar registration fees, and Professional training.

(6)

Medicine and drugs.

(7)

Utilities including gas, electric, water and sewer.

(8)

Advertisements in professional publications or newspapers. Add-Advertising time and space in radio, television, and social media platforms including local Chamber of Commerce.

(9) Legal Services, which must be approved by the County Administrator or County Council.

**(10) Add- Fixed Wing and Rotary Wing Aircraft Maintenance.**

**Sec. 2-517. - Small purchases.**

Any contract not exceeding **\$35,000.00** shall be made in accordance with the small purchase procedures established in regulations and updated periodically by the purchasing director; provided, however, that purchase requirements shall not be artificially divided so as to constitute a small purchase under this section.

*(Code 1982, § 12-18)*

**Sec. 2-521. - Requisition required.**

Department heads shall use requisitions for goods or services for the operation of the department. Requisitions shall be processed according to the steps outlined in the purchasing administrative regulations.

*(Code 1982, § 12-22)*

**Sec. 2-522. - Purchase order required.**

Any purchase made with county funds shall be recorded on a purchase order bearing the quantity and description of each item to be purchased. If exceptions are made by the purchasing director, a control system shall be in effect.

*(Code 1982, § 12-23)*

**Sec. 2-541. - Fiscal responsibility.**

Every contract modification, change order, or contract price adjustment in excess of ten percent of the original price under a contract with the county pursuant to this division shall be subject of prior approval by the **Purchasing Director and Budget Director.** **The requesting department must provide a copy of the approved electronic CO form to the Purchasing Department.** **Purchasing will attach a copy of the approved CO to the contract file before proceeding with the CO process. The Department may proceed with the CO once they receive a copy of the updated purchase order. The CO must not exceed the overall budget, which was approved by County Council.**

*(Code 1982, § 12-42)*

## **Procurement Code Recommended Changes By Staff**

### **Sec. 2-508. - Establishment, appointment and qualifications of purchasing director.**

(a)

*Establishment of position.* There is created the position of purchasing director, who shall be the county's principal public procurement official. The purchasing director shall report to the Assistant County Administrator, Finance (ACA, Finance).

### **Sec. 2-509. - Authority and duties of purchasing director.**

(a)

*Principal public procurement official.* The purchasing director shall serve as the principal public procurement official of the county and shall be responsible for the procurement of supplies, services, and construction in accordance with this division, as well as the management and disposal of supplies.

(b)

*Duties.* In accordance with this division, the purchasing director shall:

(1)

*Purchase.* Purchase all supplies, materials, equipment, and contractual services required by county agencies and perform the purchasing-related functions required of the purchasing director in this division.

(2)

*Negotiate contracts.* Negotiate contracts for personal services, submit them for approval, and award as provided in this division.

(3)

*Use standard specifications.* Use standard specifications wherever they are applicable to purchase orders and contracts, and ensure compliance with such specifications through adequate inspection of deliveries.

(4)

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(6)

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(7)

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(8)

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(c)

*Operational procedures.* Consistent with this division, the purchasing director shall adopt operational procedures relating to the execution of his duties.

(d)

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(5)

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(6)

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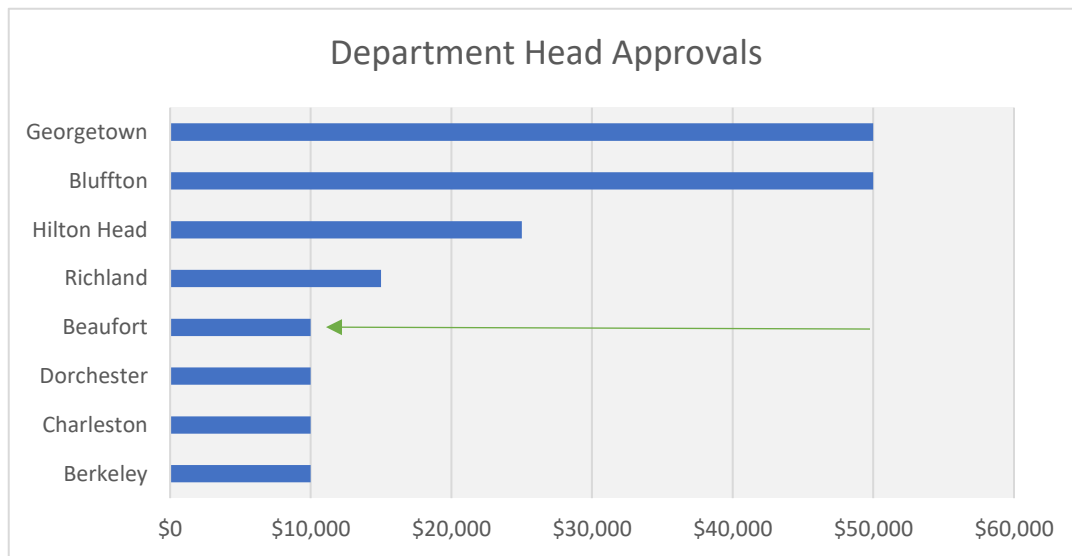
*(Code 1982, § 12-42)*

## Department Head Threshold

<u>From</u>	<u>To</u>
\$ 10,000	\$ 15,000

## Cities and Counties

<u>Berkeley</u>	<u>Charleston</u>	<u>Dorchester</u>	<u>Beaufort</u>	<u>Richland</u>	<u>Hilton Head</u>	<u>Bluffton</u>
\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 15,000	\$ 25,000	\$ 50,000



Note: All other entities (Greenville, Horry, Lexington & Spartanburg) are \$10,000 or less

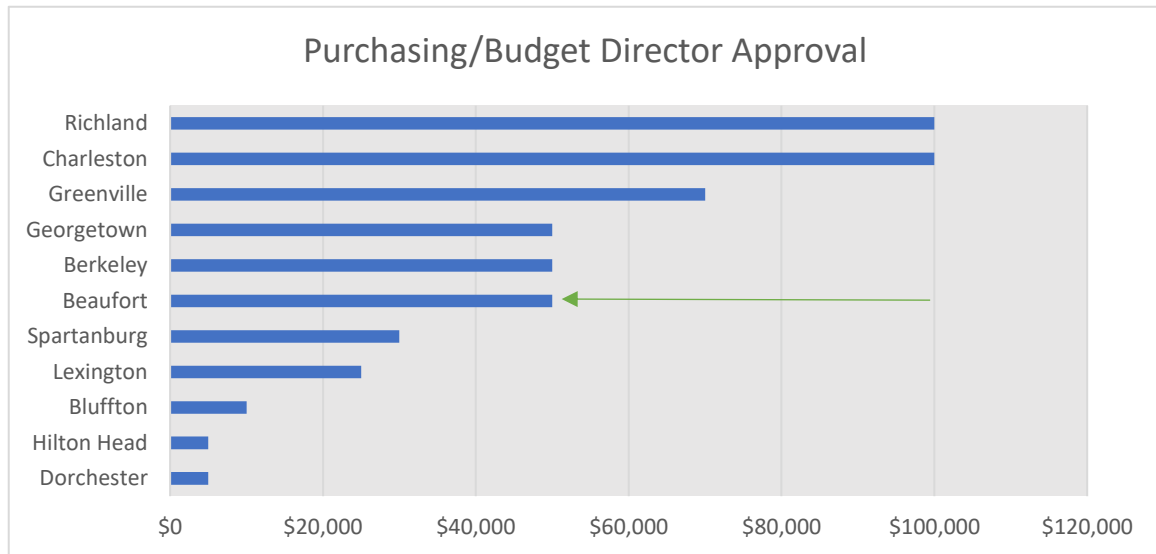
<u>Georgetown</u>	<u>Greenville</u>	<u>Horry</u>	<u>Lexington</u>	<u>Spartanburg</u>
\$ 50,000	\$10,000 or less			

## Purchasing and/or Budget Director Threshold

<u>From</u>	<u>To</u>
\$ 10,000	\$ 50,000

### Cities and Counties

<u>Dorchester</u>	<u>Hilton Head</u>	<u>Bluffton</u>	<u>Lexington</u>	<u>Spartanburg</u>	<u>Beaufort</u>	<u>Berkeley</u>
\$ 5,000	\$ 5,000	\$ 10,000	\$ 25,000	\$ 30,000	\$ 50,000	\$ 50,000



Note: If the item was approved in the current budget, the Purchasing Director may approve the item. Otherwise, approval must be sought through the Budget Director with an amendment from another line item.

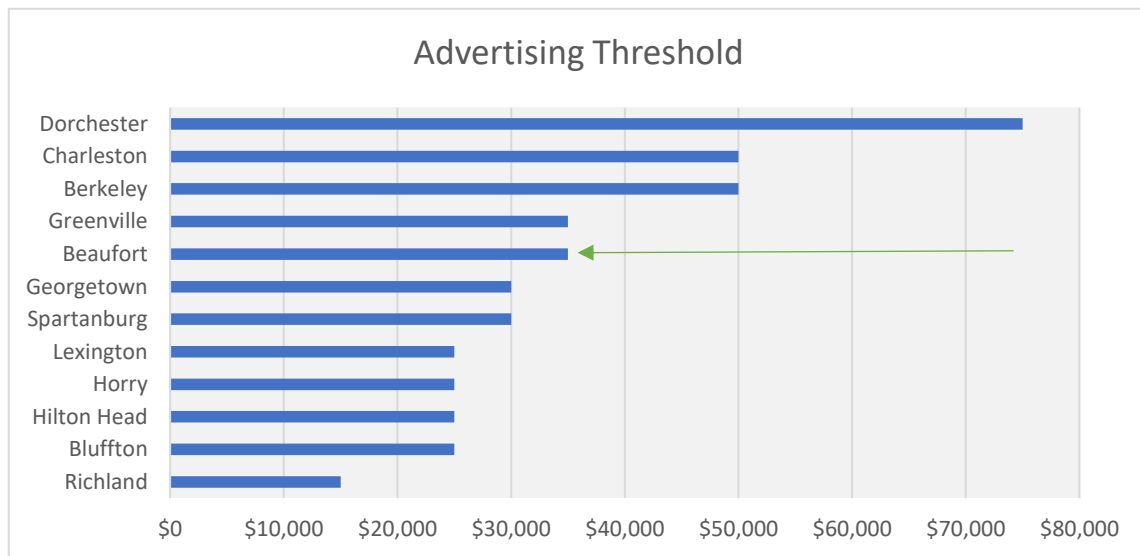
<u>Georgetown</u>	<u>Greenville</u>	<u>Charleston</u>	<u>Richland</u>	<u>Horry</u>
\$ 50,000	\$ 70,000	\$ 100,000	\$ 100,000	Unlimited

## Advertising Threshold

<u>From</u>	<u>To</u>
\$ 25,000	\$ 35,000

### Cities and Counties

<u>Richland</u>	<u>Bluffton</u>	<u>Hilton Head</u>	<u>Horry</u>	<u>Lexington</u>	<u>Spartanburg</u>	<u>Georgetown</u>
\$ 15,000	\$ 25,000	\$ 25,000	\$ 25,000	\$ 25,000	\$ 30,000	\$ 30,000



Note: If the purchase is over \$35,000 and not available on a state, cooperative, or GSA contract, the Goods or Services must be publically advertised in accordance with our procurement code. This does not apply to our prequalified lists pre-qualified under 50K A & E and Contractor lists.

	<u>Beaufort</u>		<u>Greenville</u>		<u>Berkeley</u>		<u>Charleston</u>		<u>Dorchester</u>
\$	35,000	\$	35,000	\$	50,000	\$	50,000	\$	75,000



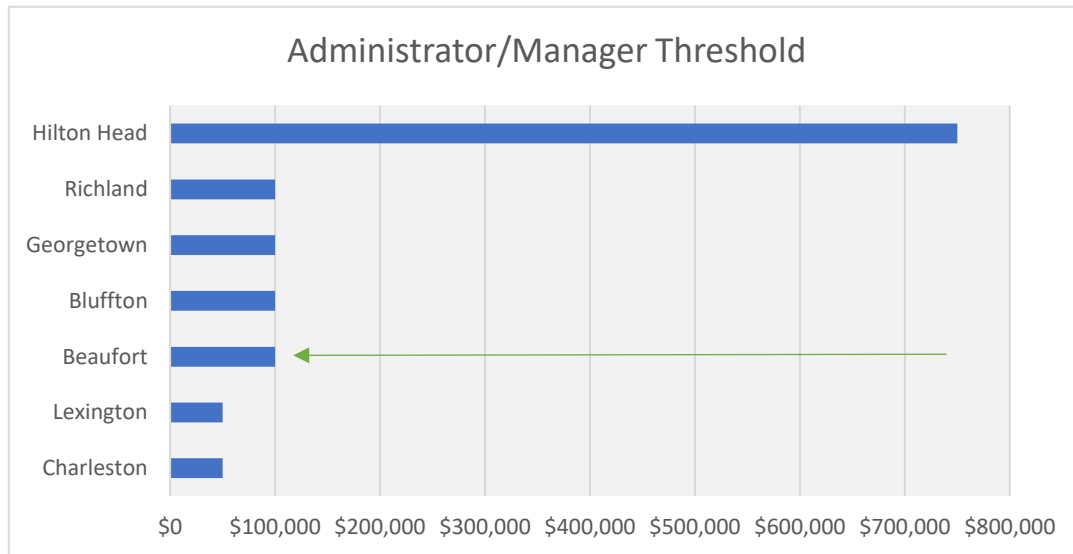


## Administrator/Manager Threshold

<u>From</u>	<u>To</u>
\$ 50,000	\$ 100,000

### Cities and Counties

<u>Charleston</u>	<u>Lexington</u>	<u>Beaufort</u>	<u>Bluffton</u>	<u>Georgetown</u>	<u>Richland</u>	<u>Hilton Head</u>
\$ 50,000	\$ 50,000	\$ 100,000	\$ 100,000	\$ 100,000	\$ 100,000	\$ 750,000



Note: If the item was approved in the current budget, the Purchasing Director may approve the item. Otherwise, approval must be sought through the Budget Director with an amendment from another line item.

<u>Dorchester</u>	<u>Berkeley</u>	<u>Greenville</u>	<u>Horry</u>	<u>Spartanburg</u>
\$ 5,000,000	Unlimited	Unlimited	Unlimited	Unlimited



## Summary of Purchasing Thresholds

<b>Purchasing Thresholds</b>	<b>Old</b>	<b>New</b>
Department Heads	\$ 10,000	\$ 15,000
Advertise for IFB/RFP/FRQ	\$ 25,000	\$ 35,000
Purchasing/Budget Director	\$ 25,000	\$ 50,000
Administrator	\$ 50,000	\$ 100,000
Committee	\$ 100,000	\$ 200,000
Council	Above \$100,000	Above \$200,000

Department Heads

Advertise

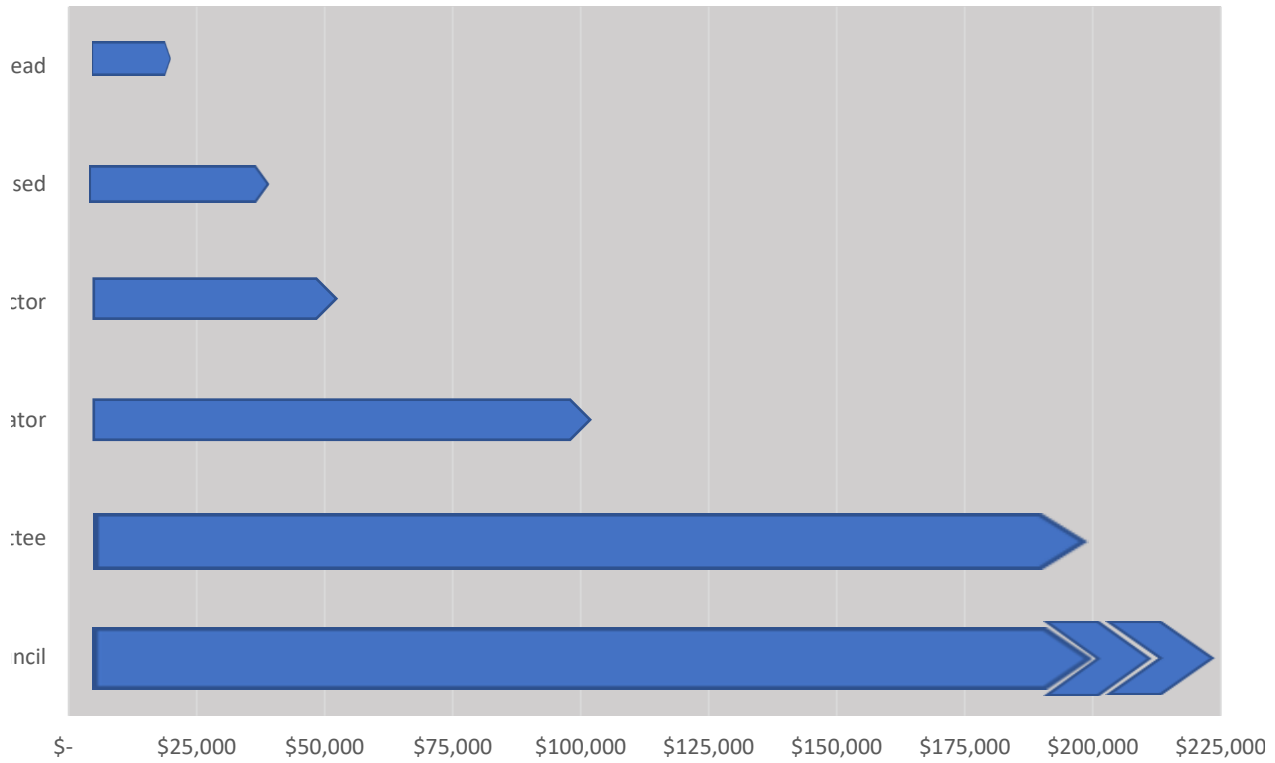
Purchasing/Budget Director

Administrator

Committee

Council

### Purchasing Thresholds



)

Council	Committee.dministratcing/Budget	Advertised	partment H
	\$	-	

PO  
\$ 3,000



**Exclusions/Exemptions-Price must be fair and reasonable.**

*Goods, Services or Other Expenditures that, by nature of what they are, may render the requirement to*

Current Exemption Examples:

Utilities

Membership Dues

Postal stamps and fees

Education/Training

Additional Exclusions:

PO Box rentals

Aircraft Maintenance

Legal Fees

Advertising time and space in radio, television, and social media platforms

**Other Changes**

The County Administrator may approve contract renewals and be exempt from the dollar limitations on expenditure authority identified in this Section 2-509-Authority and duties of purchasing director, paragraph (d-e) Dollar limitations in paragraphs (1-4) provided that the funds have been approved by the county council as part of the annual budget appropriation process, and that any expenditure of funds regardless of the amount will not result in a budget deficit.

*obtain 3 quotes impractical. Normally only one source is available.*

## **Beaufort County Department Heads and Staff Comments** **Supporting the Procurement Code Changes**

### **ACA-Public Safety:**

In reference to the changes for Division 4, Procurement Code:

AS the ACA for the Public Safety Division, I support the presented changes to the threshold amounts in the procurement code. The vast majority of our everyday business is between \$1 and \$100,000; the change will help departments with their everyday operational needs. I am a firm believer that all Ordinances and Policies should be reviewed and changed as necessary to keep up with our changing times.

### **Director Mosquito Control:**

- 1) The recommended Procurement Code changes will encourage an efficient and effective work flow for various County procurement actions
- 2) Standardize cost-saving procurement actions within a timely manner
- 3) Simplify the procurement processes among County Council, various County committees, and/or County staff

### **Human Resources Director:**

I do not have any specific comment other than the changes seemed to be practical and in the spirit of improving the efficiency and agility of the purchasing process. Good work. Thanks for the opportunity to review.

### **Airports Director:**

We like what you are doing and definitely support it. There have been times in the past when important projects that may not qualify, as emergencies but are still time-sensitive have been difficult to accomplish because of lower thresholds and the time it takes to get through the "pipeline." Therefore, the Purchasing Departments plan to align better with other counties similarly sized and situated is a very positive one.

### **ACA-Engineering:**

I fully support this endeavor! An update to this ordinance will significantly allow staff to perform the functions of the County in a more expeditious manner. The change will require fewer resources manage and will allow staff to deliver projects and services more swiftly. I think the documentation detailing the number of expenditures in the proposed range of values displays that this is a small portion of County operations and this level of expenditures does not adversely affect the County's financials. Way to go!!!



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 4.

<b>ITEM TITLE:</b>
<b>AN ORDINANCE AUTHORIZING THE EXECUTION AND DELIVERY OF AN ACCESS AND UTILITY EASEMENT FOR A PORTION OF A RIGHT OF WAY OWNED BY BEAUFORT COUNTY KNOWN AS CASSIDY DRIVE OFF BUCKWALTER PARKWAY IN BLUFFTON TOWNSHIP SOUTH CAROLINA</b>
<b>MEETING NAME AND DATE:</b>
County Council Meeting 10-25-21
<b>PRESENTER INFORMATION:</b>
Jared Fralix, P.E., Assistant County Administrator, Engineering (5 Minutes)
<b>ITEM BACKGROUND:</b>
<b>Item was approved at PFC on 10-18-21</b> The County ownership of Cassidy Drive is recorded in Deed Book 3710 at Page147 on 10-24-2018.
<b>PROJECT / ITEM NARRATIVE:</b>
BJWSA has requested an Access and Utility Easement to for a portion of parcel R610 022 000 1125 0000 located on Cassidy Drive off Buckwalter Parkway in Bluffton Township.
<b>FISCAL IMPACT:</b>
N/A
<b>STAFF RECOMMENDATIONS TO COUNCIL:</b>
Staff recommends approval of Access and Utility Easement to BJWSA
<b>OPTIONS FOR COUNCIL MOTION:</b>
Motion to either Approve or Deny Access and Utility Easement to BJSWA. <i>Next Step – 3 readings and public hearing by County Council</i>

# EXHIBIT A

## “Access and Utility Easement”

TG&D File #0075

STATE OF SOUTH CAROLINA     )  
  )  
COUNTY OF BEAUFORT         )     ACCESS AND UTILITY EASEMENT

WHEREAS, the Grantor is the owner of the property described herein, known as Cassidy Drive, a portion of Buckwalter, Town of Bluffton, Beaufort County, South Carolina; and

NOW, THEREFORE, KNOW ALL MEN BY THESE PRESENTS that Beaufort County, for and in consideration of the sum of TEN AND NO/100 DOLLARS (\$10.00), and no other valuable consideration, in hand paid, the receipt and legal sufficiency of which is hereby acknowledged, has bargained and sold, and by these presents, subject to the terms and conditions contained herein, does bargain, sell, convey, transfer and deliver unto Grantee a permanent utility easement and right-of-way, including the perpetual rights to enter upon the real estate hereinafter described, for the purposes intended herein, to-wit: to enter upon, construct, extend, inspect, operate, replace, relocate, repair, and perpetually maintain upon, over, along, across, through, and under the Easement Area, various water/sewer main and service lines, manholes, hydrants, valves, meters, and other usual fixtures and appurtenances as may from time to time be or become convenient to the transaction of its business, or that of municipal, public or private systems, for the provision of water and sewer services to the Grantor's property, together with the right of ingress, egress, and access to and from, and across and upon lands of Grantor as may be necessary or convenient for the purposes connected therewith.

120

landscaping, back to its pre-construction condition (to the extent Grantee is responsible therefor).

The permanent easement and right-of-way hereby granted to the Grantee consists of a parcel of land as hereinafter described on property as shown on the drawing referenced herein and more particularly described as follows (herein referred to as "Easement Area"):

ALL that certain piece, parcel or tract of land, situate, lying and being in the Town of Bluffton, Beaufort County, South Carolina, consisting of 0.01 acres, 473 SF, more or less, lying within the right-of-way of Cassidy Drive as will be more fully shown and identified as "Beaufort County Utility Easement" on that certain plat entitled "Easement Plat, Access & Utility Easement within Cassidy Drive, Portion of Buckwalter" prepared by Thomas & Hutton, certified by \_\_\_\_\_, SCPLS, dated \_\_\_\_\_, a copy of which is recorded in the Office of the Register of Deeds for Beaufort County, South Carolina, in Plat Book \_\_\_\_\_ at Page \_\_\_\_\_.

This being a portion of the property conveyed to the Grantor herein by deeds recorded in the Office of the Register of Deeds for Beaufort County, South Carolina, in Records Book 3710 at Page 141 and Deed Book 3710 at Page 147.

TAX REF: R610 022 000 1125 0000 (PORTION OF)

AND ALSO, the Grantor grants to the Grantee the right and authority to approve the location of any additional utility easement that might be located within the above-described easement.

To have and to hold said permanent easement unto the Grantee, its Successors and Assigns, forever.

Grantor hereby covenants with the Grantee that it is lawfully seized and possessed of the real estate above-described, that it has good lawful right to convey it, or any part thereof, and that it will forever warrant and forever defend the title thereto against the lawful claims of its successors and assigns.

WITNESS the hands and seals of the undersigned the date and year first above-written.

IN THE PRESENCE OF:

GRANTOR:

COUNTY OF BEAUFORT

\_\_\_\_\_  
witness signature

\_\_\_\_\_  
(printed name of witness)

\_\_\_\_\_  
Notary Public signature

\_\_\_\_\_  
(printed name of Notary Public)

By: \_\_\_\_\_  
(authorized signature)

\_\_\_\_\_  
Eric L. Greenway  
(printed name)

Its: \_\_\_\_\_  
County Administrator  
(printed title)

STATE OF SOUTH CAROLINA        )  
  )  
COUNTY OF CHARLESTON        )

PROBATE

PERSONALLY appeared before me the undersigned witness who made oath that s/he  
saw the within named County of Beaufort by \_\_\_\_\_ its  
\_\_\_\_\_, sign, seal and as its act and deed, deliver the within written  
instrument, and that s/he with the other witness above-named witnessed the execution thereof.

SWORN TO BEFORE ME, this \_\_\_\_\_ day of \_\_\_\_\_, 2021.

\_\_\_\_\_  
(Notary Public signature)

\_\_\_\_\_  
(printed name of Notary Public)  
Notary Public for South Carolina  
My Commission Expires:

\_\_\_\_\_  
witness signature

\_\_\_\_\_  
(printed name of witness)



GRANTEE:

witness signature

(printed name of witness)

\_\_\_\_\_  
(printed name)

Notary Public signature

Its: \_\_\_\_\_  
(printed title)

(printed name of Notary Public)

PROBATE

SWORN TO BEFORE ME, this \_\_\_\_\_ day of \_\_\_\_\_, 2021.

(Notary Public signature)

witness signature

(printed name of witness)

**Ordinance No. 2021/\_\_\_\_****AN ORDINANCE AUTHORIZING THE EXECUTION AND DELIVERY OF AN ACCESS AND UTILITY EASEMENT FOR A PORTION OF A RIGHT OF WAY OWNED BY BEAUFORT COUNTY KNOWN AS CASSIDY DRIVE OFF BUCKWALTER PARKWAY IN BLUFFTON TOWNSHIP SOUTH CAROLINA.**

**WHEREAS**, Beaufort County owns real property (“County Parcel”) known as TMS No. R610 022 000 1125 0000 Right of Way located in the Town of Bluffton, also known as Cassidy Drive off of Buckwalter Parkway; and

**WHEREAS**, Beaufort Jasper Water Sewer Authority has requested that Beaufort County grant an Access and Utility Easement of said property for the purpose of accessing, constructing and servicing various water/sewer functions more particularly described in document entitled “Access and Utility Easement” prepared by the Law firm of Tupper, Grimsley, Dean & Canandy, P.A (attached as Exhibit “A”) and shown on a plat entitled "Easement Plat, Access & Utility Easement within Cassidy Drive, Portion of Buckwalter" prepared by Thomas & Hutton, certified by Robert K. Morgan, III, SCPLS, preliminary dated 09/31/2021 attached as Exhibit “B”; and

**WHEREAS**, Beaufort County Council has determined that it is in its best interest to authorize the execution and delivery of the requested Access and Utility Easement attached as Exhibit “A” and more particularly shown as "Easement Plat, Access & Utility Easement within Cassidy Drive, Portion of Buckwalter" attached as Exhibit “B”; and

**WHEREAS**, S.C. Code Ann. § 4-9-130 requires that the transfer of any interest in real property owned by the County must be authorized by Beaufort County Council and a public hearing must be held.

**NOW, THEREFORE, BE IT ORDAINED BY BEAUFORT COUNTY COUNCIL** that the County Administrator is hereby authorized to execute any and all necessary documents for the conveyance of an Access and Utility Easement for a portion of a right of way owned by Beaufort County and as described on the attached Exhibit “A” (Access and Utility Easement) and Exhibit “B” (Easement Plat, Access & Utility Easement within Cassidy Drive, Portion of Buckwalter).

DONE this \_\_\_\_ day of \_\_\_\_\_ 2021.

COUNTY COUNCIL OF BEAUFORT COUNTY

By: \_\_\_\_\_  
Joseph Passiment, Chairman

ATTEST:

\_\_\_\_\_  
Sarah W. Brock, Clerk to Council

Third and Final Reading:  
Public Hearing:  
Second Reading:  
First Reading:

Z:\25732\25732.1000\Survey\DWG\25732.1000sp01 Beaufort County Esmt.dwg - Aug 31, 2021 - 9:04:45 AM

Exhibit B

BUCKWALTER PARKWAY 120' R/W

953.3' TO U.S. HIGHWAY NO. 278

20' UTILITY EASEMENT

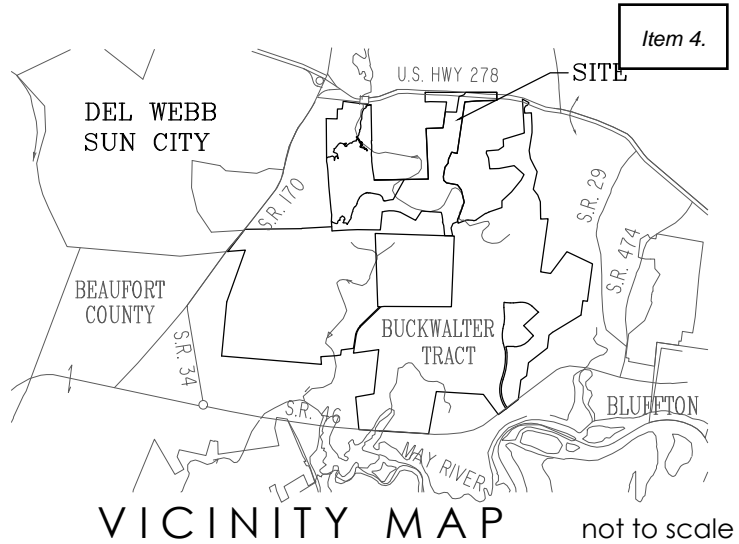
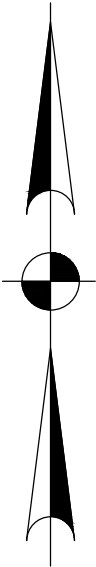
50' PUD BUFFER

LINE TABLE		
LINE	BEARING	LENGTH
L1	N 86°08'00" E	15.00'
L2	S 02°37'52" E	23.19'
L3	S 43°50'08" W	7.03'
L4	S 87°22'07" W	21.78'
L5	N 43°50'08" E	16.38'
L6	N 02°37'52" W	16.43'
L7	S 02°37'53" E	10.00'

NOTES

1. TAX MAP NO. (PARENT TRACT): R610 022 000 1125 0000.
2. ACCORDING TO F.I.R.M. MAP 45013C0270G, EFFECTIVE DATE 3-23-21, THIS PROPERTY FALLS ON ZONE X.
3. COORDINATES AND DIRECTIONS SHOWN ON THIS SURVEY ARE BASED ON SOUTH CAROLINA STATE PLANE COORDINATE SYSTEM (NAD83). DISTANCES SHOWN ARE GROUND DISTANCES, NOT GRID DISTANCES.
4. THIS SURVEY IS VALID ONLY IF THE PRINT OF SAME HAS THE ORIGINAL SIGNATURE AND EMBOSSED SEAL OF THE LAND SURVEYOR.
5. A TITLE SEARCH WAS NOT PERFORMED BY THOMAS & HUTTON ENGINEERING CO. AT THE TIME OF THIS SURVEY.
6. THE PROPERTY PLATTED HEREON IS SUBJECT TO ALL EASEMENTS AND RESTRICTIONS OF RECORD.
7. THE POSITION OF UNDERGROUND UTILITIES SHOWN ON THIS DRAWING IS BASED UPON THE LOCATION OF SURFACE APPURTENANCES AND/OR SURFACE MARKINGS AND SHOULD BE CONSIDERED APPROXIMATE.
8. FOR WETLAND BUFFERS AND SETBACKS REFER TO BUCKWALTER P.U.D. AND ANNEXATION DOCUMENTS.
9. PLAT REFERENCES: PB 150 PAGE 33 & PB 153 PAGE 170.

GRID NORTH



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EASEMENT PLAT  
UTILITY EASEMENT  
WITHIN CASSIDY DRIVE  
PORTION OF  
BUCKWALTER

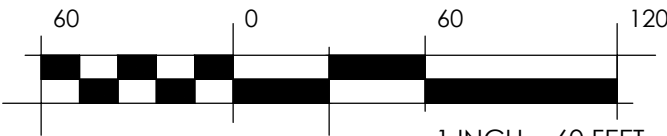
TOWN OF BLUFFTON  
BEAUFORT COUNTY, SOUTH CAROLINA

prepared for  
BEAUFORT COUNTY

**THOMAS  
&  
HUTTON**

50 Park of Commerce Way  
Savannah, GA 31405 • 912.234.5300

www.thomasandhutton.com



plat 08-31-21 drawn LPO reviewed RKM field N/A crew

job 25732.1000

SHEET 1

126

CASSIDY DRIVE R/W VARIES

N: 165,380.31  
E: 2,028,373.88

N 87°22'07" E 188.08'

N: 165,361.69  
E: 2,028,186.45

N/F PARCEL CI, LLC  
PB 150, PAGE 33  
R610 022 000 1122 0000

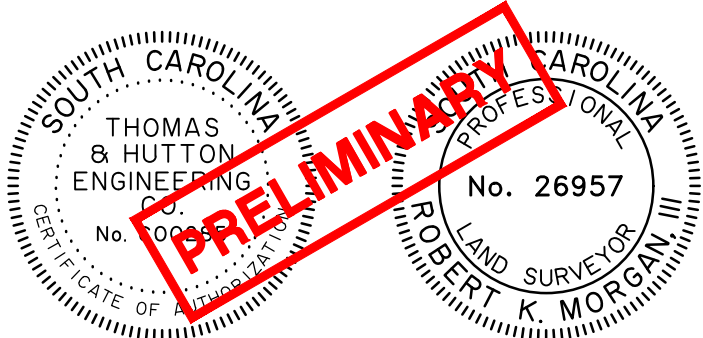
BEAUFORT COUNTY  
UTILITY EASEMENT  
473 SF  
0.01 AC.

BJWSA EASEMENT

N/F BEAUFORT COUNTY  
PB 150, PAGE 33  
R610 022 000 1125 0000

N/F RAYMOND A. AND  
JOHNNIE S. BOYLES, TRUSTEE  
R600 022 000 0013 0000

BJWSA  
PUMP STATION  
CPI64



I HEREBY STATE THAT TO THE BEST OF MY PROFESSIONAL KNOWLEDGE, INFORMATION, AND BELIEF, THE SURVEY SHOWN HEREON WAS MADE IN ACCORDANCE WITH THE REQUIREMENTS OF THE STANDARDS OF PRACTICE MANUAL FOR SURVEYING IN SOUTH CAROLINA, AND MEETS OR EXCEEDS THE REQUIREMENTS FOR A CLASS "A" SURVEY AS SPECIFIED THEREIN.

ROBERT K. MORGAN, III  
SOUTH CAROLINA PROFESSIONAL LAND SURVEYOR  
LICENSE NO. 26957

LEGEND

- MEANDER POINT (NO MONUMENT)
- CONCRETE MONUMENT (FOUND)
- IRON PIPE (FOUND)



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 5.

<b>ITEM TITLE:</b>
AN ORDINANCE DECLARING CERTAIN COUNTY OWNED REAL PROPERTY AS SURPLUS PROPERTY AND AUTHORIZING THE COUNTY ADMINISTRATOR TO EXECUTE ANY AND ALL NECESSARY DOCUMENTS TO SELL REAL PROPERTY IDENTIFIED AS TMS NO. R700 036 000 13J 0000, R700 036 000 0112 0000, R700 036 000 0109 0000, R700 036 000 002C 0000 AND R600 036 000 001B 0000
<b>MEETING NAME AND DATE:</b>
Finance Committee, 10/12/2021
<b>PRESENTER INFORMATION:</b>
Brittany Ward, Deputy County Attorney 10 Minutes
<b>ITEM BACKGROUND:</b>
County staff presented to County Council on August 19, 2021 at a Special Called meeting.
<b>PROJECT / ITEM NARRATIVE:</b>
County staff and legal department reviewed County owned real property and have determined that the use of real property identified as TMS NO. R700 036 000 13J 0000, R700 036 000 0112 0000, R700 036 000 0109 0000, R700 036 000 002C 0000 AND R600 036 000 001B 0000 has discontinued. The properties are vacant and unoccupied. Appraisals on the aforementioned properties have or will be completed prior to advertising the sale of the property.
<b>FISCAL IMPACT:</b>
The sale of real property will be for an amount equal to or greater than fair market value.
<b>STAFF RECOMMENDATIONS TO COUNCIL:</b>
Approve to sell surplus properties.
<b>OPTIONS FOR COUNCIL MOTION:</b>
Disapprove. Move forward to Council for First Reading on October 25, 2021.

**ORDINANCE 2021/\_\_\_\_\_**

**AN ORDINANCE DECLARING CERTAIN COUNTY OWNED REAL PROPERTY AS SURPLUS PROPERTY AND AUTHORIZING THE COUNTY ADMINISTRATOR TO EXECUTE ANY AND ALL NECESSARY DOCUMENTS TO SELL REAL PROPERTY IDENTIFIED AS TMS NO. R700 036 000 13J 0000, R700 036 000 0112 0000, R700 036 000 0109 0000, R700 036 000 002C 0000 AND R600 036 000 001B 0000**

**WHEREAS**, Beaufort County (“County”) is the sole owner of the real properties with TMS Nos. R700 036 000 13J 0000, R700 036 000 0112 0000, R700 036 000 0109 0000, R700 036 000 002C 0000 and R600 036 000 001B 0000; hereinafter individually referenced as “Property” and collectively as “Properties”; and

**WHEREAS**, the County has determined that any use of the Properties has been discontinued, thereby leaving the Properties vacant and unoccupied; and

**WHEREAS**, each Property shall be sold at or above the fair market value, whereby such fair market value shall be determined by a licensed appraiser; and

**WHEREAS**, the County shall publicly advertise the sale of the Properties, and any bids for purchase received shall be reviewed and accepted by the County Administrator, or his designee, based on a purchase price and subsequent use of the property; and

**WHEREAS**, Beaufort County Council has determined that it is in the best interest of the citizens of Beaufort County to declare the Properties as surplus property and to sell the Properties upon such terms and conditions as may be most favorable to the County.

**NOW, THEREFORE, BE IT ORDAINED** by Beaufort County Council, that the above-described Properties be declared surplus property and authorize the County Administrator to execute any and all necessary documents to sell the surplus Properties upon such terms and conditions as determined to be reasonably prudent and in the best interest of the citizens of Beaufort County.

ADOPTED this \_\_\_\_ day of \_\_\_\_\_ 2021.

COUNTY COUNCIL OF BEAUFORT COUNTY

By: \_\_\_\_\_  
Joseph F. Passiment, Chairman

ATTEST:

\_\_\_\_\_  
Sarah W. Brock, Clerk to Council

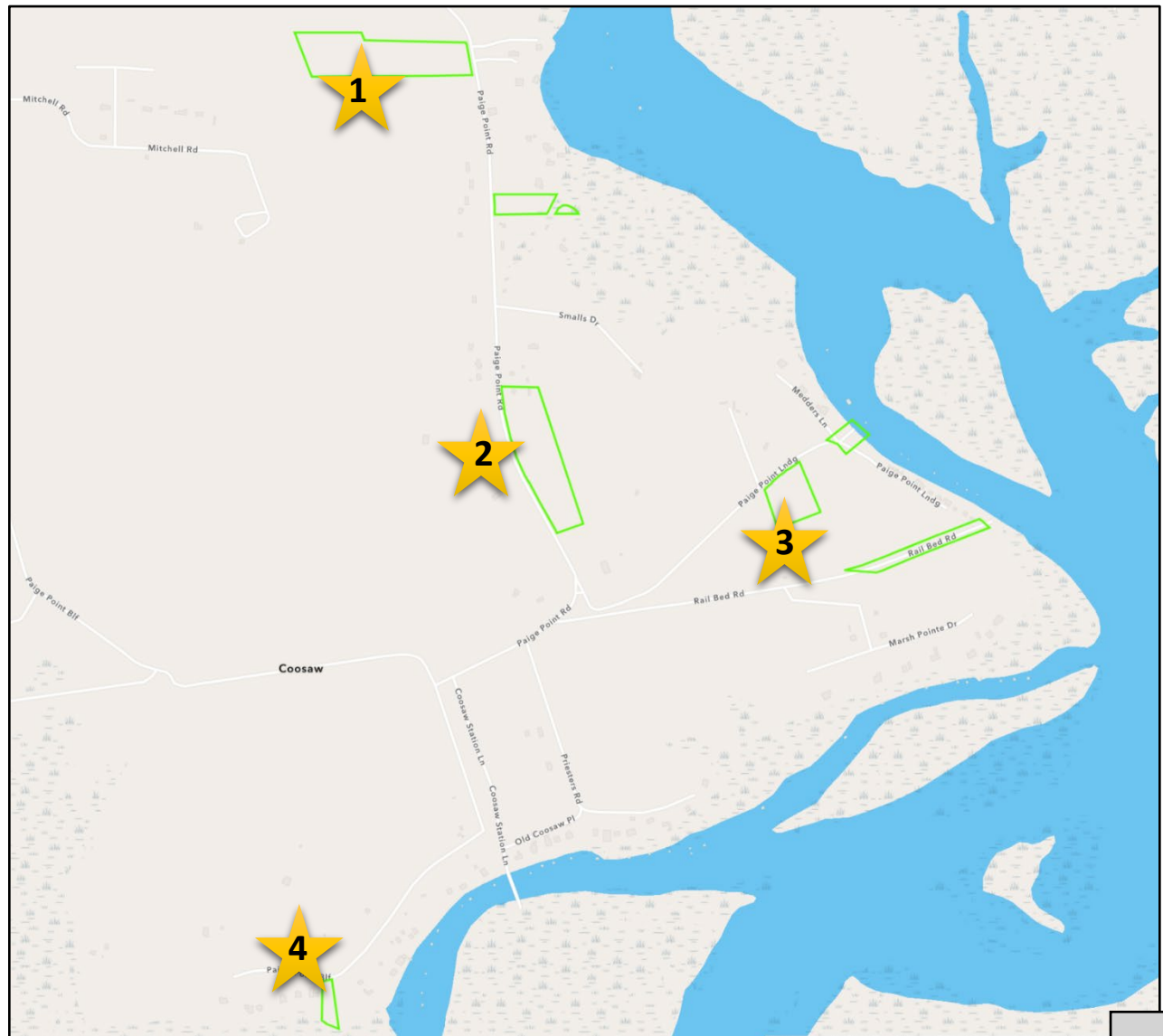
# PAIGE POINT AREA PROPERTIES

**1. R700 036 000 002C 0000**  
*616 Paige Point Road*

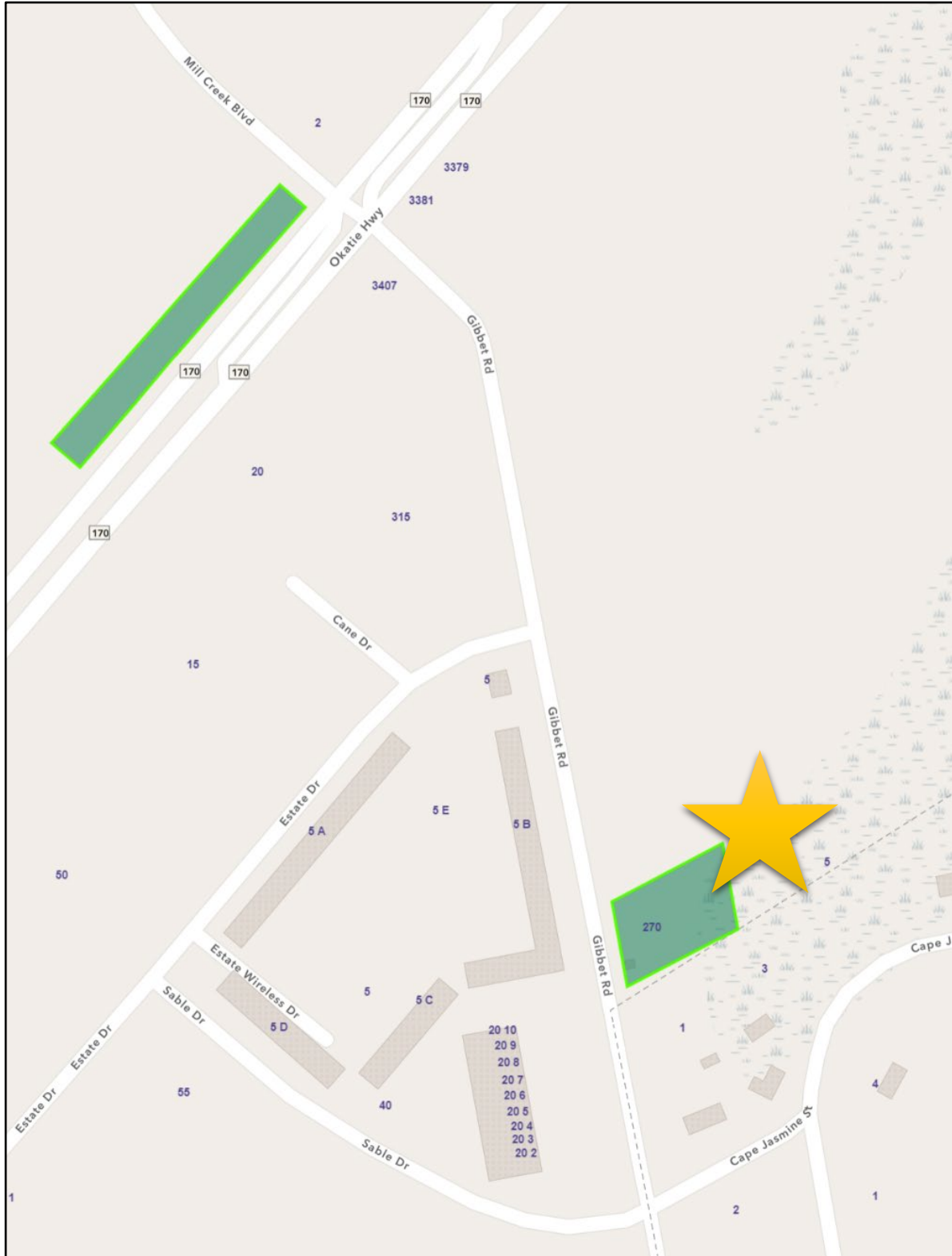
**2. R700 036 000 0112 0000**  
*743 Paige Point Road*

**3. R700 036 000 0109 000**

**4. R700 036 000 013J 0000**  
*465 Paige Point Bluff*



**R600 036 000 001B 0000**  
**270 GIBBET ROAD**







## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 6.

<b>ITEM TITLE:</b>
AN ORDINANCE ADOPTING UPDATES TO THE SOUTHERN LOWCOUNTRY DESIGN MANUAL (\$0.00)
<b>MEETING NAME AND DATE:</b>
Natural Resources Committee – November 1, 2021
<b>PRESENTER INFORMATION:</b>
Jared Fralix, ACE – Engineering Neil Desai, P.E - Public Works Director ( <i>Alternate</i> ) (5 min)
<b>ITEM BACKGROUND:</b>
January 11 <sup>th</sup> , 2021 – County Council Approved adoption of Southern Lowcountry Design Manual October 13 <sup>th</sup> , 2021 – Stormwater Utility Board approved proposed updates to the Southern Lowcountry Design Manual.
<b>PROJECT / ITEM NARRATIVE:</b>
As Beaufort County has implemented the Southern Lowcountry Design Manual, staff has recognized the need for updates to be made to stay current as knowledge in our field improves. Updates to this manual also include process improvements for the development community in Beaufort County. The manual updates are consistent with the regional standards for those who have adopted the Southern Lowcountry Design Manual.
<b>FISCAL IMPACT:</b>
There are no fiscal impacts associated with the adoption of the Southern Lowcountry Design Manual updates.
<b>STAFF RECOMMENDATIONS TO COUNCIL:</b>
Staff recommends approval of the proposed Southern Lowcountry Design Manual updates.
<b>OPTIONS FOR COUNCIL MOTION:</b>
Motion to approve/deny the adoption of the proposed Southern Lowcountry Design Manual updates. <i>(Next Step – Upon approval, send to County Council for First Reading)</i>

**A ORDINANCE TO AMEND THE STORMWATER MANAGEMENT UTILITY ORDINANCE AS ADOPTED SEPTEMBER 26, 2016 TO PROVIDE FOR THE ADOPTION OF STORMWATER MANAGEMENT STANDARDS SET FORTH IN THE SOUTHERN LOWCOUNTRY DESIGN MANUAL TO MEET THE MUNICIPAL SEPARATE STORMSEWER SYSTEM (MS4) PERMIT REQUIREMENTS**

**WHEREAS**, Act 283 of 1975, The Home Rule Act, vested Beaufort County Council with the independent authority to control all acts and powers of local governmental authority that are not expressly prohibited by South Carolina law; and

**WHEREAS**, Chapter 99, Article II, “Stormwater Management Utility” was adopted on August 27, 2001 and was modified by ordinance on August 22, 2005, September 28, 2015 and September 26, 2016; and

**WHEREAS**, Stormwater Management Utility was established for the purpose of managing, acquiring, constructing, protecting, operating, maintaining, enhancing, controlling, and regulating the use of stormwater drainage systems in the county; and

**WHEREAS**, pursuant to the requirements mandated by the Municipal Separate Stormsewer System (MS4) permit issued by the South Carolina Department of Health and Environmental Control (DHEC) on December 1, 2015, Beaufort County is required to adopt standards related to Stormwater management and create a regulatory framework to enforce the same; and

**WHEREAS**, County Council adopted the Southern Lowcountry Design Manual on January 11th, 2021 as the source of the technical stormwater standards used in the development of Stormwater Plans; and

**WHEREAS**, County Council desires to authorize the County Administrator to adopt the updates to the Southern Lowcountry Design Manual;

**NOW THEREFORE, BE IT RESOLVED, THAT BEAUFORT COUNTY COUNCIL**, in a meeting duly assembled, does hereby authorize the County Administrator to adopt and implement Southern Lowcountry Design Manual attached hereto and made part of this Ordinance:

**ADOPTED**, this \_\_\_\_ day of \_\_\_\_\_, 2021.

COUNTY COUNCIL OF BEAUFORT COUNTY

BY: \_\_\_\_\_  
Joseph Passiment, Chairman

ATTEST:

\_\_\_\_\_

# Southern Lowcountry Stormwater Design Manual

Stormwater Best Management Practices

Prepared by

March 2020

**Lead Authors:**

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Greg Hoffmann, P.E., Center for Watershed Protection

Kathryn Ellis, EIT, McCormick Taylor

**Southern Lowcountry Stormwater Technical Subcommittee:**

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Nate Farrow, City of Beaufort

Katie Herrera, CEPSCI, CSPR, Beaufort County

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Rhett Lott, City of Hardeeville

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Sarah Ryan, formerly Center for Watershed Protection

Nehemiah Stewart, McCormick Taylor

Ellen Zagrobelny, Center for Watershed Protection

# Table of Contents

<b>CHAPTER 1. INTRODUCTION, BACKGROUND, PURPOSE, AND ADMINISTRATION .....</b>	<b>1</b>
1.1 INTRODUCTION .....	1
1.2 BACKGROUND.....	1
1.3 PURPOSE.....	2
1.4 APPLICABILITY AND EXEMPTIONS.....	2
1.4.1 <i>Applicability</i> .....	2
1.4.2 <i>Exemptions</i> .....	2
1.5 ADMINISTRATION .....	3
1.5.1 <i>Approval Requirements</i> .....	3
1.5.2 <i>Fees</i> .....	3
<b>CHAPTER 2. DESIGN, REVIEW, &amp; PERMITTING PROCESS.....</b>	<b>4</b>
2.1 SATISFYING THE STORMWATER MANAGEMENT, SITE PLANNING, & DESIGN CRITERIA .....	4
2.1.1 <i>Overview</i> .....	4
2.1.2 <i>Better Site Design in the Planning Process</i> .....	4
2.1.3 <i>Natural Resources Inventory</i> .....	6
2.1.4 <i>Conservation Development</i> .....	8
2.1.5 <i>Residential Streets &amp; Parking Lots</i> .....	9
2.1.6 <i>Lot Development Principles to Meet Requirements</i> .....	10
2.1.7 <i>Site Planning &amp; Design Process</i> .....	12
2.1.8 <i>Integrating Natural Resource Protection &amp; Stormwater Management with the Site Planning &amp; Design Process</i> .....	15
2.2 SUBMITTAL & REVIEW PROCESS OF STORMWATER MANAGEMENT PLANS .....	19
2.2.1 <i>Components of a Stormwater Management Plan</i> .....	20
2.2.2 <i>Resubmission of Stormwater Management Plans</i> .....	23
2.2.3 <i>Design Certifications</i> .....	24
2.2.4 <i>Performance Bonds</i> .....	24
2.3 CONSTRUCTION INSPECTION REQUIREMENTS.....	25
2.3.1 <i>Inspection Schedule &amp; Reports</i> .....	25
2.3.2 <i>Inspection Requirements Before &amp; During Construction</i> .....	25
2.3.3 <i>Final Construction Inspection Reports</i> .....	27
2.3.4 <i>Inspection for Preventative Maintenance</i> .....	27
2.4 INSPECTIONS & MAINTENANCE .....	28
2.4.1 <i>Inspections &amp; Maintenance Responsibilities</i> .....	28
2.4.2 <i>Inspection &amp; Maintenance Agreements</i> .....	28
2.5 AS-BUILT SUBMITTALS .....	29
2.6 REFERENCES.....	30
<b>CHAPTER 3. MINIMUM CONTROL REQUIREMENTS .....</b>	<b>32</b>
3.1 INTRODUCTION .....	32
3.2 REGULATED SITE DEFINITION .....	32
3.3 INFILL & REDEVELOPMENT .....	34
3.4 STORMWATER RUNOFF QUALITY & PEAK DISCHARGE CONTROL.....	34
3.5 SOUTHERN LOWCOUNTRY STORMWATER MANAGEMENT PERFORMANCE REQUIREMENTS.....	35
3.5.1 <i>Watershed Protection Area Designations</i> .....	35
3.5.2 <i>Overall Performance Requirements</i> .....	38

3.5.3	<i>Southern Lowcountry Stormwater Precipitation &amp; Runoff</i> .....	40
3.5.4	<i>Savannah River Watershed Protection Area</i> .....	40
3.5.5	<i>Bacteria &amp; Shellfish Watershed Protection Area</i> .....	41
3.5.6	<i>General Stormwater Management Watershed Area</i> .....	41
3.5.7	<i>Runoff Reduction &amp; Pollutant Removal</i> .....	41
3.6	EROSION & SEDIMENT CONTROL (ESC) REQUIREMENTS .....	43
3.7	RETENTION STANDARD & VOLUME.....	43
3.7.1	<i>Total Suspended Solids, Nutrients, &amp; Bacteria</i> .....	45
3.7.2	<i>Hydrologic &amp; Hydraulic Analysis</i> .....	45
3.7.3	<i>Maintenance Easements</i> .....	47
3.8	EXTREME FLOOD REQUIREMENT: 10% RULE .....	48
3.9	MAXIMUM EXTENT PRACTICABLE.....	49
3.10	OFF-SITE STORMWATER MANAGEMENT.....	50
3.11	FEE-IN-LIEU .....	51
3.12	WAIVERS .....	51
3.13	REFERENCES.....	52
CHAPTER 4. STORMWATER BEST MANAGEMENT PRACTICES (BMPS) .....		54
4.1	STANDARD STORMWATER BMP DESIGN SECTIONS .....	54
4.1.1	<i>Format of Standard Stormwater BMP Design Sections</i> .....	54
4.1.2	<i>Standard Nomenclature</i> .....	54
4.2	SUMMARY OF BMP STORMWATER MANAGEMENT CAPABILITIES, SITE APPLICABILITY, & PHYSICAL FEASIBILITY.....	54
4.2.1	<i>Stormwater Retention &amp; Water Quality Treatment</i> .....	55
4.2.2	<i>Site Applicability</i> .....	55
4.2.3	<i>Site Conditions &amp; Physical Feasibility</i> .....	56
4.3	BIORETENTION .....	58
4.3.1	<i>Bioretention Feasibility Criteria</i> .....	62
4.3.2	<i>Bioretention Conveyance Criteria</i> .....	65
4.3.3	<i>Bioretention Pretreatment Criteria</i> .....	67
4.3.4	<i>Bioretention Design Criteria</i> .....	68
4.3.5	<i>Bioretention Landscaping Criteria</i> .....	82
4.3.6	<i>Bioretention Construction Sequence</i> .....	88
4.3.7	<i>Bioretention Maintenance Criteria</i> .....	90
4.3.8	<i>Bioretention Stormwater Compliance Calculations</i> .....	92
4.3.9	<i>References</i> .....	93
4.4	PERMEABLE PAVEMENT SYSTEMS .....	96
4.4.1	<i>Permeable Pavement Feasibility Criteria</i> .....	99
4.4.2	<i>Permeable Pavement Conveyance Criteria</i> .....	102
4.4.3	<i>Permeable Pavement Pretreatment Criteria</i> .....	102
4.4.4	<i>Permeable Pavement Design Criteria</i> .....	102
4.4.5	<i>Permeable Pavement Landscaping Criteria</i> .....	109
4.4.6	<i>Permeable Pavement Construction Sequence</i> .....	109
4.4.7	<i>Permeable Pavement Maintenance Criteria</i> .....	114
4.4.8	<i>Permeable Pavement Stormwater Compliance Calculations</i> .....	115
4.4.9	<i>References</i> .....	117
4.5	INFILTRATION PRACTICES .....	118
4.5.1	<i>Infiltration Feasibility Criteria</i> .....	123
4.5.2	<i>Infiltration Conveyance Criteria</i> .....	125
4.5.3	<i>Infiltration Pretreatment Criteria</i> .....	126

4.5.4	<i>Infiltration Design Criteria</i>	126
4.5.5	<i>Infiltration Landscaping Criteria</i>	130
4.5.6	<i>Infiltration Construction Sequence</i>	130
4.5.7	<i>Infiltration Maintenance Criteria</i>	132
4.5.8	<i>Infiltration Stormwater Compliance Calculations</i>	133
4.5.9	<i>References</i>	134
4.6	<b>GREEN ROOFS</b>	135
4.6.1	<i>Green Roof Feasibility Criteria</i>	137
4.6.2	<i>Green Roof Conveyance Criteria</i>	139
4.6.3	<i>Green Roof Pretreatment Criteria</i>	139
4.6.4	<i>Green Roof Design Criteria</i>	139
4.6.5	<i>Green Roof Landscaping Criteria</i>	145
4.6.6	<i>Green Roof Construction Sequence</i>	147
4.6.7	<i>Green Roof Maintenance Criteria</i>	148
4.6.8	<i>Green Roof Stormwater Compliance Calculations</i>	149
4.6.9	<i>References</i>	150
4.7	<b>RAINWATER HARVESTING</b>	151
4.7.1	<i>Rainwater Harvesting Feasibility Criteria</i>	154
4.7.2	<i>Rainwater Harvesting Conveyance Criteria</i>	157
4.7.3	<i>Rainwater Harvesting Pretreatment Criteria</i>	157
4.7.4	<i>Rainwater Harvesting Design Criteria</i>	159
4.7.5	<i>Rainwater Harvesting Landscaping Criteria</i>	170
4.7.6	<i>Rainwater Harvesting Construction Sequence</i>	170
4.7.7	<i>Rainwater Harvesting Maintenance Criteria</i>	171
4.7.8	<i>Rainwater Harvesting Stormwater Compliance Calculations</i>	172
4.7.9	<i>References</i>	173
4.8	<b>IMPERVIOUS SURFACE DISCONNECTION</b>	175
4.8.1	<i>Impervious Surface Disconnection Feasibility Criteria</i>	176
4.8.2	<i>Impervious Surface Disconnection Conveyance Criteria</i>	177
4.8.3	<i>Impervious Surface Disconnection Pretreatment Criteria</i>	177
4.8.4	<i>Impervious Surface Disconnection Design Criteria</i>	177
4.8.5	<i>Impervious Surface Disconnection Landscaping Criteria</i>	178
4.8.6	<i>Impervious Surface Disconnection Construction Sequence</i>	178
4.8.7	<i>Impervious Surface Disconnection Maintenance Criteria</i>	179
4.8.8	<i>Impervious Surface Disconnection Stormwater Compliance Calculations</i>	179
4.8.9	<i>References</i>	180
4.9	<b>OPEN CHANNEL SYSTEMS</b>	181
4.9.1	<i>Open Channel Feasibility Criteria</i>	186
4.9.2	<i>Open Channel Conveyance Criteria</i>	189
4.9.3	<i>Open Channel Pretreatment Criteria</i>	189
4.9.4	<i>Open Channel Design Criteria</i>	190
4.9.5	<i>Open Channel Landscaping Criteria</i>	203
4.9.6	<i>Open Channel Construction Sequence</i>	204
4.9.7	<i>Open Channel Maintenance Criteria</i>	206
4.9.8	<i>Open Channel Stormwater Compliance Calculations</i>	207
4.9.9	<i>References</i>	209
4.10	<b>FILTERING SYSTEMS</b>	211
4.10.1	<i>Filtering System Feasibility Criteria</i>	220
4.10.2	<i>Filtering System Conveyance Criteria</i>	221

4.10.3	<i>Filtering System Pretreatment Criteria</i>	222
4.10.4	<i>Filtering System Design Criteria</i>	222
4.10.5	<i>Filtering System Landscaping Criteria</i>	227
4.10.6	<i>Filtering System Construction Sequence</i>	227
4.10.7	<i>Filtering System Maintenance Criteria</i>	229
4.10.8	<i>Filtering System Stormwater Compliance Calculations</i>	230
4.10.9	<i>References</i>	230
4.11	<b>STORAGE PRACTICES</b>	232
4.11.1	<i>Storage Feasibility Criteria</i>	235
4.11.2	<i>Storage Conveyance Criteria</i>	237
4.11.3	<i>Storage Pretreatment Criteria</i>	238
4.11.4	<i>Storage Design Criteria</i>	239
4.11.5	<i>Storage Landscaping Criteria</i>	240
4.11.6	<i>Storage Construction Sequence</i>	241
4.11.7	<i>Storage Maintenance Criteria</i>	243
4.11.8	<i>Storage Stormwater Compliance Calculations</i>	244
4.11.9	<i>References</i>	244
4.12	<b>PONDS</b>	245
4.12.1	<i>Pond Feasibility Criteria</i>	249
4.12.2	<i>Pond Conveyance Criteria</i>	250
4.12.3	<i>Pond Pretreatment Criteria</i>	252
4.12.4	<i>Pond Design Criteria</i>	252
4.12.5	<i>Pond Landscaping Criteria</i>	257
4.12.6	<i>Pond Construction Sequence</i>	258
4.12.7	<i>Pond Maintenance Criteria</i>	259
4.12.8	<i>Pond Stormwater Compliance Calculations</i>	261
4.12.9	<i>References</i>	261
4.13	<b>STORMWATER WETLANDS</b>	264
4.13.1	<i>Stormwater Wetland Feasibility Criteria</i>	268
4.13.2	<i>Stormwater Wetland Conveyance Criteria</i>	270
4.13.3	<i>Stormwater Wetland Pretreatment Criteria</i>	270
4.13.4	<i>Stormwater Wetland Design Criteria</i>	271
4.13.5	<i>Stormwater Wetland Construction Sequence</i>	273
4.13.6	<i>Stormwater Wetland Landscaping Criteria</i>	276
4.13.7	<i>Stormwater Wetland Maintenance Criteria</i>	281
4.13.8	<i>Stormwater Wetland Stormwater Compliance Calculations</i>	282
4.13.9	<i>References</i>	282
4.14	<b>TREE PLANTING &amp; PRESERVATION</b>	283
4.14.1	<i>Preserving Existing Trees during Construction</i>	284
4.14.2	<i>Planting Trees</i>	287
4.14.3	<i>Tree Inspection Criteria</i>	292
4.14.4	<i>Tree Maintenance Criteria</i>	292
4.14.5	<i>Tree Stormwater Compliance Calculations</i>	293
4.14.6	<i>References</i>	293
4.15	<b>PROPRIETARY PRACTICES</b>	297
4.15.1	<i>Proprietary Practice Feasibility Criteria</i>	298
4.15.2	<i>Proprietary Practice Conveyance Criteria</i>	298
4.15.3	<i>Proprietary Practice Pretreatment Criteria</i>	298
4.15.4	<i>Proprietary Practice Design Criteria</i>	298



4.15.5	<i>Proprietary Practice Landscaping Criteria</i> .....	299
4.15.6	<i>Proprietary Practice Construction Sequence</i> .....	299
4.15.7	<i>Proprietary Practice Maintenance Criteria</i> .....	299
4.15.8	<i>Proprietary Practice Stormwater Compliance Calculations</i> .....	299
4.15.9	<i>References</i> .....	299
4.16	CONSERVATION AREA .....	301
4.16.1	<i>Scenario 1: Natural Conservation Area</i> .....	301
4.16.2	<i>Scenario 2: Reforestation/Revegetation</i> .....	301
4.16.3	<i>Scenario 3: Soil Restoration</i> .....	301
4.16.4	<i>Scenario 4: Reforestation/Revegetation &amp; Soil Restoration</i> .....	301
CHAPTER 5. EROSION & SEDIMENT CONTROL .....		302
5.1	SEDIMENTATION CYCLE .....	302
5.2	FACTORS INFLUENCING EROSION .....	302
5.3	CONCEPTS OF EROSION & SEDIMENT CONTROL .....	302
5.4	GENERAL CRITERIA .....	303
5.5	REFERENCES .....	304
CHAPTER 6. ENFORCEMENT & VIOLATIONS .....		305

## List of Figures

### Chapter 2

Figure 2.1. Conservation (i.e., cluster) development versus conventional development. ....	8
Figure 2.2. Site planning & design process (source: Center for Watershed Protection, Inc.) .....	12
Figure 2.3. Conventional Site Design (source: Merrill et al., 2006) .....	14
Figure 2.4. Conservation Site Design (source: Merrill et al., 2006) .....	14
Figure 2.5. New Urbanist Site Design (source: Merrill et al., 2006) .....	15
Figure 2.6. Integrating Natural Resource Protection & Stormwater Management with the Site Planning & Design Process (source: Center for Watershed Protection, Inc.). ....	17
Figure 2.7. Buildable Area and Primary/Secondary Conservation Areas (source: Merrill et al., 2006) .....	18

### Chapter 3

Figure 3.1. Southern Lowcountry Stormwater Design Manual applicability diagram .....	33
Figure 3.2. Watershed Protection Areas of the Southern Lowcountry. ....	37

### Chapter 4

Figure 4.1. Bioretention in parking lot (photo credit: Center for Watershed Protection, Inc.) .....	59
Figure 4.2. Example bioretention design without an underdrain .....	60
Figure 4.3. Example bioretention design with internal water storage (IWS) .....	61
Figure 4.4. Example standard bioretention design .....	61
Figure 4.5. Example streetscape bioretention. ....	62
Figure 4.6. Example design of an on-line bioretention with an overflow structure .....	67
Figure 4.7. Example design of a bioretention with an observation well/cleanout device. ....	74
Figure 4.8. Example design of a tree box .....	78
Figure 4.9. Example design of a tree box with compacted media extending below sidewalk. ....	79
Figure 4.10. Example design of a stormwater planter (B-4) .....	80

Figure 4.11. Cross-section of permeable pavement (source: ICPI).....	97
Figure 4.12. Cross-section of a standard permeable pavement design.....	98
Figure 4.13. Cross-section of an enhanced permeable pavement design with an underdrain .....	99
Figure 4.14. Cross-section of an enhanced permeable pavement design without an underdrain.....	99
Figure 4.15. Use of flow barriers to encourage infiltration on sloped sites. ....	103
Figure 4.16. Infiltration practice in median strip. ....	119
Figure 4.17. Example design of an infiltration trench.....	120
Figure 4.18. Example design of an infiltration practice with supplemental pipe storage. ....	121
Figure 4.19. Example design of an infiltration basin.....	122
Figure 4.20. Green roof (photo: Center for Watershed Protection, Inc.) .....	136
Figure 4.21. Green roof layers (note: the relative placement of various layers may vary depending on the type and design of the green roof system). ....	140
Figure 4.22. Design requirements for structures constructed above green roofs .....	144
Figure 4.23. Example cistern application (photo: Marty Morganello).....	152
Figure 4.24. Example of a rainwater harvesting system detail .....	154
Figure 4.25. Diagram of a first flush diverter (photo: Texas Water Development Board, 2005).....	158
Figure 4.26. Diagram of a roof washer (photo: Texas Water Development Board, 2005) .....	159
Figure 4.27. Cistern Design 1: Storage associated with the design storm volume only. ....	163
Figure 4.28. Cistern Design 2: Storage associated with design storm, channel protection, and flood volume. ....	164
Figure 4.29. Cistern Design 3: Constant drawdown version where storage is associated with design storm, channel protection, and flood volume. ....	165
Figure 4.30. Incremental design volumes associated with cistern sizing .....	167
Figure 4.31. Example of graph showing Average Available Storage Volume and Overflow Volume for an example cistern design. ....	169
Figure 4.32. Rooftop disconnection (photo: Center for Watershed Protection, Inc.) .....	176
Figure 4.33. Open channel (photo: Center for Watershed Protection, Inc.) .....	182
Figure 4.34. Grass channel typical plan, profile, and section views (O-1) .....	183
Figure 4.35. Example of a dry swale/bioswale (O-2) .....	184
Figure 4.36. Example of a wet swale (O-3) .....	185
Figure 4.37. Example of Regenerative Stormwater Conveyance (O-4) .....	186
Figure 4.38. Typical Width and Depth of Riffle Sections (Anne Arundel County, 2011).....	202
Figure 4.39. Typical schematic for a nonstructural or surface sand filter (note: material specifications are found in Table 4.44) .....	213
Figure 4.40. Example of a three-chamber underground sand filter (F-3) for separate sewer options. Part A. Note: material specifications are indicated in Table 4.44. ....	214
Figure 4.41. Example of a three-chamber underground sand filter (F-3) for separate sewer areas. Part B. Note: material specifications are indicated in Table 4.44. ....	215
Figure 4.42. Example of a three-chamber underground sand filter (F-3) for separate sewer areas. Part C. Note: material specifications are indicated in Table 4.44. ....	216
Figure 4.43. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part A. Note: Material specifications are indicated in Table 4.44. ....	217
Figure 4.44. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part B. Note: Material specifications are indicated in Table 4.44. ....	218

Figure 4.45. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part C. Note: Material specifications are indicated in Table 4.44. ....	219
Figure 4.46. Example of a perimeter sand filter (F-4). Note: material specifications are indicated in Table 4.44. ....	220
Figure 4.47. Dry Extended Detention Pond (Photo: Center for Watershed Protection, Inc.).....	233
Figure 4.45 Example of an underground detention vault and/or tank (S-1) .....	234
Figure 4.46 Example of a dry detention pond (S-2) .....	235
Figure 4.47 Wet Pond (photo: Denise Sanger).....	246
Figure 4. 48 Design schematics for a wet pond (C-2).....	247
Figure 4. 49 Typical extended detention pond (C-3) details. ....	248
Figure 4.50 Stormwater Wetland at Carolina Forest Recreation Center, Myrtle Beach (photo: Kathryn Ellis).....	265
Figure 4.51 Example of extended detention shallow wetland. ....	267
Figure 4.52 Cross section of a typical stormwater wetland.....	268
Figure 4.53 Interior wetland zones. Adapted from Hunt et al. (2007) .....	268
Figure 4.54 Tree Planting and Preservation in Bioretention (photo: Center for Watershed Protection, Inc.). ....	284
Figure 4.55. Tree planting guidelines. Adapted from Flott, 2004 and ISA, 2003b.....	290
Figure 4.56 Trees planted on steep slopes require a constructed level planting surface.....	291

## List of Tables

### Chapter 2

Table 2. 1. Summary of land cover changes in Southern Lowcountry from 1996 to 2010. ....	5
Table 2.2. Resources to be identified and mapped during the Natural Resources Inventory.....	7
Table 2. 3. Better Site Design principles for conservation. ....	9
Table 2.4. Better Site Design principles for streets and parking to meet <local jurisdiction> requirements. ....	10
Table 2. 5. Better Site Design principles for lot development. ....	11

### Chapter 3

Table 3.1. Watershed Protection Area HUC-12 Codes. ....	38
Table 3.2. Watershed Area Overall Performance Requirements .....	39
Table 3.3. Pollutant Removal Efficiencies of Structural BMPs.....	42
Table 3.4. Rainfall depth (inches) for the Southern Lowcountry.....	46
Table 3.5. Drainage maintenance access easements. ....	48

### Chapter 4

Table 4.1. Site applicability for BMPs.....	55
Table 4.2. Feasibility limitations for BMPs.....	57
Table 4.3. Maximum contributing drainage area (CDA) to bioretention.....	63
Table 4.4. Filter media grain size distribution.....	71
Table 4.5. Summary of filter media criteria for bioretention .....	72
Table 4.6. Bioretention material specifications. ....	76
Table 4.7. Bioretention-appropriate plants: perennial and grass.....	83

Table 4.8. Bioretention-appropriate plants: shrubs and bushes .....	86
Table 4.9. Typical maintenance tasks for bioretention practices. ....	91
Table 4.10. Retention and pollutant removal for bioretention practices without underdrains.....	92
Table 4.11. Retention and pollutant removal for bioretention practices with IWS design. ....	93
Table 4.12. Retention and pollutant removal for standard bioretention practices. ....	93
Table 4.13. Permeable pavement specifications for a variety of typical surface materials. ....	105
Table 4.14. Material specifications for typical layers beneath the surface of permeable pavements. ....	106
Table 4.15. Typical maintenance tasks for permeable pavement practices.....	115
Table 4.16. Retention and pollutant removal for enhanced permeable pavement practices.....	116
Table 4.17. Retention and pollutant removal for standard permeable pavement practices. ....	116
Table 4.18. Infiltration practice material specifications. ....	128
Table 4.19. Maximum facility depth for infiltration practices. ....	129
Table 4.20. Typical maintenance activities for infiltration practices. ....	133
Table 4.21. Retention and pollutant removal for infiltration practices. ....	133
Table 4.22. Extensive Green Roof Material Specifications .....	142
Table 4.23. Ground Covers Appropriate for Green Roofs in the State of South Carolina .....	145
Table 4.24. Typical Maintenance Activities Associated with Green Roofs .....	149
Table 4.25. Retention and pollutant removal of green roofs .....	149
Table 4.26. Advantages and Disadvantages of Typical Cistern Materials.....	161
Table 4.27. Design Specifications for Rainwater Harvesting Systems .....	162
Table 4.28. Typical Maintenance Tasks for Rainwater Harvesting Systems .....	172
Table 4.29. Rainwater Harvesting Retention and Pollutant Removal.....	173
Table 4.30. Feasibility Criteria for Disconnection .....	177
Table 4.31. Disconnection Retention and Pollutant Removal .....	180
Table 4.32. Typical Check Dam Spacing to Achieve Effective Channel Slope .....	191
Table 4.33. Grass Channel Material Specifications.....	193
Table 4.34. Dry Swale Material Specifications.....	194
Table 4.35. Regenerative Stormwater Conveyance System Material Specifications .....	196
Table 4.36. Maximum Allowable Velocity.....	203
Table 4.37. Recommended Vegetation for Open Channels.....	204
Table 4.38. Typical Maintenance Activities and Schedule for Open Channels.....	207
Table 4.39. Grass Channel Retention and Pollutant Removal .....	207
Table 4.40. Grass Channel on Amended Soils Retention and Pollutant Removal .....	208
Table 4.41. Dry Swale Retention and Pollutant Removal .....	208
Table 4.42. Wet Swale Retention and Pollutant Removal .....	208
Table 4.43. RSC Retention and Pollutant Removal .....	209
Table 4.44. Filtering Practice Material Specifications.....	225
Table 4.45. Typical Annual Maintenance Activities for Filtering Practices .....	229
Table 4.46. Filter Retention and Pollutant Removal.....	230
Table 4.47. Typical Maintenance Activities for Storage Practices. ....	243
Table 4.48. Storage Retention and Pollutant Removal.....	244
Table 4.49. Clay Liner Specifications.....	254
Table 4.50. Pond Maintenance Tasks and Frequency.....	260
Table 4.51. Ceiling Levels Governing Management of Accumulated Sediment <sup>1</sup> .....	260

Table 4.52. Pond Retention and Pollutant Removal.....	261
Table 4.53. Popular, Versatile, and Available Native Trees and Shrubs for Stormwater Wetlands.....	278
Table 4.54. Popular, Versatile, and Available Native Emergent and Submergent Vegetation for Stormwater Wetlands.....	279
Table 4.55. Stormwater Wetland Retention and Pollutant Removal .....	282
Table 4.56. Selecting Priority Trees and Forests for Preservation .....	286
Table 4.57. Methods for Addressing Urban Planting Constraints.....	288
Table 4.58. Tree Planting Techniques .....	289
Table 4.59. T-1 Preserved and Planted Tree Retention .....	293

## List of Equations

### Chapter 3

Equation 3.1. Curve number runoff equation.....	43
Equation 3.2. Stormwater retention volume (SWRv) equation.....	44

### Chapter 4

Equation 4.1. Bioretention storage volume.....	81
Equation 4.2. Bioretention infiltration rate check equation.....	81
Equation 4.3. Reservoir layer or infiltration sump depth. ....	107
Equation 4.4. Drawdown time. ....	108
Equation 4.5. Permeable pavement storage volume .....	108
Equation 4.6. Maximum surface basin depth for infiltration basins .....	128
Equation 4.7. Maximum underground reservoir depth for infiltration trenches. ....	128
Equation 4.8. Surface basin surface area for infiltration basins .....	129
Equation 4.9. Underground reservoir surface area for infiltration trenches.....	129
Equation 4.10. Storage volume for surface basin area for infiltration basins .....	130
Equation 4.11. Storage volume for underground reservoir surface area for infiltration trenches. ....	130
Equation 4.12. Storage Volume for Green Roofs.....	144
Equation 4.13 Manning's Equation .....	197
Equation 4.14 Continuity Equation .....	198
Equation 4.15 Minimum Width.....	198
Equation 4.16 Corresponding Velocity.....	198
Equation 4.17 Grass Channel Length for Hydraulic Residence Time of 9 minutes (540 seconds) .....	199
Equation 4.18 Grass Channel Storage Volume .....	199
Equation 4.19 Dry Swale Storage Volume .....	199
Equation 4.20 Wet Swale Storage Volume .....	200
Equation 4.21 Riffle Pool Length.....	202
Equation 4.22 RSC Systems Storage Volume .....	203
Equation 4.23 Minimum Filter Surface Area for Filtering Practices.....	226
Equation 4.24 Required Ponding Volume for Filtering Practices.....	226
Equation 4.25 Storage Volume for Filtering Practices .....	227
Equation 4.26 Pond Storage Volume .....	256
Equation 4.27 Water Balance Equation for Acceptable Water Depth in a Wet Pond .....	256

Equation 4.28 Baseflow Conversion .....	257
Equation 4.29 Stormwater Wetland Storage Volume .....	272
Equation 4.30 Water Balance for Acceptable Water Depth in a Stormwater Wetland.....	273
Equation 4.31 Minimum Depth of the Permanent Pool .....	273

## Acronym Definitions

Acronym/Abbreviation	Definition
ARC	Antecedent Runoff Condition
BMP	Best Management Practice
BSD	Better Site Design
CDA	Contributing Drainage Area
CN	Curve Number
C-SWPPP	Construction Stormwater Pollution Prevention Plan
EGL	Energy Grade Line
EPA	United States Environmental Protection Agency
ESC	Erosion and Sediment Control
FHWA	Federal Highway Administration
GI	Green Infrastructure
HDS	Hydraulic Design Services
HGL	Hydraulic Grade Line
HUC	Hydrologic Unit Code
IWS	Internal Water Storage
LID	Low-Impact Development
LOD	Limits of Disturbance
MEP	Maximum Extent Practicable
MS4	Municipal Separate Storm Sewer System
NC DEQ	North Carolina Department of Environmental Quality
NEH	National Engineering Handbook
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PROW	Public Right-of-Way
PUD	Planned Unit Development
SC DHEC	South Carolina Department of Health and Environmental Control
SC DOT	South Carolina Department of Transportation
SDA	Site Drainage Area
SWMP	Stormwater Management Plan
SWRv	Stormwater Retention Volume

## Chapter 1. Introduction, Background, Purpose, and Administration

### 1.1 Introduction

Upon passage of the Southern Lowcountry Stormwater Ordinance as amended and adopted by Beaufort County Public Works Department, participating municipalities/jurisdictions will follow the design and permitting requirements of the *Southern Lowcountry Stormwater Design Manual*. The Ordinance directs residents, land developers, redevelopment, and government permit applicants to submit details and plans that comply with this Manual. It is the intent of the Ordinance that all proposed development, redevelopment, and major substantial improvement shall provide stormwater quality control for the stormwater retention volume (SWRv) for Watershed Protection Areas and/or Special Watershed Protection Areas. In the following chapters, Better Site Design (BSD) practices, green infrastructure/low impact development practices (GI/LID), and stormwater best management practices (BMPs) are described in detail to support the stormwater retention requirements. Through in-line and off-line application of these practices, the cumulative impact is reduction of the runoff and the retention on site of design storms.

This Manual and the design criteria presented within represent good engineering practice and should be used in the preparation of stormwater management plans. The criteria are intended to establish requirements, minimum standards, and methods for a sound planning, design, and review process. It is intended to guide the stormwater design review of proposed work done by developers, private parties, and governmental agencies.

### 1.2 Background

The U.S. Environmental Protection Agency (EPA) recommends that the Phase II Small Municipal Separate Storm Sewer System (MS4) permit require the permittee to adopt a planning process that identifies the municipality's program goals (e.g., minimize water quality impacts resulting from post-construction runoff from new development and redevelopment), implementation strategies (e.g., adopt a combination of structural and/or non-structural BMPs), operation and maintenance policies and procedures, and enforcement procedures. In developing the program, EPA states that the permit should also require the permittee to assess existing ordinances, policies, programs and studies that address stormwater runoff quality. These policy assessments should include the following:

- Policies and ordinances that:
  - provide requirements and standards to direct growth to identified areas,
  - protect sensitive areas such as wetlands and riparian areas,
  - maintain and/or increase open space (including a dedicated funding source for open space acquisition),
  - provide buffers along sensitive water bodies,
  - minimize impervious surfaces, and
  - minimize disturbance of soils and vegetation;
- Policies or ordinances that encourage infill development in higher density urban areas and areas with existing infrastructure;
- Education programs for developers and the public about project designs that minimize water quality impacts; and
- Measures such as minimization of percent impervious area after development and minimization of directly connected impervious areas (81 Federal Register 237).

### 1.3 Purpose

This Manual's purpose is to provide a framework for designing a stormwater management system to:

- Improve water quality through runoff reduction to the maximum extent practicable (MEP);
- Prevent downstream stream bank and channel erosion;
- Reduce downstream overbank flooding; and
- Safely pass or reduce the runoff from extreme storm events.

This Manual presents a unified approach for sizing stormwater best management practices (BMPs) in the Southern Lowcountry to meet pollutant removal goals, reduce peak discharges, and pass extreme floods. Additionally, it follows a watershed approach for their size and specification. Based on the site's watershed, stormwater design criteria specific to each must be met for development permit approval.

### 1.4 Applicability and Exemptions

#### 1.4.1 Applicability

Design criteria in this Manual are applicable to any new development or redevelopment activity that meets one or more of the following criteria, or is a major substantial improvement, unless exempt pursuant to Section 1.4.2 below:

1. New development that involves the creation of 5,000 square feet of land disturbance.
2. Redevelopment that involves the creation, addition, or replacement of 5,000 square feet or more of land disturbance.
3. New development or redevelopment, regardless of size, that is part of a larger common plan of development, even though multiple, separate and distinct land disturbing activities may take place at different times and on different schedules.
4. A major substantial improvement of an existing property, which is defined as a renovation or addition to a structure that meets both of the following cost and size thresholds: a) construction costs for the building renovation/addition are greater than or equal to 50% of the pre-project assessed value of the structure as developed using current Building Valuation Data of the International Code Council, and b) project size where the combined footprint of structure(s) exceeding the cost threshold and any land disturbance is greater than or equal to 5,000 square feet.

The design criteria are applicable for infill development of platted lots, whether they are new development or redevelopment sites if the work involves creation, addition or replacement of 5,000 square feet or more of land disturbance

#### 1.4.2 Exemptions

The following activities are exempt from the permitting requirements of this Manual:

1. Any maintenance, alteration, renewal, or improvement as approved by Beaufort County Public Works Department which does not alter existing drainage pattern, does not result in change or adverse impact on adjacent property and/or downstream properties, or create adverse environmental or water quality impacts, and does not increase the temperature, rate, quality, volume, or location of stormwater runoff discharge.
2. Projects that are exclusively for agricultural or silvicultural activities within areas zoned for these agricultural and silvicultural uses. Proof of Silviculture permit required;
3. Agricultural activity not involving relocation of drainage canals;



4. Redevelopment that constitutes the replacement of the original square footage of impervious cover and original acreage of other land development activity when the original development is wholly or partially lost due to natural disaster or other acts of God occurring after January 31st, 2021,
5. Work by agencies or property owners required to mitigate emergency flooding conditions. If possible, emergency work should be approved by the duly appointed officials in charge of emergency preparedness or emergency relief. Property owners performing emergency work will be responsible for any damage or injury to persons or property caused by their unauthorized actions. Property owners will stabilize the site of the emergency work within 60 days, or as soon as reasonable, following the end of the emergency period;
6. Golf courses are required to comply with all site runoff volume and water quality and drainage planning and design requirements. However, both golf courses and private lagoons shall be exempt from the peak attenuation requirements.
7. Existing dirt roads which are improved or paves as part of Beaufort County's Dirt Road Paving Program as set forth in Beaufort County Policy Statement 15 and Policy Statement 17 are deemed not to constitute "development" under the County Code of Ordinance Chapter 99 (Stormwater Utility Ordinance), MS4 Program, or this manual and are, therefore, exempt from the provisions and requirements herein.
8. Small subdivisions may be exempt from the permitting requirements of this manual, and shall be handled on a case by case basis and to be approved by the Public Works Director.

## **1.5 Administration**

### **1.5.1 Approval Requirements**

Before the Beaufort County Public Works Department may issue a stormwater permit for any project requiring stormwater management, the Beaufort County Public Works Department must approve a Stormwater Management Plan (SWMP) meeting the requirements of the Southern Lowcountry Stormwater Ordinance and receive all fees required by the Beaufort County Public Works Department for site and building development plans.

A complete SWMP submittal includes a completed engineer's certification statement, a submittal checklist, plans and design that are signed and sealed by a registered professional engineer licensed in South Carolina. Erosion and sediment control for sites below the South Carolina Department of Health and Environmental Control (SC DHEC) National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Construction Activities (SCR100000) thresholds must obtain permit coverage under this stormwater permit. All construction stormwater permit applications above the SC DHEC thresholds are reviewed by the DHEC Office of Coastal Resources Management, or the reviews are delegated to the Beaufort County Public Works Department to determine compliance with the requirements of SCDHEC's NPDES General Permit for Stormwater Discharges from Construction Activities (SCR100000) and of the Construction Stormwater Pollution Prevention Plan (C-SWPPP). These permit applications must be approved, issued, and provided to Beaufort County Public Works Department prior to the issuance of the stormwater management plan approval.

### **1.5.2 Fees**

An applicant is responsible for paying fees that provide for the cost of review, administration, and management of the stormwater permitting process and inspection of all projects subject to the requirements of Beaufort County Public Works. These fees are posted by the Beaufort County Public Works Department.

## Chapter 2. Design, Review, & Permitting Process

### 2.1 Satisfying the Stormwater Management, Site Planning, & Design Criteria

#### 2.1.1 Overview

This chapter presents a comprehensive set of site planning and design and post-construction criteria that must be applied to new development and redevelopment activities occurring within the Southern Lowcountry region. Satisfying these criteria promotes the systematic development of acceptable stormwater management plans, and a successful integration of natural resource protection and stormwater management through the site planning and design process (Figure 2.2).

Through the use of Better Site Design, as described in detail below, the integration of natural resource protection and stormwater management can be achieved by:

- Identifying and protecting valuable natural resources;
- Limiting land disturbance, new impervious cover, and disturbed pervious cover; and
- Reducing and managing post-construction stormwater runoff rates, volumes, and pollutant loads.

This approach involves the use of two distinct but complementary groups of natural resource protection and stormwater management techniques:

- **Green Infrastructure Practices:** Natural resource protection and stormwater management practices and techniques (i.e., better site planning and design techniques, low impact development practices) that can be used to help prevent increases in post-construction stormwater runoff rates, volumes and pollutant loads.
- **Stormwater Management Practices:** Stormwater management practices (e.g., wet ponds, swales) that can be used to manage post-construction stormwater runoff rates, volumes and pollutant loads.

Natural resource protection and stormwater management techniques help control and minimize the negative impacts of the land development process while retaining and, perhaps, even enhancing a developer's vision for a development site. When applied during the site planning and design process, they can be used to create more natural and aesthetically pleasing development projects and create more cost-effective post-construction stormwater management systems (ARC, 2001). The use of these techniques, particularly the green infrastructure practices, can even reduce overall development costs while maintaining or increasing the resale value of a development project (MacMullan and Reich, 2007; US EPA, 2007; Winer-Skonovd et al., 2006).

### 2.1.2 Better Site Design in the Planning Process

Better Site Design (BSD) refers to encouraged planning land development using certain principles to minimize stormwater impacts. Integral to low impact development design, proper application of BSD principles can allow for smaller required stormwater BMP storage and retention volumes, and can help provide significant reductions in post-construction peak flows and pollutant loads. These principles include reduction/restoration of impervious cover, conservation of natural cover areas, stream restoration, and integration of both structural and non-structural stormwater management within site design. The principles of Better Site Design are referenced in the sections below. To note, any design standards in conflict with the Beaufort County Community Development Code (CDC) will be superseded by the CDC.

Fundamental to the application of Better Site Design is the correlation between impervious surface area in a watershed and negative impacts on receiving water resources. On a national level, the Impervious Cover Model (ICM) estimates stream quality based on percentage of impervious cover (Schueler and Fraley-McNeal, 2009). This model demonstrates that streams follow a continuous gradient of degradation in response to increasing impervious cover in a watershed. Local studies have supported this paradigm, and report that changes in the rate and volume of stormwater runoff were primary causes of ecological impairment in headwater tidal creeks, such as those found in Beaufort and Jasper Counties. These studies have shown that physical and chemical characteristics such as altered hydrography, increased salinity variance, increased chemical contaminants, and increased fecal coliform loadings of tidal creeks were negatively impacted with as little as 10 to 20% impervious cover. When impervious cover exceeded 30% of the watershed, measurable impacts to living resources were observed, indicating the ecological processes in the creek ecosystems were impaired (Holland et al., 2004).

Such findings are of consequence to Beaufort and Jasper Counties. Increasing pressure for development in response to population growth, and land development practices of the Lowcountry result in significant tree removal and loss of vegetative cover from land grading and storm pond construction and increases in impervious surfaces. According to the NOAA C-CAP Land Cover Analysis (<https://coast.noaa.gov/ccapatlas/>), from 1996 to 2010, the percent net increase in impervious surface area was 60% for Beaufort County and 59% for Jasper County. Table 2. 1. Summary of land cover changes in Southern Lowcountry from 1996 to 2010. below summarizes the findings of this NOAA report. Although the percentage of total wetlands lost is relatively low for both counties, the actual wetland types have been converted from palustrine forested wetlands to palustrine scrub/shrub and palustrine emergent wetlands, which may alter ecosystem processes and hydrology in these areas.

Table 2. 1. Summary of land cover changes in Southern Lowcountry from 1996 to 2010.

Land Cover %	Beaufort County <sup>1</sup>			Jasper County <sup>1</sup>		
	1996	2010	% Change	1996	2010	% Change
Development	3.87	6.16	+59.12	1.62	2.52	+55.15
Forested Area	25.28	21.5	-14.98	62.50	48.37	-22.60
Wetlands	33.85	33.20	-1.93	45.24	44.74	-1.11

<sup>1</sup> Percent of County under each land cover type.

Given the rapid growth the Southern Lowcountry experienced in the past 20 years, the goals of Better Site Design should resonate with those charged with managing stormwater and its release into the area watersheds. Succinctly, the goals of Better Site Design include the following:

- Preventing stormwater impacts rather than mitigating them;
- Managing stormwater (quantity and quality) as close to the point of origin as possible and minimizing collection and conveyance;
- Utilizing simple, nonstructural methods for stormwater management that are lower cost and lower maintenance than structural controls;
- Creating a multifunctional landscape; and
- Using hydrology as a framework for site design.

The Center for Watershed Protection's Better Site Design Handbook outlines 22 model development principles for site design that act to reduce impervious cover, conserve open space, prevent stormwater pollution, and reduce the overall cost of development (CWP, 2017). The principles can provide notable reductions in post-construction stormwater runoff rates, volumes and pollutant loads (ARC, 2001).

Better Site Design across the country is implemented through review of existing planning and development codes, and streets, parking and stormwater engineering criteria. Within the context of a stormwater management document and this Manual, the Better Site Design techniques of greatest application include protection of existing natural areas, incorporation of open space into new development, effective sediment and erosion control practices, and stormwater management that mimics natural systems. The following sections apply Better Site Design to the Southern Lowcountry Watershed Protection Areas and Special Watershed Protection Areas to help mitigate the effects of development to the watersheds. Therefore, the conservation principles below are part of an overall watershed approach to stormwater management and will complement the Watershed Protection Area approach in this Manual. Their application is subject to Beaufort County Public Works Department requirements and/or standards.

### 2.1.3 Site Planning & Design Process

Figure 2.2 depicts the site planning and design process that is captured in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al., 2014) and is applicable to the Beaufort County Public Works Department. The site planning and design checklist of the Southern Lowcountry Design Manual does not make each of the phases of the process a submittal requirement. The checklist, however, gives the Beaufort County Public Works Department the opportunity to ask whether each of these steps have been considered. Required steps for the Beaufort County Public Works Stormwater Permit submittal are the conceptual plan and final plan, with construction and final inspections occurring after final plan has been approved. The actual document submittal begins with the preliminary plan when considered in context of the planning process below:

- **Site Prospecting:** During the site prospecting phase, some basic information is used to evaluate the feasibility of completing a development or redevelopment project. A *feasibility study* is typically used to evaluate the many factors that influence a developer's decision about whether or not to move forward with a potential development project. Factors that are typically evaluated during a *feasibility study* include information about site characteristics and constraints, applicable local, state and federal stormwater management and site planning and design requirements, adjacent land uses and access to local infrastructure (e.g., water, sanitary sewer).
- **Site Assessment:** Once a potential development or redevelopment project has been deemed feasible, a more thorough assessment of the development site is completed. The site assessment, which is typically completed using acceptable site reconnaissance and surveying techniques, provides additional information about a development site's

characteristics, its natural resource inventory and constraints. Once the assessment is complete, a developer can identify and analyze the natural, man-made, economic and social aspects of a potential development project, define the actual buildable area available on the development site and begin making some preliminary decisions about the layout of the proposed development project.

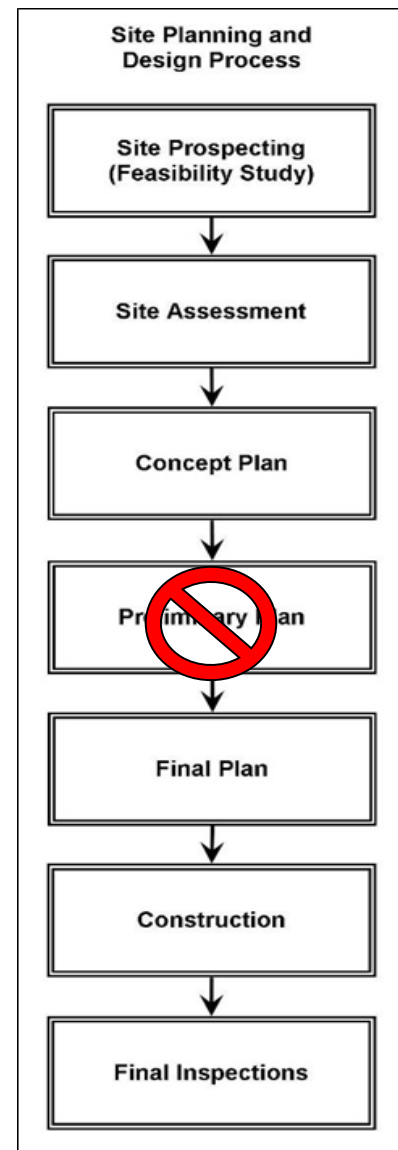


Figure 2.1. Site planning & design process

- Concept Plan: The results of the site assessment are typically used to create a concept plan for the proposed development project. A concept plan is used to illustrate the basic layout of the proposed development project, including lots and roadways, and is usually reviewed with the local development review authority before additional resources are used to create a more detailed plan of development. During this phase, several alternative concept plans can be created and compared with one another to craft a plan of development that best “fits” the character of the development site (Figure 2.3, Figure 2.4, and Figure 2.5). It is at this point in the planning and design process that a Maximum Extent Practicable demonstration described in Section 3.9 is required for development projects that will seek a waiver from requirements of this Manual.
- Final Plan: The final plan adds further detail to the preliminary plan and reflects any changes to the plan of development that were requested or required by the local development review authority. The final plan typically includes all of the information that was included in the preliminary plan, as well as information about landscaping, pollution prevention, erosion and sediment control and long-term operation and maintenance of the site’s post-construction stormwater management system. There may be several iterations of the final plan between the time that it is submitted and the time that it is approved by the local development review authority.
- ⑦ Construction: Once the final plan has been reviewed and approved, performance bonds are set and placed, contractors are retained, and construction begins. During the construction phase, a development project may be inspected on a regular basis by the local development review authority to ensure that all roadways, parking areas, buildings, utilities and other infrastructure, including the post-construction stormwater management system, are being built in accordance with the approved final plan and that all primary and secondary conservation areas have been protected from any land disturbing activities.
- ⑦ Final Inspections: Once construction is complete, final inspections take place to ensure that all roadways, parking areas, buildings, utilities and other infrastructure, including the post-construction stormwater management system, were built according to the approved final plan. As-built plans are also typically prepared and executed during this phase. If a development project passes all final inspections, an occupancy permit may be issued for the project.

#### **2.1.4 Natural Resources Inventory**

The first step to conserve natural resources is properly documenting existing assets. An up-to-date natural resources inventory map can provide geospatial information for water resources, soils, sensitive natural resource areas, critical habitats, and other unique resources (Ellis et al., 2014).

An application for new development requires a natural resources inventory prior to the start of any land disturbing activities. A natural resources inventory prepared by a qualified person shall be used to identify and map the most critical natural resources identified on the property that would be best to preserve, such as those listed in Table 2.2, as they exist predevelopment. Qualified persons include individuals with a working knowledge of hydrology, wetlands, plant taxonomy, and field survey methods. Qualified individuals include but are not limited to licensed foresters, professional wetland scientists, and geographic information professionals. A thorough assessment of the natural resources, both terrestrial and aquatic, found on a development site shall be submitted in the development application.

Table 2.2. Resources to be identified and mapped during the Natural Resources Inventory.

Resource Group	Resource Type
General Resources	<ul style="list-style-type: none"> <li>• Topography</li> <li>• Natural Drainage Divides</li> <li>• Natural Drainage Patterns</li> <li>• Natural Drainage Features (e.g., Swales, Basins, Depressional Areas)</li> <li>• Soils</li> <li>• Erodible Soils</li> <li>• Steep Slopes (e.g., Areas with Slopes Greater Than 15%)</li> <li>• Trees and Other Existing Vegetation</li> </ul>
Freshwater Resources	<ul style="list-style-type: none"> <li>• Freshwater Wetlands</li> </ul>
Estuarine Resources	<ul style="list-style-type: none"> <li>• Tidal Rivers and Streams</li> <li>• Tidal Creeks</li> <li>• Coastal Marshlands</li> <li>• Tidal Flats</li> </ul>
	<ul style="list-style-type: none"> <li>• Scrub-Shrub Wetlands</li> </ul>
	<ul style="list-style-type: none"> <li>• Near Coastal Waters</li> </ul>
	<ul style="list-style-type: none"> <li>•</li> </ul>
Groundwater Resources	<ul style="list-style-type: none"> <li>• Groundwater Recharge Areas</li> <li>• Wellhead Protection Areas</li> <li>•</li> </ul>
Terrestrial Resources	<ul style="list-style-type: none"> <li>• Bottomland Hardwood Forests</li> <li>• Beech-Magnolia Forests</li> </ul>



Other Resources

- Pine Flatwoods
- Longleaf Pine-Wiregrass Savannas
- Longleaf Pine-Scrub Oak Woodlands
- Shellfish Harvesting Areas
- Floodplains
- Aquatic Buffers
- Other High Priority Habitat Areas as described by South Carolina Department of Natural Resources

### 2.1.5 Conservation Development

Conservation development, also known as open space development or cluster development, is a site planning and design technique used to concentrate structures and impervious surfaces in a small portion of a development site, leaving room for larger conservation areas and managed open spaces elsewhere on the site (Figure 2.2). Alternative lot designs are typically used to “cluster” structures and other impervious surfaces within these conservation developments.

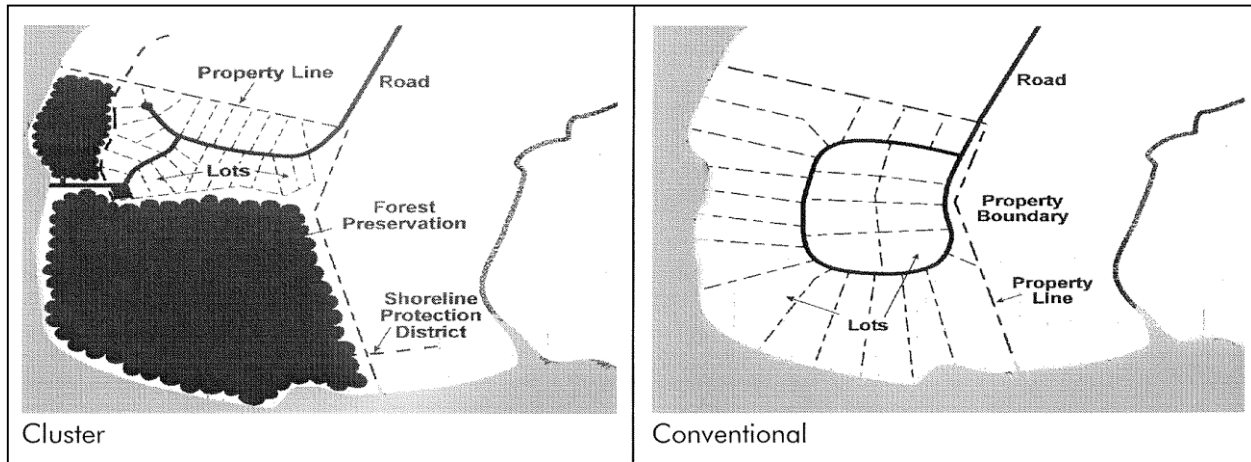


Figure 2.2. Conservation (i.e., cluster) development versus conventional development.

Conservation development projects provide a host of environmental benefits that are typically more difficult to achieve with conventional site design techniques. They provide for better natural resource protection on development sites and inherently limit increases in site imperviousness, sometimes by as much as 40 to 60 percent. Reduced site imperviousness results in reduced post-construction stormwater runoff rates, volumes and pollutant loads, which helps better protect both on-site and downstream aquatic resources from the negative impacts of the land development process. Reduced stormwater runoff rates, volumes and pollutant loads also help reduce the size of and need for storm drain systems and stormwater management practices on development sites.

As a number of recent studies have shown conservation development projects can also be significantly less expensive to build than more conventional development projects. Most of the cost savings can be attributed to the reduced amount of infrastructure (e.g., roads, sidewalks, post-construction stormwater management practices) needed on these development projects. And while these projects are frequently less expensive to build, developers often find that the lots located within conservation developments command higher prices and sell more quickly than those located within more conventional developments (ARC, 2001).

Table 2. 3 provides suggestions for Better Site Design techniques that will help protect valuable resources such as buffers, trees, wetlands, and open space.

Table 2. 3. Better Site Design principles for conservation.

Principle	Description
Vegetated Buffer System	Create a variable width, naturally vegetated buffer system along all streams that also encompasses critical environmental features such as the 100-year floodplain, steep slopes, and freshwater wetlands. <i>Recommended buffer widths are included in Table 3.2-4 in Ellis et al., 2014</i>
Buffer Maintenance	The riparian buffer should be preserved or restored with native vegetation that can be maintained through delineation, plan review, construction, and occupancy stages of development.
Clearing and Grading	Clearing and grading of forests and native vegetation should be limited to the minimum amount needed to build lots, allow access, and provide fire protection. A fixed portion of any community open space should be managed as protected green space in a consolidated manner.
Tree Conservation	Conserve trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native plants. Wherever practical, manage community open space, street rights-of-way, parking lot islands, and other landscaped areas to promote natural vegetation.
Land Conservation	Open space development should be encouraged to promote conservation of stream buffers, forests, meadows, and other areas of environmental value. In addition, off-site mitigation consistent with locally-adopted watershed plans should be encouraged.
Stormwater Outfalls	New stormwater outfalls should not discharge unmanaged into jurisdictional wetlands, sole-source aquifers, or sensitive areas.

### 2.1.6 Residential Streets & Parking Lots

Up to 65% of the total impervious cover in a watershed can be attributed to streets, parking lots, and driveways (CWP, 1998). Table 2.4 describes Better Site Design principles related to techniques to reduce the impervious surfaces associated with these hardscapes.

Table 2.4. Better Site Design principles for streets and parking to meet Beaufort County Community Development Code requirements.

Principle	Description
Street Width	Design residential streets for the minimum required pavement width needed to support travel lanes; on-street parking; and emergency, maintenance, and service vehicles.
Street Length	Reduce the total length of residential streets by examining alternative street layouts to determine the best option for increasing the number of homes per unit length.

Right-of-Way Width	Wherever possible, residential street right-of-way widths should reflect the minimum required to accommodate the travel-way, the sidewalk, and vegetated open channels. Utilities and storm drains should be located within the pavement section of the right-of-way wherever feasible.
Cul-de-sacs	Minimize the number of residential cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. The radius of cul-de-sacs should be the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds should be considered.
Vegetated Open Channels	Where density, topography, soils, and slope permit, vegetated open channels should be used in the street right-of-way to convey and treat stormwater runoff.
Parking Ratios	The required parking ratio governing a particular land use or activity should be enforced as both a maximum and a minimum in order to curb excess parking space construction. Existing parking ratios should be reviewed for conformance, taking into account local and national experience to see if lower ratio is warranted and feasible.
Parking Lots	Reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in spillover parking areas.
Structured Parking	Utilize structured (e.g., parking garage) and shared parking to reduce impervious surface area.
Parking Lot Runoff	Wherever possible, provide stormwater treatment for parking lot runoff using bioretention areas, filter strips, and/or other practices that can be integrated into required landscaping areas and traffic islands.

### 2.1.7 Lot Development Principles to Meet Requirements

Development of lots follows similar guidelines for reducing impervious cover and protecting natural areas, such as open space.

Table 2. 5 summarizes Better Site Design principles for lot development. Preserving open space is critical to maintaining water quality at the regional level. Compared to traditional development, open space development can reduce the annual runoff volume from a site by 40%–60%, nitrogen loads by 42%–81%, and phosphorus loads by 42%–69% (CWP, 1998). Large, continuous areas of open space reduce and slow runoff, absorb sediments, serve as flood control, and help maintain aquatic communities. Open space can be provided by minimizing lot sizes, setbacks, and frontage distances

Table 2. 5. Better Site Design principles for lot development.

Principle	Description
Open Space Development	Utilize open space development that incorporates smaller lot sizes to minimize total impervious area, reduce total construction costs, conserve natural areas, provide community recreational space, and promote watershed protection.
Setbacks and Frontages	Consider minimum setbacks allowed by Beaufort County Community Development Code. Relax side yard setbacks and allow narrower frontages to reduce total road length in the community and overall site imperviousness. Relax front setback requirements to minimize driveway lengths and reduce overall lot imperviousness.
Sidewalks	Where practical, consider locating sidewalks on only one side of the street and providing common walkways linking pedestrian areas.
Driveways	Reduce overall lot imperviousness by promoting alternative driveway surfaces and shared driveways that connect two or more homes together.
Rooftop Runoff	Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas and should avoid routing rooftop runoff to the roadway and the stormwater conveyance system.
Open Space Management	Clearly specify how community open space will be managed and designate a sustainable legal entity responsible for managing both natural and recreational open space.

For more detailed descriptions of these techniques, please reference *Better Site Design: A Handbook for Changing Development Rules in Your Community* (CWP, 1998) and Chapter 3 of *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al., 2014).

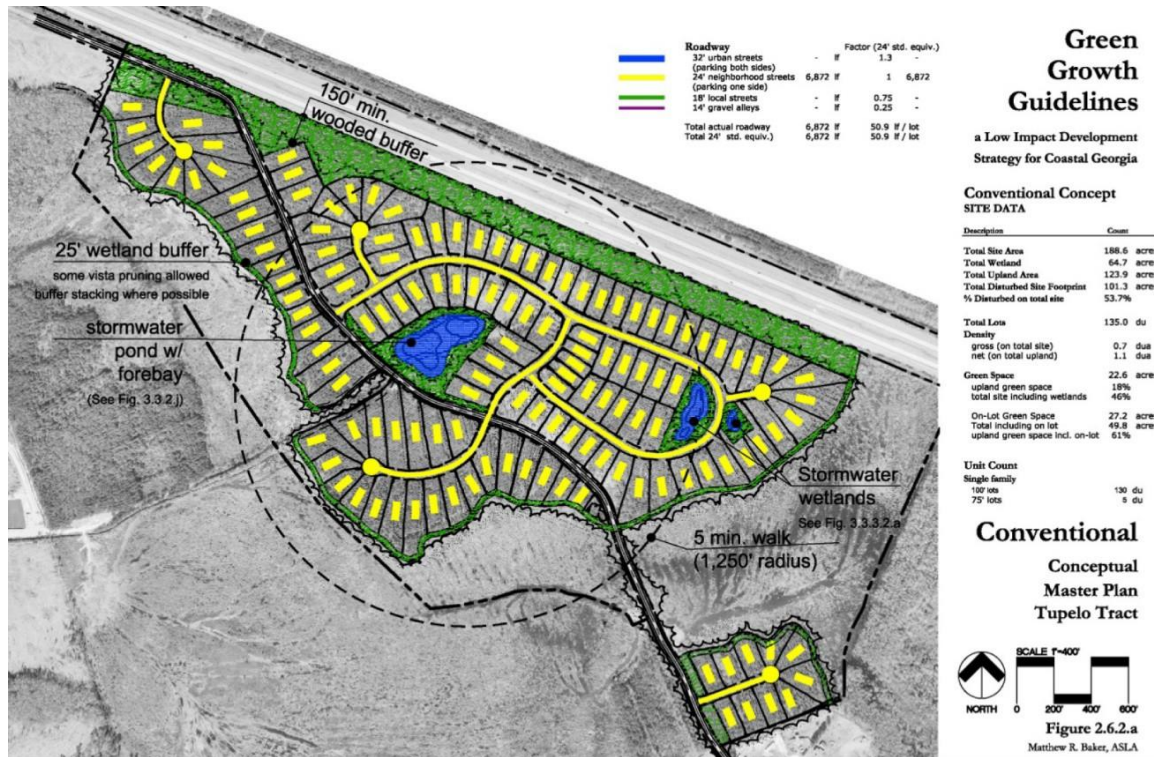


Figure 2.3. Conventional Site Design (source: Merrill et al., 2006).

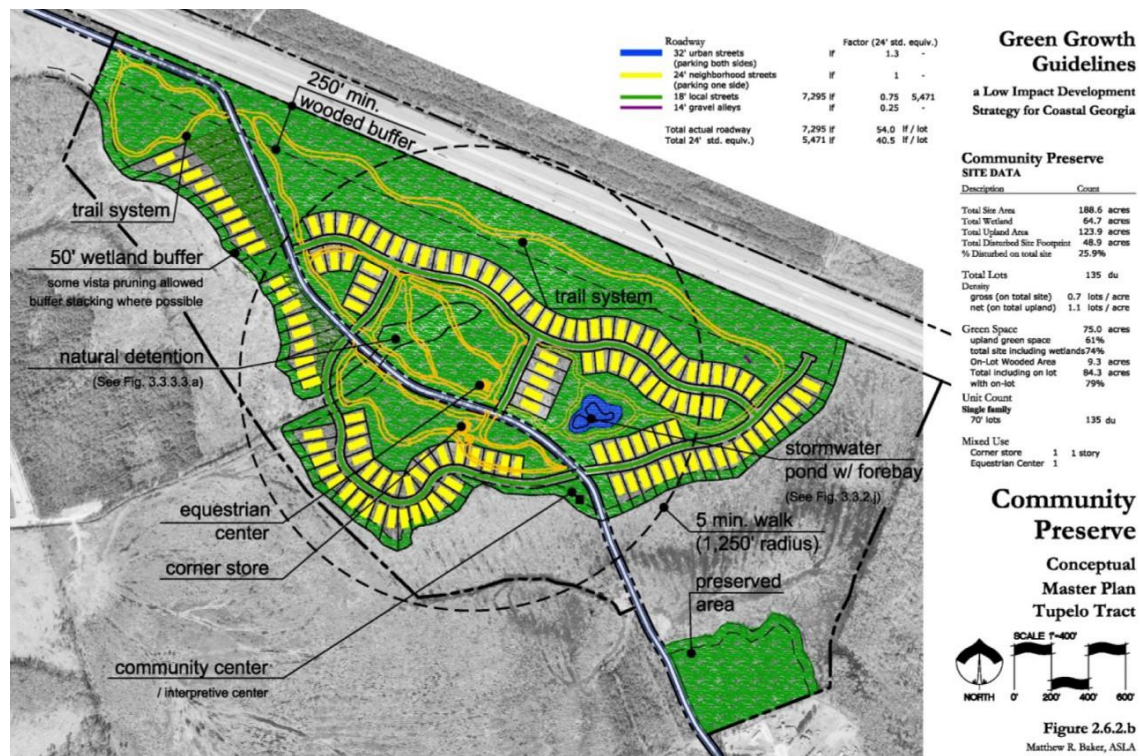


Figure 2.4. Conservation Site Design (source: Merrill et al., 2006).





Figure 2.5. New Urbanist Site Design (source: Merrill et al., 2006).

## 2.1.8 Integrating Natural Resource Protection & Stormwater Management with the Site Planning & Design Process

In order to successfully *integrate* natural resource protection and stormwater management with the site planning and design process, site planning and design teams are to consider following questions at the beginning of the process:

- What valuable natural resources, both terrestrial and aquatic, can be found on the development site?
- How can better site planning techniques be used to protect these valuable natural resources from the direct impacts of the land development process?
- How can better site design techniques be used to minimize land disturbance and the creation of new impervious and disturbed pervious cover?
- What low impact development practices can be used to help preserve pre-development site hydrology and *reduce* post-construction stormwater runoff rates, volumes and pollutant loads?
- What stormwater management practices can be used to *manage* post-construction stormwater runoff rates, volumes and pollutant loads?
- Are there any site characteristics or constraints that prevent the use of any particular low impact development or stormwater management practices on the development site?

Although answering these questions is no easy task, they can be readily obtained within the context of the six-step *stormwater management planning and design process* outlined in Figure 2.1, and the steps are described in more detail below.

- **Step 1: Pre-Application Meeting**

It is recommended that a pre-application meeting between the applicant's site planning and design team and the Beaufort County Staff Review Team with development review authority occur at the very beginning of the stormwater management planning and design process. This meeting, which should occur during the site prospecting phase of the overall site planning and design process (Figure 2.6), helps establish a relationship between the site planning and design team and the Beaufort County Staff Review Team with development review authority. The pre-application meeting also provides an opportunity to discuss the local site planning and stormwater management design criteria that will apply to the proposed development project, which increases the likelihood that the remainder of the site planning and design process will proceed both quickly and smoothly.

- **Step 2: Review of Local, State, and Federal Stormwater Management, Site Planning, & Design Requirements**

Once a pre-application meeting has been completed, it is recommended that the site planning and design team review the local, state and federal requirements that will apply to the proposed development project. This review should occur during the site prospecting phase of the overall site planning and design process (Figure 2.6), while the feasibility study is still being completed.

During their review of stormwater management and site planning and design requirements, the applicant's site planning and design teams should also investigate opportunities and incentives for land conservation, and opportunities and incentives for conservation development as illustrated earlier in Figure 2.1.

- **Step 3: Natural Resources Inventory**

Once the potential development or redevelopment project has been deemed feasible, acceptable site reconnaissance and surveying techniques must be used to complete a thorough assessment of the natural resources, both terrestrial and aquatic, found on the development site. The identification and subsequent preservation and/or restoration of these natural resources helps reduce the negative impacts of the land development process "by design." The natural resources inventory should be completed during the site assessment phase of the overall site planning and design process (Figure 2.6). A map that is created to illustrate the results of the natural resources inventory, known as a site fingerprint, should be used to prepare a stormwater management concept plan for the proposed development project.

Once the natural resources inventory has been completed and a site fingerprint has been created, the site planning and design team should have a better understanding of a development site's characteristics and constraints. This information can be used to identify primary and secondary conservation areas (Figure 2.6. Buildable Area and Primary/Secondary Conservation Areas (source: Merrill et al., 2006).) and define the actual buildable area available on the development site. Along with information about adjacent land uses and available infrastructure (e.g., roads, utilities), the site



fingerprint can also be used to make some preliminary decisions about the layout of the proposed development project and to guide the creation of the stormwater management concept plan.

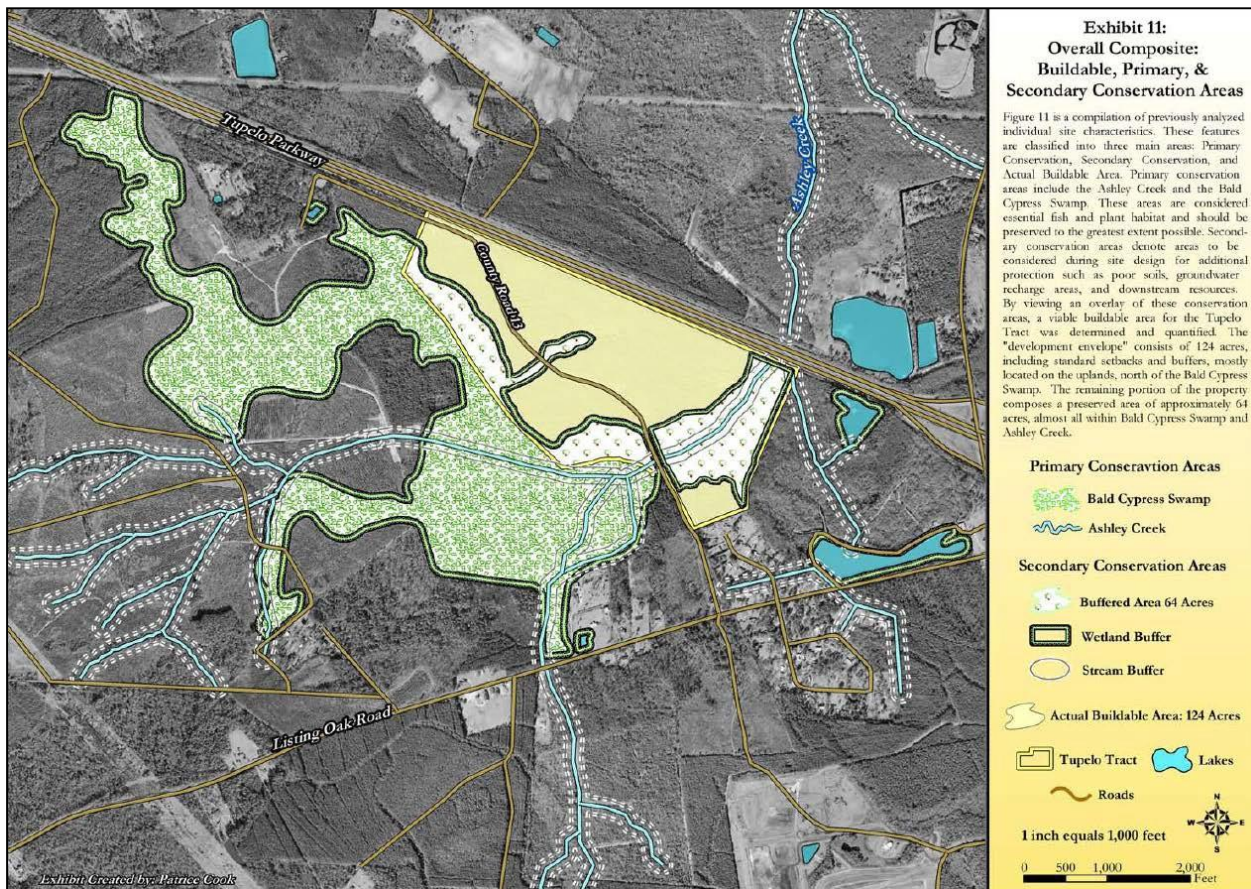


Figure 2.6. Buildable Area and Primary/Secondary Conservation Areas (source: Merrill et al., 2006).

- **Step 4: Prepare Stormwater Management Concept Plan**

After the natural resources inventory has been completed, it is recommended that the site fingerprint be used to develop a stormwater management concept plan for the proposed development project. The stormwater management concept plan should illustrate the layout of the proposed development project and should show, in general, how post-construction stormwater runoff will be managed on the development site.

The creation of a stormwater management concept plan allows the applicant's site planning and design team to make some preliminary decisions about the layout of the proposed development project. If it is submitted to the local development review authority prior to the preparation and submittal of the stormwater management design plan, it can also be used to solicit early feedback on the project and on the green infrastructure and stormwater management practices that will be used to manage post-construction stormwater runoff on the development site.

During the creation of the stormwater management concept plan, most of the site layout, including the layout of lots, buildings, roadways, parking areas, sidewalks and green infrastructure and stormwater management practices, will be completed. Therefore, it is very important that natural resource protection and stormwater management be considered throughout this part of the stormwater management planning and design process.

- **Step 6: Prepare Stormwater Management Design Plan**

Subsequent to review and approval of the stormwater management concept plan, the site planning and design team should prepare a stormwater management design plan. The stormwater management design plan should detail how post-construction stormwater runoff will be managed on the development site and should include maps, narrative descriptions and design calculations (e.g., hydrologic and hydraulic calculations) that show how the stormwater management and site planning and design criteria that apply to the development project have been met. The stormwater management design plan should be submitted to the local development review authority for review and approval.

## **2.2 Submittal & Review Process of Stormwater Management Plans**

The Stormwater Management Plan (SWMP) consists of the entire submittal package and includes the following components:

- Project description and narrative;
- Description of selected stormwater management systems;
- Erosion and sediment control plans;
- Sufficient information to evaluate the environmental characteristics of the affected areas, the potential impacts of the proposed development on water resources, the effectiveness and acceptability of stormwater best management practices (BMPs), and land covers for managing stormwater runoff;
- Supporting computations and drawings; and
- Construction, inspection, and maintenance schedules.

All SWMPs must include the Stormwater submittal checklist (Appendix D) and calculations summary. The plans must include the calculated stormwater retention volume (SWRv) for each BMP and for the overall project, the pre and post development peak flow comparison, extreme flood requirements, and any off-site retention or detention volume obligation.

The SWMP and accompanying documentation may be submitted according to the Beaufort County Public Works Department process, but the applicant must also submit one paper copy of the SWMP carrying the stamp of a registered professional engineer licensed in the State of South Carolina with all supporting documentation to Beaufort County Public Works Department.

Upon acceptance of a complete application (which includes payment of filing fees), the Beaufort County Public Works Department will review the SWMP and make a determination to approve, approve with conditions, or disapprove the SWMP. Relatively large and/or complicated projects tend to require a longer review time than smaller and less complicated projects. A written response of approval or disapproval will be provided to the applicant. If it is determined that more information is needed or that a significant number of changes must be made before the SWMP can be approved, the applicant must resubmit the applications with the revisions required and certified by the registered professional engineer according to the plan resubmittal process of the Beaufort County Public Works Department.

When a SWMP approval is granted, a final submission package is required, including the following:

- One PDF copy of the SWMP, certified by a registered professional engineer licensed in the State of South Carolina,
- A declaration of covenants that has been approved for legal sufficiency by the Beaufort County Public Works Department, and
- All supporting documents specified within this Manual or as requested during the review process according to the Beaufort County Public Works Department requirements.

### **2.2.1 Components of a Stormwater Management Plan**

As itemized in the SWMP checklist in Appendix D Design Checklists, a SWMP includes the following:

#### **Site Plan**

The following information must be formatted to print as a standard drawing size of 24 by 36 inches. The site drawing will provide details of existing and proposed conditions:

- A cover page that contains a blank space measuring 7 inches wide by 9.5 inches high. The blank space must be located 1 inch below the top edge and 1 inch from the left edge of the page;
- A plan showing property boundaries and the complete address of the property;
- Lot number or property identification number designation (if applicable);
- North arrow, scale, and date;
- Property lines (include longitude and latitude);
- Location of easements (if applicable);
- Existing and proposed structures, utilities, roads, and other paved areas;
- Existing and proposed topographic contours;
- Soil information for design purposes;
- Area(s) of soil disturbance;
- Drainage area(s) within the limits of disturbance (LOD) and contributing to the LOD;
- Contributing drainage area (CDA) to each BMP;
- Location(s) of BMPs, marked with the BMP ID Numbers to agree with the BMP design summary list;
- Delineation of existing and proposed land covers including natural cover, compacted cover, and impervious surfaces. Consult Appendix G Compliance Calculator Instructions for details;
- Natural resources inventory with site fingerprint map;

- ⑦ All plans and profiles must be drawn at a scale of 1 in. = 10 ft, 1 in. = 20 ft, 1 in. = 30 ft, 1 in. = 40 ft, 1 in. = 50 ft, or 1 in. = 100 ft. Although, 1 in. = 10 ft, 1 in. = 20 ft, and 1 in. = 30 ft, are the most commonly used scales. Vertical scale for profiles must be 1 in. = 2 ft, 1 in. = 4 ft, 1 in. = 5 ft, or 1 in. = 10 ft;
- ⑦ Drafting media that yield first- or second-generation, reproducible drawings with a minimum letter size of No. 4 (1/8 inch);
- ⑦ Location and size of existing utility lines including gas lines, sanitary lines, telephone lines or poles, electric utilities and water mains;
- ⑦ A legend identifying all symbols used on the plan;
- ⑦ Applicable flood boundaries and FEMA map identification number for sites lying wholly or partially within the 100-year floodplain;
- ⑦ Site development plan and stormwater management narrative;
- ⑦ Assess potential application of green infrastructure practices in the form of better site planning and design techniques. Low impact development practice should be used to the maximum extent practicable during the creation of a stormwater management concept plan. A demonstration of better site planning is required. The following site information and practices shall be considered:
  - Soil type (from Soil Study);
  - Depth of ground water on site;
  - Whether the type of development proposed is a hotspot as defined by the Ordinance and Design Manual and address how this influences the concept proposal;
  - Protection of primary and secondary conservation areas;
  - Reduced clearing and grading limits;
  - Reduced roadway lengths and widths;
  - Reduced parking lot and building footprints to minimize impervious surface;
  - Soil restoration;
  - Site reforestation/revegetation;
  - Impervious area disconnection;
  - Green roof (for redevelopment, infill and major substantial improvement projects); and
  - Permeable pavements.
- ⑦ Stormwater Pollution Prevention Plan (SWPPP) or Erosion and Sediment Control narrative (for projects disturbing over an acre);
- ⑦ Information regarding the mitigation of any off-site impacts anticipated as a result of the proposed development;
- ⑦ Construction specifications;
- ⑦ Design and As-Built Certification, including the following:
  - i Certification by a registered professional engineer licensed in the State of South Carolina seal that the site design, land covers, and design of the BMPs conforms to the standard of care applicable to the treatment and disposal of stormwater pollutants and that the Facility has been designed in accordance with the specifications required under the stormwater ordinance of the Beaufort County Public Works Department.
  - ii Submission one set of the As-Built drawings sealed by a registered professional engineer licensed in the State of South Carolina within 21 days after completion of construction of the site, all BMPs, land covers, and stormwater conveyances.
  - iii For a project consisting entirely of work in the public right-of-way (PROW), the submission of a Record Drawing certified by an officer of the project contracting company is acceptable if it details the as-built construction of the BMP and related stormwater infrastructure.

- Maintenance sheet for stormwater BMPs, including the following:
  - i A maintenance plan that identifies routine and long-term maintenance needs and a maintenance schedule;
  - ii A maintenance agreement and schedule for all post construction best management practices in a form and manner that meets the Beaufort County Public Works Department requirements.
  - iii For applicants using Rainwater Harvesting, submission of third-party testing of end-use water quality may be required at equipment commissioning as determined by the requirements in Appendix J Rainwater Harvesting Treatment and Management Requirements. Additional regular water quality reports certifying compliance for the life of the BMP may also be required in Appendix J Rainwater Harvesting Treatment and Management Requirements.

### **Stormwater Retention Volume Computations**

The following summary calculations must be included on the plan set. Supporting documentation and the South Carolina DHEC C-SWPPP are not in the plan set but provided separately.

- ☐ Calculation(s) of the required SWRv for the entire site within the LOD and each site drainage area (SDA) within the LOD;
- ☐ Calculation(s) for each proposed BMP demonstrating retention value towards SWRv in accordance with Chapters 2 and 4;
- ☐ For Rainwater Harvesting BMP, calculations demonstrating the annual water balance between collection, storage, and demand, as determined using the Rainwater Harvesting Retention Calculator;
- ☐ For proprietary and non-proprietary BMPs follow the guidance in Chapter 4.13 to identify/receive approval or denial to use these practice(s); and
- ☐ Off-site stormwater volume requirement.
- ☐ Compliance Calculator sheets identifying that proposed BMP(s) meet standards for water quality

### **Pre-/Post-Development Hydrologic Computations**

Include in the plan set a summary of the pre-/post-runoff analysis with the following information at a minimum:

- ☐ A summary of soil conditions and field data;
- ☐ Pre- and post-project curve number summary table;
  - Pre and post construction peak flow summary table for the 2-, 10-, 25-, 50-, 100-year 24-hour storm events for each SDA within the project's LOD; and
- ☐ Flow control structure elevations.

### **Hydraulic Computations**

Hydraulic computations for the final design of water quality and quantity control structures may be accomplished by hand or through the use of software using equations/formulae as noted in Chapters 3 and 4. The summary of collection or management systems will include the following:

- ☐ Existing and proposed SDA must be delineated on separate plans with the flow paths used for calculation of the times of concentration;
- ☐ Hydraulic capacity and flow velocity for drainage conveyances, including ditches, swales, pipes, inlets, and gutters. Plan profiles for all open conveyances and pipelines, with energy and hydraulic gradients for the 2-, 10-, 25-, 50-, 100-year, 24-hour storms;

- ⑦ The proposed development layout including the following:
  - Location and design of BMP(s) on site, marked with the BMP ID Numbers;
  - Stormwater lines and inlets;
  - A list of design assumptions (e.g., design basis, 2 through 50-year return periods);
  - The boundary of the CDA to the BMP;
  - Schedule of structures (a listing of the structures, details, or elevations including inverts); and
  - Manhole to manhole profile, listing of pipe size, pipe type, slope, (i.e., a storm drain pipe schedule) computed velocity, and computed flow rate, energy grade line (EGL) and hydraulic grade line (HGL).

### **Supporting Documentation**

Provide a written report with the following supporting documentation:

- ⑦ Pre- and post-project curve number selection
- ⑦ Time of concentration calculation;
- ⑦ Travel time calculation;
- Hydrologic computations supporting peak discharges assumed for each SDA within the project's LOD for the 2-, 10-, 25-, 50-, and 100-year, 24-hour storm events;
- SC DHEC's Construction Stormwater Pollution Prevention Plan (C-SWPPP).

A professional engineer registered in the State of South Carolina must also submit the following:

1. Elevation and topographic data illustrating changes in topography and drainage;
2. Impacts upon local flood flows (2-, 10-, 25-, 50-, and 100-year storm events);
3. Identify areas where stormwater flows are discharged off-site or off-property;
4. For proposed off-site/property discharge points, perform analysis of receiving off-site conveyance systems to confirm safe conveyance from the proposed developed property, no negative impact to adjacent properties, and adequacy of the receiving, existing conveyance system for 25-yr storm flows. Such analysis shall be taken to point where the 25-yr storm conveyance is determined to be adequate in the public stormwater conveyance/infrastructure system; and
5. Documentation supporting safe passage of the 100-yr post development flow according to the 10% Rule (see Section 3.8);

### **2.2.2 Resubmission of Stormwater Management Plans**

If changes occur in the design or construction of an accepted SWMP, the applicant may be required to resubmit the SWMP for approval. Examples of changes during design and construction that will require SWMP resubmission for review include, but may not be limited to the following:

1. Revision to the property boundary, property size, or LOD boundaries that may require redesigning BMPs;
2. Any change to SWRV through land cover designation change;
3. Change in compaction or infiltration rates due to construction activities;
4. Encountering contaminated soil or other underground source of contamination;
5. Changes to floodplain designation or requirements;
6. Changes in any component of the BMP that may adversely affect the intended capacity of the approved BMP, such as the following:

- a. Modification to approved BMP selection, dimensions, or location
  - b. Modification to approved material specification
  - c. Changes to the size, invert, elevation, and slopes of pipes and conveyances
  - d. Installation of new drains and conveyance structures
  - e. Need for a new storm sewer outlet connection to the sanitary/storm sewer main
  - f. Changes to the amount of off-site requirements
  - g. Changes to the CDA to a BMP
- 7. Revision to the approved grading and drainage divides and that may require redesigning BMPs;
  - 8. Relocation of an on-site storm sewer or conveyance; or
  - 9. Abandonment, removal, or demolition of a BMP.

If the applicant resubmits an SWMP after making changes, the resubmission must contain a list of the changes made and may be in the form of a response to comments. The resubmittal plans and calculations must include the stamp of the registered professional engineer in South Carolina.

However, if any of the following minor changes are made to the SWMP, resubmission is not required. These minor changes may be made anytime during inspection or at the as-built submittal by Beaufort County Public Works Department.

- 1. Changes to SWM components that do not adversely affect BMP capacity while in consultation with Beaufort County Public Works Department. The inspector should review the appropriate manufacturer's documentation to his/her satisfaction before approving such a change and should ensure that such changes are recorded as red line changes or deviations in the as-built plans. These changes include the following:
  - a. Changes to parts type of similar function (e.g. dewatering valve)
  - b. Change in hole pattern or size of underdrain pipe perforations
  - c. Change in project address, ownership, permit status, or zoning

### **Design Certifications**

The engineer shall certify that this Plan satisfies all requirements of the Southern Lowcountry Ordinance and Stormwater Design Manual. The following statement with engineer's seal is required in the Plan submittal.

The engineering features of all stormwater best management practices (BMPs), stormwater infrastructure, and land covers (collectively the "Facility") have been designed/examined by me and found to be in conformity with the standard of care applicable to the treatment and disposal of stormwater pollutants. The Facility has been designed in accordance with the specification required under of Beaufort County Stormwater Ordinance.

## **2.3 Construction Inspection Requirements**

### **2.3.1 Inspection Schedule & Reports**

Prior to the approval of a SWMP, the applicant will submit a proposed construction inspection schedule. Beaufort County Public Works Department will review the schedule to determine if changes are required. The construction schedule should reflect the construction sequences defined in each BMP section Stormwater Best Management Practices (BMPs) of this Manual. The construction and inspection schedule must be included in the SWMP. Beaufort County Public Works Department may conduct inspections and file reports of inspections during construction of BMPs and site stormwater conveyance systems to ensure compliance with the approved plans.

Note: No stormwater management work may proceed past the stage of construction that Beaufort County Public Works Department has identified as requiring an inspection unless

- Beaufort County Public Works Department has issued an “approved” or “passed” report;
- Beaufort County Public Works Department has approved a plan modification that eliminates the inspection requirement; or
- Beaufort County Public Works Department has eliminated or modified the inspection requirement in writing.

Beaufort County Public Works Department may require that the professional engineer responsible for sealing the approved SWMP, the professional engineer responsible for certifying the as-built SWMP, or, for a project entirely in the PROW, the officer of the contracting company responsible for certifying the Record Drawing be present during inspections.

If Beaufort County Public Works Department conducts an inspection and finds work that is not in compliance with the SWMP, Beaufort County Public Works Department may issue a Notice of Violation, and the applicant must take prompt corrective action. The written notice provides details on the nature of corrections required and the time frame within which corrections must be made.

### **2.3.2 Inspection Requirements Before & During Construction**

Beaufort County Public Works Department construction stormwater inspection form is provided in Appendix E Construction Inspection Form.

**Preconstruction Meetings.** These meetings are required prior to the commencement of any land-disturbing activities and prior to the construction of any BMPs. The applicant is required to contact Beaufort County Public Works Department to schedule preconstruction meetings three (3) days prior to beginning any construction activity subject to the requirements Beaufort County Public Works Department.

**Inspections During Construction.** The applicant is required to contact Beaufort County Public Works Department to schedule inspection three (3) days prior to any stage of BMP construction, or other construction activity, requiring an inspection. For large, complicated projects, the applicant and Beaufort County Public Works Department may agree during the preconstruction meeting to an alternative approach such as a weekly notification schedule. Any such agreement must be made in writing and signed by all parties. Beaufort County Public Works Department will revert to the 3-day notification procedure if the agreement is not followed.

**During construction, Beaufort County Public Works Department may require the presence of the professional engineer responsible for sealing the approved SWMP; the professional engineer responsible for certifying the as-built SWMP; or for a project entirely in the PROW, the officer of the contracting company responsible for certifying the Record Drawing.**

**Final Inspection.** The applicant is required to contact Beaufort County Public Works Department to schedule a final inspection one week prior to the completion of a BMP construction to schedule a final inspection of the BMP. Upon completion of the BMP, Beaufort County Public Works Department will conduct a final inspection to determine if the completed work was constructed in accordance with approved plans.



**Inspection Requirements by BMP Type.** Chapter 4 Stormwater Best Management Practices (BMPs) of this Manual provides details about the construction sequences for each BMP. After holding a preconstruction meeting, regular inspections may be made at the following specified stages of construction:

- **Infiltration Systems and Bioretention Areas** may be inspected at the following stages to ensure proper placement and allow for infiltration into the subgrade:
  - During on-site or off-site percolation or infiltration tests;
  - Upon completion of stripping, stockpiling, or construction of temporary sediment control and drainage facilities;
  - Upon completion of excavation to the subgrade;
  - Throughout the placement of perforated PVC/HDPE pipes (for underdrains and observation wells) including bypass pipes (where applicable), geotextile materials, gravel, or crushed stone course and backfill; and
  - Upon completion of final grading and establishment of permanent stabilization;
- **Flow Attenuation Devices**, such as open vegetated swales upon completion of construction;
- **Retention and Detention Structures**, at the following stages:
  - Upon completion of excavation to the sub-foundation and, where required, installation of structural supports or reinforcement for structures, including but not limited to the following:
  - During testing of the structure for water tightness;
  - During placement of structural fill and concrete and installation of piping and catch basins;
  - During backfill of foundations and trenches;
  - During embankment construction; and
  - Upon completion of final grading and establishment of permanent stabilization.
- **Stormwater Filtering Systems**, at the following stages:
  - Upon completion of excavation to the sub-foundation and installation of structural supports or reinforcement for the structure;
  - During testing of the structure for water tightness;
  - During placement of concrete and installation of piping and catch basins;
  - During backfill around the structure;
  - During prefabrication of the structure at the manufacturing plant;
  - During pouring of floors, walls, and top slab;
  - During installation of manholes/trap doors, steps, orifices/weirs, bypass pipes, and sump pit (when applicable);
  - During placement of the filter bed; and
  - Upon completion of final grading and establishment of permanent stabilization.

- **Green Roof Systems**, at the following stages:
  - During placement of the waterproofing layer, to ensure that it is properly installed and watertight;
  - During placement of the drainage layer and drainage system;
  - During placement of the growing media, to confirm that it meets the specifications and is applied to the correct depth (certification for vendor or source must be provided);
  - Upon installation of plants, to ensure they conform to the planting plan (certification from vendor or source must be provided); and
  - At the end of the first or second growing season, to ensure desired surface cover specified in the Care and Replacement Warranty has been achieved.

### **2.3.3 Final Construction Inspection Reports**

Beaufort County Public Works Department will conduct a final inspection to determine if the completed work is constructed in accordance with approved plans and the intent of this Manual and the Stormwater Ordinance. Within 21 days of the final inspection, the applicant must submit an as-built package, including one PDF copy of the as-built SWMP certified by a registered professional engineer licensed in the State of South Carolina. For a project consisting entirely of work in the PROW, the submission of a Record Drawing certified by an officer of the project contracting company is acceptable if it details the as-built construction of the BMPs, related stormwater infrastructure, and land covers.

A registered professional engineer licensed in South Carolina is required to certify as-built SWMPs and state that all activities including clearing, grading, site stabilization, the preservation or creation of pervious land cover, the construction of drainage conveyance systems, the construction of BMPs, and all other stormwater-related components of the project were accomplished in strict accordance with the approved SWMP and specifications. As stated in Section 2.2.2 Resubmission of Stormwater Management Plans, all plan changes are subject to Beaufort County Public Works Department approval. The as-built certification must be on the original SWMP.

Upon completion, these plans will be submitted to Beaufort County Public Works Department for processing. The estimated time for processing will be two weeks (10 working days), after which the plans will be returned to the engineer. Beaufort County Public Works Department will provide the applicant with written notification of the final inspection results.

### **2.3.4 Inspection for Preventative Maintenance**

The Stormwater Ordinance requires maintenance inspections for BMPs and land covers to ensure their ongoing performance is in compliance with their original design. The inspection will occur at least once every three (3) years. Maintenance inspection forms are provided in Appendix F Maintenance Inspection Checklists. Beaufort County Public Works Department may conduct these maintenance inspections, though it may, in certain circumstances, allow a property to self-inspect and provide documentation.

Beaufort County Public Works Department will maintain maintenance inspection reports for all BMPs that they inspect and are provided by the landowner. The reports will evaluate BMP functionality based on the detailed BMP requirements of Stormwater Best Management Practices (BMPs) and inspection forms found in Appendix F Maintenance Inspection Checklists.

If, after an inspection by Beaufort County Public Works Department, the condition of a BMP presents an immediate danger to the public safety or health because of an unsafe condition or improper maintenance, Beaufort County Public Works Department may take such action as may be necessary to

protect the public and make the BMP safe. Any costs incurred by Beaufort County Public Works Department may be assessed against the owner(s).

## **2.4 Inspections & Maintenance**

### **2.4.1 Inspections & Maintenance Responsibilities**

A site with an approved SWMP must also have a responsible party inspect and maintain the BMPs and land covers according to the inspections and maintenance schedule in the SWMP and this Manual. Land covers must be maintained in type and extent as approved. Approved BMPs must be kept in good condition, including all the engineered and natural elements of each practice, as well as conveyance features (e.g., grade surfaces, walls, drains, structures, vegetation, soil erosion and sediment control measures, and other protective devices). All repairs or restorations must be in accordance with the approved SWMP.

A Maintenance Agreement including an exhibit stating the owner's specific maintenance responsibilities must be recorded with the property deed at the Record of Deeds. An inspection and maintenance schedule for any BMP will be developed for the life of the project and shall state the inspection and maintenance to be completed, the time for completion, and who will perform the inspections and maintenance. The schedule will be printed on the SWMP and will appear as an exhibit in the Maintenance Agreement.

### **2.4.2 Inspection & Maintenance Agreements**

Inspection and maintenance obligations are binding on current and future owners of a property subject to recorded covenants. Beaufort County Public Works Department will not issue final approval of a complete set of the SWMP for private parcels until the applicant has executed a stormwater maintenance agreement providing notice of this obligation to current and subsequent owners of the land served by the BMP(s) and land covers. Inspection and maintenance agreements by regulated projects include providing access to the site and the BMP(s) at reasonable times for regular inspection by Beaufort County Public Works Department and for regular or special assessments of property owners, as needed, to ensure that the BMP(s) is maintained in proper working condition and the land covers are retained as approved in the SWMP. An example of the declaration of covenants/maintenance agreement for a site with BMPs and designated land covers is provided at the end of this chapter.

The applicant must record the agreement as a declaration of covenants with Beaufort County Public Works Department Recorder of Deeds. The agreement must also provide that, if after written notice by Beaufort County Public Works Department to correct a violation requiring maintenance work, satisfactory corrections are not made by the owner(s) of the land served by the BMP within a reasonable period of time, not to exceed 45 to 60 days unless an extension is approved in writing by Beaufort County Public Works Department. Beaufort County Public Works Department may perform all necessary work to place the BMP in proper working condition. The owner(s) of property served by the BMP will be assessed the cost of the work and any potential penalties/fines.

### **As-Built Submittals**

One set of As-Built drawings sealed by a registered professional engineer licensed in the State of South Carolina must be submitted as required by the procedure for handling close out documents for private development projects by Beaufort County Planning and Zoning department.

The following items must be completed and provided:

#### **General Information:**

- Words As-Built in or near the project title
- As-Built Signature/Approval block on each sheet
- As-builts shall have a coordinate system based on the South Carolina Coordinate System North American Datum of 1983 (NAD83).
- Elevations shown shall be based on the North American Vertical Datum of 1988 (NAVD88).
- Vicinity map
- Sheets numbered correctly
- Project ID number, Project Name, Permit number and name, address and contact information of project engineer
- All measurements and coordinates shall be shown on all drainage structures, detention and BMP structure outlets, outlet control structures and manholes.
- Any change to BMP capacities, dimensions, specifications or location shall be shown as mark-through of the original design on the drawings
- Elevations to the nearest 0.1 ft.

**Basins:**

- At least two benchmarks on the plans
- Profile of the top of berm
- Cross-section of emergency spillway at the control section
- Profile along the centerline of the emergency spillway
- Cross-section of berm at the principle spillway
- Elevation of the principle spillway crest or top of structure elevations
- Elevation of the principle spillway inlet and outlet invert
- Riser diameter/dimensions and riser base size
- Diameter, invert elevation and sizes of any stage orifices, weirs or storm drain pipes
- Barrel diameter, length, and slope
- Types of material used
- Outfall protection length, width, depth, size of rip rap and filter cloth
- Size, location, and type of anti-vortex and trash rack device (height and diameter, elevations and spacing)
- Pipe cradle information
- On plan view show length, width and depth of pond and contours of the basin area so that design volume is specified
- As-built spot elevations with the disturbed area required for basin construction in sufficient detail to provide accurate as-built contours
- Core trench limits and elevations of bottom of cut off trench
- Show length width and depth of outfall rip rap
- Certification by a Geotechnical Engineer for compact and unified soil classes
- Vegetation cover certification
- Show location of planted landscaping
- Utility locations and elevations encountered, test pitted and/or relocation during contract work

**Storm Drain Piping:**

- At least two benchmarks on the plans
- Diameter and class of pipe
- Invert of pipe at outfall, structures and/or field connections

- Slope of pipe
- Pipe lengths (show stationing)
- Types of materials
- Location of all pipes and structures horizontally on the plan
- Length, width and depth of all rip rap and other outfall protection as specified
- Elevation of rip rap at outfall and at changes in grade
- Utility locations and elevations encountered, test pitted and/or relocation during contract work

**Post construction BMP Specific details:**

- Provide as-built details as described for each best management practice in Chapter 4.

## Chapter 3. Minimum Control Requirements

### 3.1 Introduction

This chapter establishes the minimum stormwater control standards necessary to implement the Southern Lowcountry Stormwater Ordinance within Beaufort County Public Works Department. The term “runoff reduction” is used throughout this chapter to describe the retention of the stormwater on site. The SWRV is used to describe the volume of stormwater to be retained on site.

Two levels of stormwater retention are prescribed, the 85<sup>th</sup> and the 95<sup>th</sup> percentile storm, and are assigned based on a site’s subwatershed as identified by the U.S. Geological Survey Hydrologic Unit Code 12 (HUC-12) presented in Section 3.5.1 below. In addition, peak discharge control of the post-development 2-, 10-, 25-, 50-, 100-year, 24-hour storms to their predevelopment flow shall be provided by a combination of structural controls, GI/LID practices and other non-structural BMPs. As well, requirements to manage the 100-yr, 24-hour storm event are provided in the extreme flood event section below. Further, this Manual and Appendices provide the framework and necessary tools to document the methods proposed by development plans to comply with these requirements. It should be noted that stormwater ponds are considered the least favorable structural best management practice to meet the SWRV and water quality requirements of this Manual.

### 3.2 Regulated Site Definition

According to the Stormwater Ordinance, the design criteria of this Manual shall be applicable to any new development, redevelopment or major substantial improvement activity, including, but not limited to, site plan applications, public improvement projects, and subdivision applications that meet the applicability standards found in Chapter 1.4.

The Southern Lowcountry stormwater design requirements are applied according to the flow chart in Figure 3.1 and should be determined as follows:

- 1) In sequence, first determine which HUC-12 watershed that the project is in according to Table 3.1. Stormwater design criteria for the development follows the watershed area in which it is located. Next, determine the square feet of impervious area to be created, added or replaced as a part of the development or redevelopment. Will the project disturb greater than 5000 sq feet If the answer is “yes”, the project plan must meet the requirements for stormwater management in this Manual for their respective watershed area.
- 2) If a project is a major substantial improvement, refer to section 1.4.1 it must meet the water quality criteria for its respective watershed protection area to the maximum extent practicable (MEP) or obtain off-site stormwater credit. The terms MEP and off-site stormwater credit are further explained in Section 3.9 and 3.10 below. A waiver to meet Peak control requirements for major substantial improvement projects may be applied for. Approval is at the discretion of the Public Works Director or their designee.

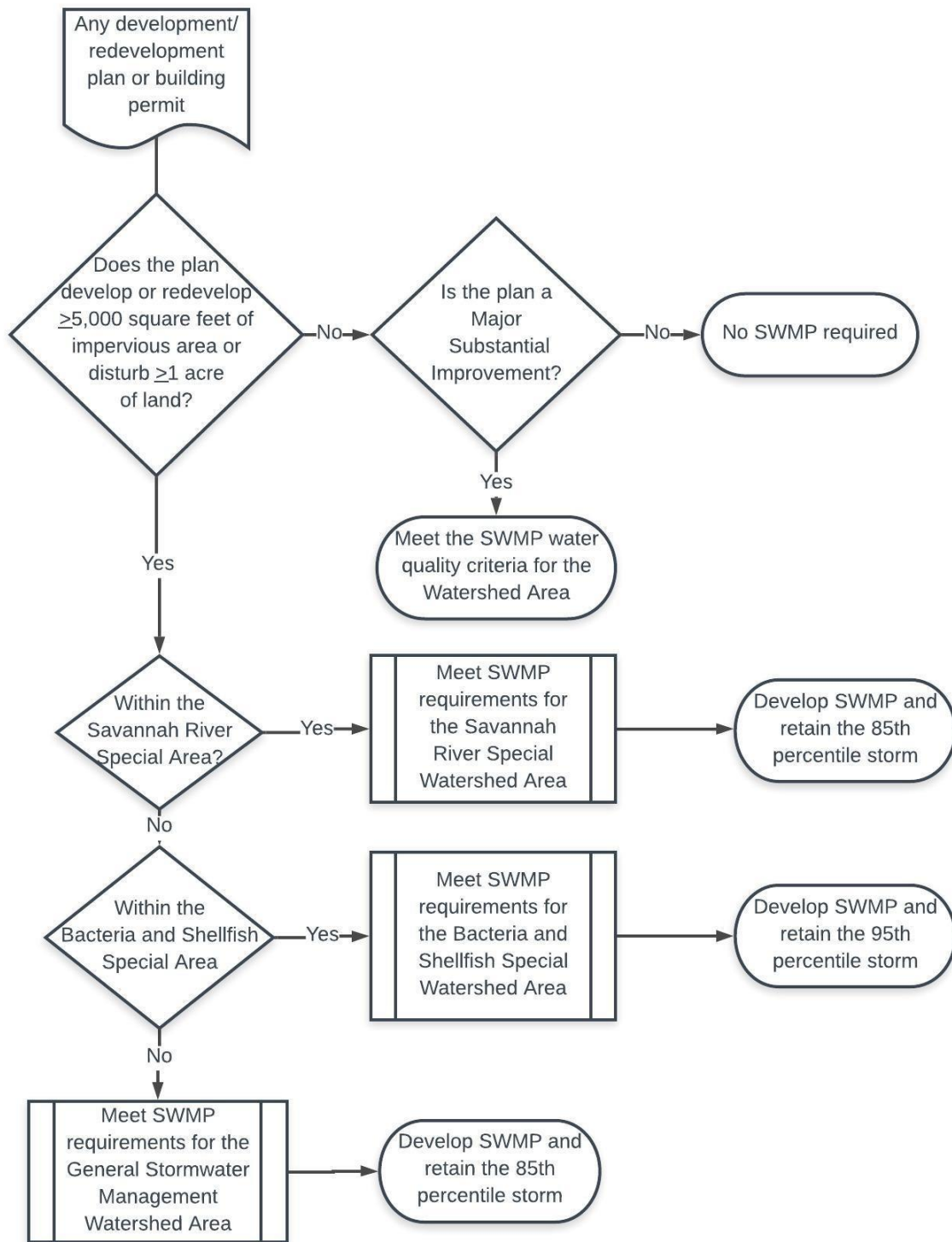


Figure 3.1. Southern Lowcountry Stormwater Design Manual applicability diagram.

### 3.3 Infill & Redevelopment

An infill project is one on a previously platted property that may or may not have stormwater management capacity in its original development plan. Regardless of size, infill that is part of a larger common plan of development, even through multiple, separate, and distinct land disturbing activities that may take place at different times and on different schedules must comply with this Manual. Such projects may include Planned Unit Developments (PUDs) that have stormwater systems built that do not meet the requirements of this Manual. If the proposed project meets the applicability criteria of Section 1.4.1, the stormwater plan review in this Manual is necessary. If the development's original stormwater management plan is sufficient to meet the current requirements of this Manual and is documented through approved plans and as-built drawings, or current field measurements and engineering calculations, no further stormwater requirements must be met. When the infill project is part of an original plan that does not meet the current stormwater requirements, the level of stormwater management that is provided in the current development may be credited toward the current volume and hydrologic analysis. Infill locations that, due to the municipal jurisdiction's zoning or land use requirements or site conditions, cannot meet the requirements of this Manual must complete the maximum extent practicable (MEP) evaluation in Section 3.9 for approval by the Public Works Director and/or their designee for project advancement/approval.

Similarly, redevelopment may be credited for the level of stormwater in place. If the redevelopment's original stormwater management plan is sufficient to meet the current requirements of this Manual and is documented through approved plans and as-built drawings, or current field measurements and engineering calculations, no further stormwater requirements must be met. When the redevelopment is part of an original plan that does not meet the current stormwater requirements, the level of stormwater management that is provided in the current development may be credited toward the current volume and hydrologic analysis. Redevelopment projects that, due to the municipal jurisdiction's zoning or land use requirements or site conditions, cannot meet the requirements of this Manual must complete the maximum extent practicable (MEP) evaluation in Section 3.9 for project approval.

### 3.4 Stormwater Runoff Quality & Peak Discharge Control

Since its inception, the Clean Water Act was designed to address the water quality impacts of stormwater runoff. As it has been applied through successive stormwater permit cycles, the Act's requirements have been interpreted to mean application of stormwater best management practices to the maximum extent practicable. The U.S. Environmental Protection Agency (EPA) has stated that such conditions include specific tasks or best management practices (BMPs), BMP design requirements, and performance requirements (EPA, 81 Fed. Reg. 3).

Consistent with the EPA's Phase II MS4 permit, this Manual requires that stormwater runoff shall be adequately treated before it is discharged from a development site. A stormwater management system is assumed to meet the stormwater runoff quality criteria by satisfying the stormwater runoff volume criteria for its respective Watershed Area presented in this Manual. If any of the required stormwater runoff volume cannot be reduced on the site, due to impractical site characteristics or constraints, the following questions shall be addressed in the permitting process:



1. Can the required stormwater volume be obtained from an adjacent site owned or available for stormwater retention purposes;
2. Is there available stormwater retention volume within the adjacent right-of-way and available through fee-in-lieu arrangements within this jurisdiction; and
3. Is a waiver granted based on a maximum extent practicable evaluation?

Further, a stormwater management system is presumed to comply with these criteria if:

- It intercepts and treats stormwater runoff in stormwater management practices that have been selected, designed, constructed and maintained in accordance with this Manual;
- It is provided with documentation to show that total suspended solids, nitrogen and bacteria removal were considered during the selection of the stormwater management practices that will be used to intercept and treat stormwater runoff on the development site;
- It is designed to provide the amount of stormwater load reduction specified in the latest edition of this Manual; and
- It manages the peak flow and extreme flood event storms in accordance with this Manual.

### **3.5 Southern Lowcountry Stormwater Management Performance Requirements**

Stormwater management requirements of this Manual are intended to enhance the quality of development, protect and enhance stormwater quality and management, protect aquatic resources from the negative impacts of the land development process, address water quality impairments or a total maximum daily load, as identified by the South Carolina Department of Health and Environmental Control (DHEC), or address localized flooding issues.

#### **3.5.1 Watershed Protection Area Designations**

Not all watersheds of the Southern Lowcountry region require the same level of post-construction stormwater management. Currently, three watershed protection areas are designated with specific unique stormwater management requirements based on the current and anticipated water quality control measures for their contributing watersheds. The Southern Lowcountry Stormwater Ordinance provides Beaufort County Public Works Department the flexibility and authority to designate sub watersheds or drainage areas as Special Watershed Protection Areas that may lead to more restrictive requirements or special criteria. Such special designations and criteria will be provided as a future appendix to this manual.

In the Southern Lowcountry, impairments include recreational water use impairment from bacteria (*Enterococcus* for saltwater and *E. coli* for freshwater), aquatic life use impairment from turbidity or dissolved oxygen, and shellfish harvesting use impairment from fecal coliform bacteria. Stormwater best management practices for these types of impairments include erosion and sediment control for turbidity impairments, illicit discharge detection, vegetated conveyances, vegetated buffers, pet waste programs, and post-construction runoff control. Currently, Southern Lowcountry water quality impairments do not include nutrient impairments, but nutrients can also be addressed through erosion and sediment control and the stormwater best management practices outlined in this Manual.

Most of Beaufort County and the lower reaches of the Jasper County watersheds have shellfish receiving waters or are recreational waters and are therefore sensitive to bacteria impairments. Land development and redevelopment projects in these watersheds require greater scrutiny to ensure that

low impact development methods are designed, implemented and maintained to be protective of these water uses.

Watersheds tributary to the Savannah River in the Southern Lowcountry include most of the freshwater wetlands of the region. River water quality is excellent and is a supply for drinking water for the City of Savannah and the Beaufort Jasper Water and Sewer Authority. Savannah River impairments downstream of the I-95 bridge are primarily aquatic life use due to low dissolved oxygen. Since the Savannah River is the boundary of Georgia and South Carolina, it is reasonable to align stormwater requirements within Jasper County with those in Chatham and Effingham Counties, GA. Stormwater permits for the Georgia jurisdictions require use of the Georgia Coastal Stormwater Supplement to the Georgia Stormwater Management Manual, which is primarily a green infrastructure/low impact development (GI/LID) design Manual with requirements specific to the Georgia coastal counties.

The remaining watersheds of the Southern Lowcountry are more upland areas and in agricultural or silvicultural use or are conservation lands. For these areas new development is subject to stormwater management requirements similar to previous county requirements. This Manual unifies stormwater management standards across the designated watersheds rather than differing across county or jurisdictional lines.

The map in Figure 3.2 outlines the boundaries of the three watershed protection areas of the Southern Lowcountry. Requirements specific to each area are further developed in this chapter. Table 3.1 lists the US Geological Survey 12-Digit Hydrologic Unit Code (HUC-12) for the watersheds in each area. To identify a site's HUC-12, refer to the South Carolina DHEC Watershed Atlas, available online at <https://gis.dhec.sc.gov/watersheds/>. After identifying the site's HUC 12, use Table 3.2 to identify the watershed protection area.

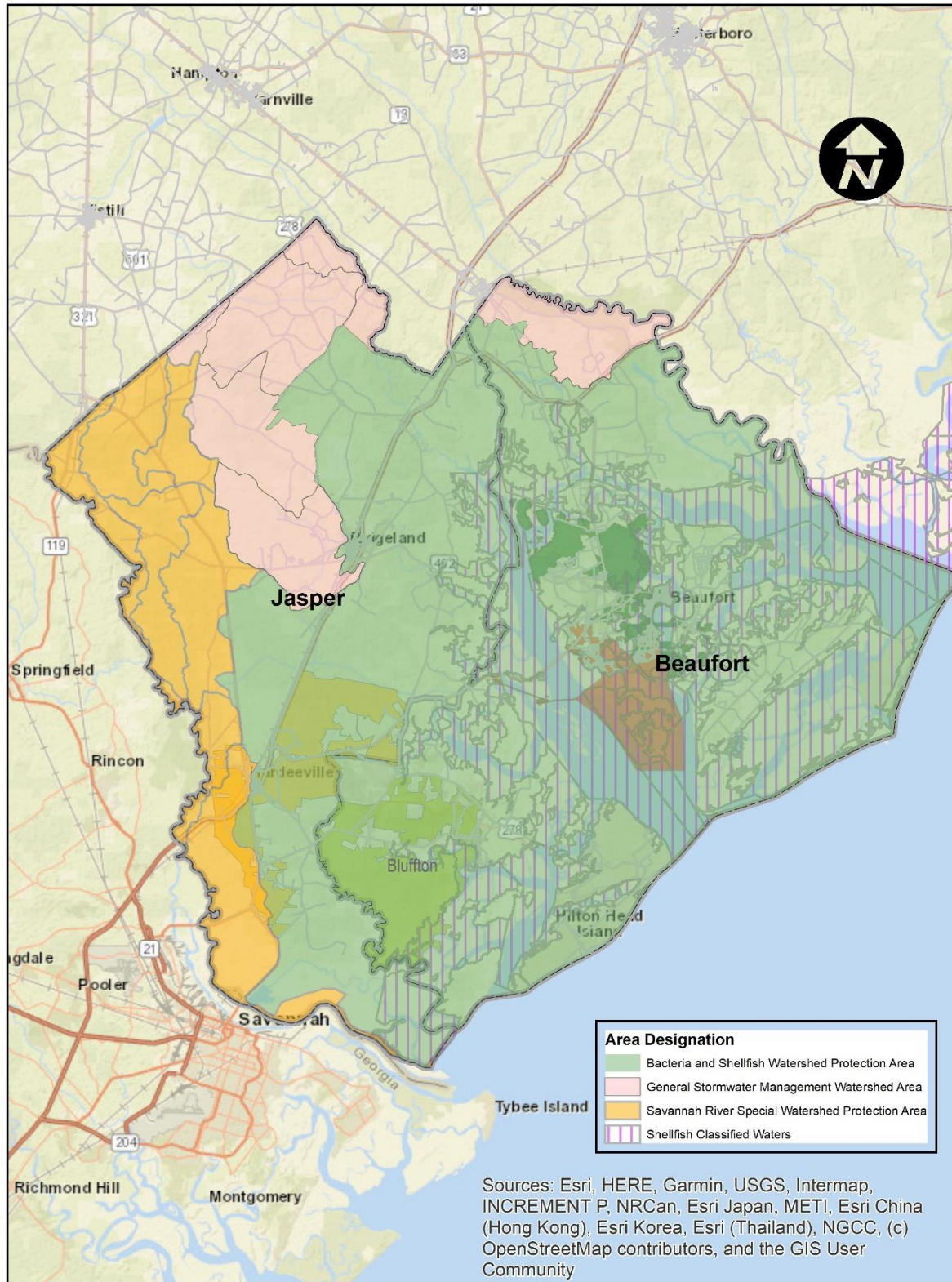


Figure 3.2. Watershed Protection Areas of the Southern Lowcountry.

Table 3.1. Watershed Protection Area HUC-12 Codes.

General Stormwater Management Watershed Areas		Savannah River Watershed Protection Area	
HUC-12 No.	Watershed Name	HUC-12 No.	Watershed Name
030502070704	Middle Combahee River	030601090107	Hog Branch-Savannah River
030502080301	Johns Pen Creek	030601090301	Cypress Branch
030502080302	Cypress Creek	030601090302	Black Swamp
030502080404	Mcpherson Creek-Coosawhatchie River	030601090303	Coleman Run
030502080405	Early Branch-Coosawhatchie River	030601090304	Sand Branch
030601100101	Gillison Branch	030601090305	Dasher Creek-Savannah River
030601100102	Upper Great Swamp	030601090307	Outlet Savannah River
Bacteria and Shellfish Watershed Protection Area			
HUC-12 No.	Watershed Name	HUC-12 No.	Watershed Name
030502070706	Lower Combahee River	030502080605	Boyd Creek-Broad River
030502071101	Wimbee Creek	030502080606	Colleton River
030502071102	Coosaw River	030502080607	Chechessee River
030502071103	Morgan River	030502080608	Broad River-Port Royal Sound
030502071104	Coosaw River-St. Helena Sound	030502100101	Harbor River-St. Helena Sound
030502080406	Bees Creek	030502100102	Harbor River-Trenchards Inlet
030502080407	Tulifiny River-Coosawhatchie River	030601090306	Wright River
030502080501	Battery Creek	030601100103	Lower Great Swamp
030502080502	Upper Beaufort River-Atlantic Intracoastal Waterway	030601100201	Upper New River-Atlantic Intracoastal Waterway
030502080503	Lower Beaufort River-Atlantic Intracoastal Waterway	030601100202	Lower New River-Atlantic Intracoastal Waterway
030502080601	Pocotaligo River-Broad River	030601100301	May River
030502080602	Huspa Creek	030601100302	Broad Creek
030502080603	Whale Branch	030601100303	Cooper River-Calibogue Sound
030502080604	Euhaw Creek	030601100304	Calibogue Sound

### 3.5.2 Overall Performance Requirements

Based on the watershed water quality criteria, its impairment status, or stormwater permit requirements, development and redevelopment stormwater management performance requirements will differ. These requirements are interpreted in terms of sizing and performance criteria. Table 3.2 presents a summary of the sizing criteria used to achieve the stormwater management performance requirements for each watershed protection area.

Table 3.2. Watershed Area Overall Performance Requirements.

General Stormwater Management Watershed Protection Areas	Savannah River Watershed Protection Area
Overall Performance Requirements	Overall Performance Requirements
<ul style="list-style-type: none"> <li>☐ Water Quality: Implement Better Site Design, maintain pre-development hydrology of the site to the Maximum Extent Practicable (MEP) for the 85<sup>th</sup> percentile storm event.</li> <li>☐ Peak Control: Control post-development peak runoff discharge rate to pre-development rate for: 2-, 10- and 25-year, 24-hour design storm events.</li> <li>☐ Accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures. Provide 10% rule analysis.</li> <li>☐ As a pollutant removal minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.</li> <li>☐ Complete a natural resources inventory for new site development applications.</li> </ul>	<ul style="list-style-type: none"> <li>☐ Water Quality: Implement Better Site Design, retain the 85<sup>th</sup> percentile storm event on-site to the MEP or obtain off-site credit.</li> <li>☐ Peak Control: Control post-development peak runoff discharge rate to pre-development rate for: 2-, 10- and 25-year, 24-hour design storm events.</li> <li>☐ Accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures. Provide 10% rule analysis.</li> <li>☐ As a pollutant removal minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.</li> <li>☐ Complete a natural resources inventory for new site development applications.</li> </ul>
Rationale	Rationale
The previous Jasper County stormwater design manual specified these overall performance requirements.	The Savannah River watershed adjoins Georgia counties that are subject to similar overall performance requirements as outlined in the Georgia Coastal Stormwater Supplement.
Bacteria and Shellfish Watershed Protection Area	
Overall Performance Requirements	
<ul style="list-style-type: none"> <li>• Water Quality: Implement Better Site Design and retain the 95<sup>th</sup> percentile storm on-site with approved infiltration/filtering BMPs. Fulfill MEP requirements or, as a last resort, fulfill off-site credit and/or fee-in-lieu requirements.</li> <li>• As a pollutant removal minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.</li> </ul>	<ul style="list-style-type: none"> <li>• Peak control: Control the post-development peak runoff discharge rate for the 2, 10, 25, 50, 100-year, 24-hour design storm events to the pre-development discharge rates.</li> <li>• Accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures. Provide 10% rule analysis.</li> <li>• Complete a natural resources inventory for new site development applications.</li> </ul>
Rationale	
The Bacteria and Shellfish Watershed Protection Areas are either impaired or have TMDLs, or the receiving waters are classified for shellfish harvesting. These watersheds require greater protection due to their Clean Water Act status or water quality classification. The site's natural resource inventory is a necessary component of permit application.	

### 3.5.3 Southern Lowcountry Stormwater Precipitation & Runoff

As in the natural environment, a site's stormwater runoff volume depends upon soil conditions and land cover. To evaluate each site's development plan, this Manual relies on the rainfall runoff estimating methods of the Natural Resources Conservation Service National Engineering Handbook (NEH).

Sometimes referred to as the curve number method or soil cover complex method, NEH chapter 9 describes the runoff response to rainfall events based on hydrologic soil group (HSG A, B, C or D) and land cover type with an integer between 29 and 100 (NRCS, 2004). Accordingly, information documenting the site's soils, their permeability, predeveloped land use or natural cover, and post-developed land cover, as well as the shallow groundwater table, are required in development plans in order to review and permit the development activity.

Precipitation event size and distribution are set by this Manual for the three watershed protection areas that make up the Southern Lowcountry.

The precipitation event distribution terms used in this Manual are defined as follows:

**85<sup>th</sup> Percentile Storm** is the 24-hour rainfall amount that according to the National Oceanic and Atmospheric Administration records for the past 30 years in which 85% of all rainfall events do not exceed at the nearest US Weather Service station to the County seat. For the General Stormwater Management Watershed Areas and the Savannah River Watershed Protection Areas, this number is 1.16 inches of rainfall.

**95<sup>th</sup> Percentile Storm** is the 24-hour rainfall amount that according to the National Oceanic and Atmospheric Administration records for the past 30 years in which 95% of all rainfall events do not exceed at the nearest US Weather Service station to the County seat. For the Bacteria and Shellfish Watershed Protection Areas this is 1.95 inches of rainfall.

Plans submitted for new development or redevelopment must demonstrate through accepted hydrologic methods that the development at post-construction will attenuate and treat the prescribed storm events. This includes volume reduction, peak flow management and extreme flood protection both on site and downstream.

### 3.5.4 Savannah River Watershed Protection Area

Upon implementation of this Manual, any applicable new development, redevelopment or major substantial improvement in the designated HUC-12 watersheds that are part of the Savannah River watershed shall meet the following requirements:

- Complete a natural resources inventory for new site development applications.
- Document use of Better Site Design.
- Retain the 85<sup>th</sup> percentile storm event on-site to the MEP or obtain off-site credit.
- Control the post-development peak runoff discharge rate for the 2, 10 and 25-year, 24-hour design storm events to the pre-development discharge rates.
- Accommodate 100-year, 24-hour storm event through the development without causing damage to the on-site and offsite structures. Provide 10% rule analysis.
- At a minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.



### 3.5.5 Bacteria & Shellfish Watershed Protection Area

Upon implementation of this Manual, any applicable new development, redevelopment or major substantial improvement in the designated HUC-12 watersheds that are part of the Bacteria and Shellfish Watershed Protection Area shall meet the following requirements:

- Complete a natural resources inventory for new site development applications.
- Document use of Better Site Design.
- Retain the 95<sup>th</sup> percentile storm on-site with approved infiltration/filtering BMPs.
- Fulfill MEP requirements or, as a last resort, fulfill off-site credit and/or fee-in-lieu requirements.
- At a minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.
- Control the post-development peak runoff discharge rate for the 2, 10, 25, 50, and 100-year, 24-hour design storm events to the pre-development discharge rates.
- Accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures. Provide 10% rule analysis.

### 3.5.6 General Stormwater Management Watershed Area

Upon implementation of this Manual, any applicable new development, redevelopment or major substantial improvement in the designated HUC-12 watersheds for the General Stormwater Management Watershed Area shall meet the following requirements:

- Complete a natural resources inventory for new site development applications.
- Document use of Better Site Design.
- Maintain pre-development hydrology of the site to the Maximum Extent Practicable (MEP) for the 85<sup>th</sup> percentile storm event.
- Control post-development peak runoff discharge rate for the 2, 10, 25, 50, and 100-year, 24-hour design storm events to pre-development discharge rates.
- Accommodate 100-year, 24-hour storm event through the development without causing damage to the on-site and offsite structures. Provide 10% rule analysis.
- As a pollutant removal minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.

### 3.5.7 Runoff Reduction & Pollutant Removal

It is the minimum criteria of this Manual that a site's stormwater best management practices shall retain the precipitation event size for its watershed protection area as summarized in Section 3.5.2. Through successive application of the practices below and that are described in detail in Chapter 4, provide at least an 80% reduction in total suspended solids loads, 30% reduction of total nitrogen load, and 60% reduction in bacteria load (Jasper County, 2011).

Stormwater best management practices, when built according to the standards in Chapter 4 and maintained according to the site's maintenance agreement, can be expected to achieve runoff reduction and pollutant removal efficiencies according to Table 3.3. These values are to be used in the pollutant removal documentation and are used within the stormwater runoff reduction calculator in Appendix H. Other water quality credits may be assigned for BMPs based on the determination by Beaufort County Public Works Department and valid study results presented with the Stormwater Management Plan submittal.

Table 3.3. Pollutant Removal Efficiencies of Structural BMPs.

BMP	Water Quality Credits			
	Runoff Reduction	TSS % Removal	Total N % Removal	Bacteria % Removal
Bioretention - No Underdrain	100% <sup>1</sup>	100% <sup>1</sup>	100% <sup>6</sup>	100% <sup>6</sup>
Bioretention – Internal Water Storage	75% <sup>1</sup>	85% <sup>1</sup>	85% <sup>4</sup>	80% <sup>5</sup>
Bioretention - Standard	60% <sup>2</sup>	85% <sup>1</sup>	75% <sup>4</sup>	80% <sup>5</sup>
Permeable Pavement - Enhanced	100% <sup>1</sup>	100% <sup>1</sup>	100% <sup>6</sup>	100% <sup>6</sup>
Permeable Pavement - Standard	30% <sup>2</sup>	80% <sup>1</sup>	45% <sup>4</sup>	30% <sup>6</sup>
Infiltration	100% <sup>1</sup>	100% <sup>1</sup>	100% <sup>6</sup>	100% <sup>6</sup>
Green Roof	100% <sup>3</sup>	100% <sup>6</sup>	100% <sup>6</sup>	100% <sup>6</sup>
Green Roof - Irrigated	50% <sup>3</sup>	50% <sup>6</sup>	50% <sup>6</sup>	50% <sup>6</sup>
Rainwater Harvesting	100% <sup>3</sup>	100% <sup>6</sup>	100% <sup>6</sup>	100% <sup>6</sup>
Impervious Surface Disconnection	40% <sup>2</sup>	80% <sup>1</sup>	40% <sup>4</sup>	40% <sup>6</sup>
Grass Channel	10% <sup>2</sup>	50% <sup>1</sup>	25% <sup>4</sup>	30% <sup>5</sup>
Grass Channel - Amended Soils	20% <sup>2</sup>	50% <sup>1</sup>	35% <sup>4</sup>	30% <sup>5</sup>
Dry Swale	60% <sup>2</sup>	85%	70% <sup>4</sup>	80% <sup>5</sup>
Wet Swale	0% <sup>1</sup>	80% <sup>1</sup>	25% <sup>4</sup>	60% <sup>5</sup>
Regenerative Stormwater Conveyance	0% <sup>1</sup>	80% <sup>1</sup>	40% <sup>6</sup>	80% <sup>6</sup>
Filtering Systems	0% <sup>3</sup>	80% <sup>1</sup>	30% <sup>4</sup>	80% <sup>6</sup>
Storage Practices	0% <sup>3</sup>	60% <sup>1</sup>	10% <sup>4</sup>	60% <sup>5</sup>
Stormwater Ponds	0% <sup>1</sup>	80% <sup>1</sup>	30% <sup>4</sup>	60% <sup>5</sup>
Stormwater Wetlands	0% <sup>1</sup>	80% <sup>1</sup>	25% <sup>4</sup>	60% <sup>5</sup>
Tree Planting and Preservation	see section 4.12			
Proprietary Practices	see section 4.13			
Conservation Areas	see section 4.14			

## Notes:

The following resources were used to develop the runoff reduction and pollutant removal values in the above table.

1. (ARC, 2016).
2. (Hirschman, 2018).
3. (DOEE, 2013)
4. (Hirschman, 2018). Nitrogen removal values from this source were applied to the remaining volume after runoff reduction was applied. The values provided in the table above represent the results of this application.
5. (Chesapeake Stormwater Network, 2018)
6. Best professional judgement was used where a BMP's pollutant removal values were not available in the above sources, or conflicts were present. In all cases, a BMP's pollutant removal value must be at least as high as its runoff reduction values (for example, if a BMP is assigned a runoff reduction value of 100%, it will also have TSS, nitrogen, and bacteria removal rates of 100%). In addition, it was assumed that a Regenerative Stormwater Conveyance (RSC) will have similar nitrogen removal to bioretention systems, so the nitrogen removal value from the Runoff Reduction Method was applied as described in reference 4, above. It was also assumed that both RSCs and filtering systems will have the same bacterial removal rate as bioretention (with no runoff reduction).



### 3.6 Erosion & Sediment Control (ESC) Requirements

The design and management of construction site runoff control measures for all qualifying developments as defined in the Ordinance shall be in accordance with SCDHEC NPDES General Permit for Stormwater Discharges from Construction Activities, the SCDHEC Erosion and Sediment Reduction and Stormwater Management regulations and its most current version of standards, where applicable. Beaufort County Public Works Department reserves the right to require additional erosion and sediment control or a higher standard of measure and make their requirement a condition of a development permit approval.

### 3.7 Retention Standard & Volume

This section provides the formulas and rationale for use of the runoff reduction method to compare predeveloped and post-development hydrology for projects submitted for approval to the Southern Lowcountry jurisdictions.

Runoff reduction is defined as “the total annual runoff volume reduced through canopy interception, soil infiltration, evaporation, transpiration, rainfall harvesting, engineered infiltration, or extended infiltration” (Hirschman, 2008). The formula to calculate the volume reduced through successive application of stormwater best management practices originates with the Natural Resources Conservation Service (NRCS) method of estimating direct runoff from storm rainfall and the curve number method of NEH Chapter 9 (NEH, 2004). As shown in Equation 3.1, rainfall event runoff (Q) is a function of depth of event rainfall (P) over the watershed, the initial abstraction ( $I_a$ ) and the maximum potential retention (S).

Equation 3.1. Curve number runoff equation.

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

$$I_a = 0.22S$$

$$Q = \frac{(P - 0.22S)^2}{(P + 0.88S)}$$

$$Q - R = \frac{(P - 0.22S)^2}{(P + 0.88S)}$$

$$S = \frac{110000}{CN^2} - 11$$

Where:

- Q = Runoff depth (in)
- P = Depth of rainfall event for the designated watershed protection area (85<sup>th</sup> or 95<sup>th</sup> percentile rain event)
- $I_a$  = Initial abstraction (in)
- S = Potential maximum retention after runoff begins (in)
- CN = Runoff curve number
- R = Retention storage provided by runoff reduction practices (in)

Not all stormwater BMPs provide runoff reduction equally. Through the crediting procedures of the Compliance Calculator found in Appendix H and the retention volumes required in this section, designers will be able to evaluate their proposed designs and submit for approval in a unified process across the Southern Lowcountry jurisdictions.<sup>1</sup>

Supplemental information on the terms below can be found in the *Low Impact Development in Coastal South Carolina: Planning and Design Guide*, and the Georgia Stormwater Management Manual (Ellis, K. et al., 2014; ARC, 2016).

The Stormwater Retention Volume (SWRv) is the volume of stormwater runoff that is required to be retained, post-development. It is calculated as shown in Equation 3.2 for the entire site and for each site drainage area (SDA). The SDA is defined as the area that drains to a single discharge point from the site or sheet flows from a single area of the site. A development site may have multiple SDAs and runoff coefficients.

Equation 3.2. Stormwater retention volume (SWRv) equation

$$SSSSRRSS = \frac{PP \times [(RRSS_{II} \times II) + (RRSS_{CC} \times CC) + (RRSS_{CC} \times CC)]}{1122}$$

Where:

- $SWRv$  = Volume required to be retained (cubic feet)
- $P$  = Depth of rainfall event for the designated watershed protection area (85<sup>th</sup> or 95<sup>th</sup> percentile rain event)
- $Rv_I$  = Runoff coefficient for impervious cover and BMP cover based on SCS hydrologic soil group (HSG) or soil type
- $I$  = Impervious cover surface area (square feet)
- $Rv_C$  = Runoff coefficient for compacted cover based on soil type
- $C$  = Compacted cover surface area (square feet)
- $Rv_N$  = Runoff coefficient for forest/open space based on soil type
- $N$  = Natural cover surface area (square feet)
- 12 = Conversion factor (inches to feet)

	Rv Coefficients			
	A soils	B Soils	C Soils	D Soils
Forest/Open Space ( $Rv_N$ )	0.02	0.03	0.04	0.05
Managed Turf ( $Rv_C$ )	0.15	0.20	0.22	0.25
Impervious Cover ( $Rv_I$ )	0.95	0.95	0.95	0.95
BMP	0.95	0.95	0.95	0.95

The Compliance Calculator in Appendix H uses best available pollutant removal efficiencies for total suspended solids, total nitrogen and fecal indicator bacteria. Use of the compliance calculator allows the designer to evaluate alternative designs to arrive at compliance with the runoff reduction and pollutant removal requirements and clearly summarize them for the local plan reviewer. The compliance

<sup>1</sup> Compliance Calculator instructions are found in Appendix G

calculator output is a necessary submittal for a plan reviewer to evaluate selected BMPs to demonstrate compliance with the watershed protection area standards of this Manual.

### **3.7.1 Total Suspended Solids, Nutrients, & Bacteria**

The minimum pollutant removal performance requirements for all watersheds of the Southern Lowcountry include the interception and treatment of stormwater runoff volume to at least an 80% reduction in total suspended solids load, 30% reduction of total nitrogen load, and 60% reduction in bacteria load. These requirements are established for the following reasons.

Stormwater in the Lowcountry conveys the plant nutrients nitrogen and phosphorus. Nitrogen tends to dissolve in water, but phosphorus is adsorbed to suspended solids predominantly. Control of total suspended solids through the BMPs in this Manual will also remove a proportional amount of phosphorus. Relying on the judgement of stormwater researchers and other state design manuals, the approach for the Southern Lowcountry is similar. If a BMP is effective at runoff reduction or retention of stormwater, it is similarly effective at removal of the initial volume of suspended solids (NCDEQ, 2014).

Many of the Southern Lowcountry watersheds at the HUC-12 size are directly tributary to bacteria and shellfish impaired waters. As these watersheds develop with rooftops, roads and other impervious surfaces, there is an increasing potential for bacteria in the stormwater from wildlife populations (deer, racoons, waterfowl), pet waste, septic system discharges and sanitary sewer system malfunctions. Similarly, nutrients can be expected to increase due to fertilizer use in erosion control practices, managed turf and landscaping, septic system leachate, and atmospheric deposition on impervious surfaces. Best management practices, along with better site design practices, can be used to reduce bacteria and nutrients in stormwater to the benefit and restoration of Southern Lowcountry water quality.

### **3.7.2 Hydrologic & Hydraulic Analysis**

In order to prevent an increase in the duration, frequency and magnitude of downstream overbank flooding and scouring, this Manual requires that enough stormwater detention be provided on a development site to control the post-development peak runoff discharge to the predevelopment runoff rates for the 2, 10, 25, 50, and 100 -year, 24-hour storm events. The capacity of the existing downstream receiving conveyance system for all off-site discharge points must be determined to be adequate. An analysis of the downstream conveyance capacity to accommodate the site's post development 25- and 100-year, 24-hour peak flow shall be provided in the engineering report. Discharge to the public right-of-way of the SC State highway system shall comply with the SCDOT Requirements for Hydraulic Design Studies. Necessary upgrades within the public right-of-way due to inadequate capacity for the post-development 25-yr flow must be identified during the permit application process. Upgrades to the downstream system to accommodate the 100-yr 24-hour flow must be considered through the MEP process outlined in Section 3.9. Documentation supporting safe passage of the 100-yr post development flow to the downstream point where the detention or storage area comprises 10% of the total drainage area, and an analysis of the surrounding neighborhood area to identify any existing capacity shortfalls or drainage blockages is required for plan approval. This analysis is called the 10% analysis rule in Section 3.8 of this Manual.

The recommended 2, 10, 25, and 100-year, 24-hour storm event values from Appendix F of the South Carolina DHEC Storm Water Management BMP Handbook, July 31, 2005 for Beaufort and Jasper Counties are in Table 3.4<sup>2</sup>.

Table 3.4. Rainfall depth (inches) for the Southern Lowcountry.

County	Return Period (years)			
	2	10	25	100
Beaufort	4.5	6.9	8.4	11.0
Jasper	4.2	6.4	7.8	10.2

In this Manual, Appendix I General Design Criteria and Guidelines provides the acceptable methodologies and computer models for estimating runoff hydrographs before and after development, as well as design criteria for stormwater collection systems and land cover designations. The following are the acceptable methodologies and computer models for estimating runoff hydrographs before and after development. These methods are used to predict the runoff response from given rainfall information and site surface characteristic conditions. The design storm frequencies used in all of the hydrologic engineering calculations will be based on design storms required in this Manual unless circumstances make consideration of another storm intensity criterion appropriate:

- Rational Method (limited to sites under 10 acres)
- Urban Hydrology for Small Watersheds TR-55
- Storage-Indication Routing
- HEC-1, WinTR-55, TR-20, ICPR v3 or 4 and SWMM computer models

These methods are given as valid in principle and are applicable to most stormwater management design situations in the Southern Lowcountry.

The following conditions should be assumed when developing predevelopment, pre-project, and post-development hydrology, as applicable:

- The design storm duration shall be the 24-hour rainfall event, using the NRCS (SCS) Type III rainfall distribution with a maximum six-minute time increment.
- The predeveloped peaking factor shall be 200 for new development (Blair et al., 2012).
- The post development peaking factor shall be 400.
- For new development sites the predeveloped condition shall be calculated as a composite CN based on the HSG and meadow conditions (NEH, 2004).
- For infill and redevelopment sites, the predeveloped condition shall be calculated as a composite CN based on the HSG and the land cover type and hydrologic condition at the time of the project's initial submittal.

<sup>2</sup> Until SCDHEC updates its Stormwater Management BMP Handbook rainfall table to the NOAA Atlas 14 values, the Southern Lowcountry region shall use the Handbook Appendix F rainfall table for 24 hour storm events.

- Antecedent Runoff Condition (ARC) II is the average adjustment factor for calculations using TR-55. ARC III is to be used for wetter conditions such as areas that receive irrigation water harvested from stormwater ponds and for poorly drained soils.

Project designs must include supporting data and source information. All storm sewer systems shall be analyzed for both inlet and outlet control (including tailwater effects) by using the following:

- Equations and nomographs as shown in the Federal Highway Administration (FHWA) Hydraulic Design Services (HDS) publication No. 5.
- Computer programs that calculate the actual hydraulic grade line for the storm sewer system can be used, provided all losses (friction, bend, junction, etc.) are taken into account using the appropriate loss coefficient (K) values.
- Design tailwater condition elevation shall be supported by a reasonable resource and/or analysis.
- Allowable headwater. The allowable headwater of all culverts, pipe systems, open channels, bridges and roadway culverts shall be established following the SCDOT Requirements for Hydraulic Design Studies.

All culverts, pipe systems, and open channel flow systems shall be sized in accordance with the design criteria found in Appendix I Hydrology and Hydraulics Design Requirements.

### 3.7.3 Maintenance Easements

Maintenance easements are provided for the protection and legal maintenance of stormwater management facilities not within a right-of-way. Drainage easements shall be required in subdivisions over any portion of a stormwater management facilities not within a right-of-way and necessary for the functioning of the system. Drainage easements for all facilities must be shown on construction drawings and approved by the stormwater manager. The easements shall be designated on the plan prior to issuance of a development permit and recorded in public records with copy of recorded easement submitted prior to Beaufort County Public Works Department permit termination. The minimum allowable width of drainage easements may be as shown in Table 3.5.

Table 3.5. Drainage maintenance access easements.

Stormwater Management Facility	Minimum Easement Width
Closed systems (storm sewers/pipes/culverts)	diameter + 4 ft + 2D(20-ft minimum)*
<b>Open drainage systems</b>	
Bottom width 20 ft or less	15 ft + BW + 2SD (30 ft minimum)**
Bottom width 20 ft to 40 ft	30 ft + BW + 2SD**
Bottom width greater than 40 ft	40 ft + BW + 2SD**
Retention/detention BMPs	20 ft around facility***
Pond Maintenance Access	A 20' maintenance access easement between lot lines and top of bank shall be provided for stormwater ponds with a permanent pool. The easement shall be provided for boat trailer access, and for all structure maintenance and repair. No permanent structures (mechanical, electrical, phone, fences) or landscaping are allowed within the 20' pond maintenance access easement.

\*Where:

D = Depth from grade to pipe invert

\*\*Where:

BW = Bottom width

S = Side slope

D = Depth of opening

Note: The minimum required width and configuration of drainage easements may be modified if deemed necessary by the stormwater manager for justifiable reasons.

### 3.8 Extreme Flood Requirement: 10% Rule

The peak discharge generated by the 100-year, 24-hour storm event under post-development conditions is considered the extreme peak discharge. The intent of the extreme flood protection is to prevent flood damage from infrequent but large storm events, maintain the boundaries of the mapped 100-year floodplain, and protect the physical integrity of the best management practices as well as downstream stormwater and flood control facilities. The 100-yr flow is to be used in the routing of runoff through the drainage system and stormwater management facilities to determine the effects on the facilities, adjacent property, and downstream. Emergency spillways of best management practices should be designed appropriately to pass the resulting flows safely.

Documentation supporting safe passage of the 100-year post-development flow shall be provided by the applicant/engineer. In order to prevent an increase in the duration, frequency and magnitude of downstream extreme flooding over existing conditions, an evaluation must be provided to include downstream analysis to the point where the project comprises 10% of the total contributing drainage area. The 10% rule evaluation must address existing conveyance system capacity and “pinch points” where a pipe/culvert would be overtopped and where the pipe/culvert will need to be upgraded or the peak discharge rate will need to be limited to the capacity of the downstream system.

The 10% rule recognizes the fact that a structural BMP control providing detention has a “zone of influence” downstream where its effectiveness can be felt. Beyond this zone of influence, the structural control becomes relatively small and insignificant compared to the runoff from the total drainage area at that point. Based on studies and master planning results from a large number of sites, that zone of influence is considered to be the point where the drainage area controlled by the detention or storage facility comprises 10% of the total drainage area. For example, if the drainage control drains 10 acres, the zone of influence ends at a point where the total drainage area is 100 acres or greater (ARC, 2016).

Demonstration of safe passage of the 100-year, 24-hour storm shall include a stage storage analysis of the system, an inflow/outflow comparison of the system, and construction of a table showing peak stage elevations in comparison to safe freeboards to structures of the system and adjacent buildings/structures/infrastructure. Safe passage to the receiving water also requires that there be no additional downstream flooding or other environmental impacts (e.g., stream channel enlargement, degradation of habitat).

Typical steps in the application of the 10% rule are:

1. Determine the target peak flow for the site for predevelopment conditions.
2. Using a topographic map, determine the lower limit of the zone of influence (10% point)

3. Using a hydrologic model, determine the predevelopment peak flows and timing of those peaks at each tributary junction beginning at the pond outlet and ending at the next tributary junction beyond the 10% point.
4. Change land use on the site to post-development and rerun the model.
5. Design the structural control facility such that the overbank flood protection (25-year) post-development flow is adequately conveyed to the lower limit of the zone of influence and the Extreme Flood (100-year) post-development flow does not impact any existing structures within the area of zone of influence.
6. If the overbank flood protection (25-year) post-development flow is not adequately conveyed to the lower limit of the zone of influence and/or Extreme Flood (100-year) post-development flow is shown to impact any structure, the structural control facility must be redesigned or one of the following options considered:
  - a. Work with Beaufort County Public Works Department to reduce the flow elevation through channel or flow conveyance structure improvements downstream.
  - b. Obtain a flow easement from downstream property owners to the 10% point.
  - c. Request a detention waiver from Beaufort County Public Works Department. This waiver would be for water quantity control only and best management practices to achieve water quality goals will still be required.

### 3.9 Maximum Extent Practicable

Maximum extent practicable (MEP) is the language of the Clean Water Act that sets the standards to evaluate efforts pursued to achieve pollution reduction to the Waters of the United States. The MEP refers to management practices; control techniques; and system, design, and engineering methods for the control of pollutants. It allows for considerations of public health risks, societal concerns, and social benefits, along with the gravity of the problem and the technical feasibility of solutions. The MEP for stormwater management is achieved, in part, through a process of selecting and implementing different design options with various structural and non-structural stormwater best management practices (BMPs), where ineffective BMP options may be rejected, and replaced when more effective BMP options are found (DOEE, 2019).

There must be a serious and demonstrated attempt to comply with this Manual, and practical solutions may not be lightly rejected. If project applicants implement and demonstrate only a few of the least expensive BMPs, and the regulated volume has not been retained, it is likely that the MEP standard has not been met. If, on the other hand, a project applicant implements all applicable and effective BMPs except those shown to be technically infeasible, then the project applicant would have achieved retention to the MEP.

Major land-disturbing activities, infill and redevelopment projects, and projects in the existing public right-of-way, must achieve the SWRv, and meet peak flow requirements for channel and extreme flood protection to the MEP. Through application of stormwater best management practices on site or at an off-site property within the same stormwater drainage catchment, land development projects should be able to comply with the Southern Lowcountry Stormwater Ordinance. It is the applicant's responsibility to demonstrate to the greatest extent that the requirements of this Manual can be met for the proposed development. The applicant must fully demonstrate that the requirements of the Manual are not possible or feasible before entering into a MEP analysis, and only after the concurrence and

approval of the Public Works director and/or their designee of Beaufort County Public Works Department based on the project submittals, documentation and discussions. The applicant must realize that if the requirements of the Manual cannot be met, the site may not be conducive for development, as proposed, in the interest of public safety and welfare.

When a new land development project, infill or redevelopment cannot meet the volume and peak flow requirements of this Manual, the following design and review process is required to comply with the MEP requirement. This evaluation is intended to be completed during the concept review stage of plan development.

- 1) Demonstrate how BSD has been implemented to the maximum extent practicable or document site restrictions that prevent BSD application.
- 2) List the site restrictions that prevent the on-site use of the stormwater BMPs of this Manual.
- 3) Cite justification for not being able to retain the SWRv and attain the required peak discharge limits.
- 4) Is there off-site capacity in the same drainage catchment as defined by Beaufort County Public Works Department to meet the volume and/or peak flow requirements for the site's contributing drainage area(s)?
- 5) Does the publicly maintained stormwater drainage system have sufficient capacity for the development site's extreme flood peak flow?
- 6) Develop a cost versus aggregated stormwater retention volume achieved curve for the site's contributing drainage area. A minimum of five cost points with three of the BMP alternatives in series as a treatment train are necessary for the curve. Include the evaluation off-site capacity cost. Identify the inflection point of the cost curve to identify the optimal solution where increased cost does not result in increased effectiveness.
- 7) The optimum aggregated retention value and BMP selection and size analysis must be submitted as a part of the stormwater management plan for the project.
- 8) Offsite stormwater volume retention credit or fee-in-lieu documents will be required for project completion.

The MEP submittal must provide documentable evidence of the process the applicant has performed that demonstrates the restrictions to the use and implementation of BMPs and approved by the Beaufort County Public Works Director and/or their designee and to meet the requirements of this Manual in whole or in part.

### **3.10 Off-Site Stormwater Management**

All stormwater management design plans shall include on-site stormwater management practices, unless post-construction stormwater runoff in an off-site or regional stormwater management practice is approved according to this Section.

The off-site or regional stormwater management practice must be located on property legally dedicated to that purpose, be designed and sized to meet the post-construction stormwater management criteria presented in this Manual, provide a level of stormwater quality and quantity control that is equal to or greater than that which would be provided by on-site green infrastructure and stormwater management practices, be in the same drainage catchment, as defined by Beaufort County Public Works Department, as the project area, and have an associated inspection and maintenance agreement and plan. In addition, appropriate stormwater management practices shall be installed, where necessary, to protect



properties and drainage channels that are located between the development site and the location of the off-site or regional stormwater management practice.

To be eligible for compliance through the use of off-site stormwater management practices, the applicant must submit a stormwater management design plan to Beaufort County Stormwater Department that demonstrates the adequacy of the off-site or regional stormwater management practice, and demonstrates, to the satisfaction of the Beaufort County Public Works Department that the off-site or regional stormwater management practice will not result in any of the following impacts:

- (1) Increased threat of flood damage or endangerment to public health or safety;
- (2) Deterioration of existing culverts, bridges, dams, and other structures;
- (3) Accelerated streambank or streambed erosion or siltation;
- (4) Degradation of in-stream biological functions or habitat; or,
- (5) Water quality impairment in violation of state water quality standards and/or violation of any other state or federal regulations.

### **3.11 Waivers**

Individuals seeking a waiver from the requirements of this Ordinance may submit to the (*administrator*) a request for a waiver in accordance with the Southern Lowcountry Stormwater Design Manual.

#### **(1) Request of a Waiver at Staff Level**

A written request for a waiver is required and shall state the specific waiver sought and the reasons, with supporting data, a waiver should be granted. The request shall include all information necessary to evaluate the proposed waiver. Requests must outline the need for such a waiver, such as site constraints, soil characteristics, or similar engineering limitations. Cost shall not be considered cause for a waiver. This waiver would be for water quantity control only and best management practices to achieve water quality goals will still be required. The applicant will address the criteria below for consideration of a waiver approval:

- a. What exceptional circumstances to the site are evident that on-site or off-site stormwater management requirements cannot be met?
- b. What unnecessary hardship is being caused?
- c. How will denial of the waiver be inconsistent with the intent of the Ordinance?
- d. How will granting the waiver comply with the intent of the Ordinance?
- e. How are state and federal regulations still being met?

#### **(2) Review of Waivers**

The Public Works Director and/or their designee will conduct a review of the request and will issue a decision within thirty (30) working days of receiving the request.

## **Chapter 4. Stormwater Best Management Practices (BMPs)**

### **4.1 Standard Stormwater BMP Design Sections**

This chapter summarizes and outlines performance criteria for 13 stormwater best management practice (BMP) categories that include:

- Bioretention (4.3)
- Permeable Pavements (4.4)
- Infiltration (4.5)
- Green Roofs (4.6)
- Rainwater Harvesting (4.7)
- Impervious Surface Disconnection (4.8)
- Open Channel Systems (4.9)
- Filtering Systems (4.10)
- Storage Practices (4.11)
- Ponds (4.12)
- Stormwater Wetlands (4.13)
- Tree Planting and Preservation (4.14)
- Proprietary Practices (4.15)

Following these criteria is the criteria to credit for stormwater benefit the use of conservation areas and open space preservation.

#### **4.1.1 Format of Standard Stormwater BMP Design Sections**

BMP performance criteria are based on several critical design factors to ensure effective and long-lived BMPs. For each BMP, the following factors are discussed:

- General Feasibility
- Conveyance
- Pretreatment
- Design and Sizing
- Landscaping
- Construction Sequencing
- Maintenance
- Stormwater Compliance Calculations

Design components that differ from these specifications, but meet their intent, may be included at Beaufort County Public Works Department's discretion.

#### **4.1.2 Standard Nomenclature**

In this chapter, and throughout the guidebook, the terms, *must* or *shall*, denote required aspects of BMPs or their design and implementation. The term, *should*, denotes a recommendation, however, justification may be necessary for design or implementation that does not correspond to certain recommendations.

## **4.2 Summary of BMP Stormwater Management Capabilities, Site Applicability, & Physical Feasibility**

Stormwater management requirements for a given site vary based on the site's location, and minimum control requirements discussed in detail in Section 3.5.

### **4.2.1 Stormwater Retention & Water Quality Treatment**

It is important to note that this Manual, and the associated compliance calculators, make a distinction between stormwater retention volume and stormwater water quality treatment. Not all BMPs achieve stormwater retention and/or water quality treatment equally, as was summarized in Table 3.3. The level to which a BMP provides stormwater retention and water quality treatment is provided in the BMP summary table of each BMP. The stormwater runoff reduction (SWRv) rates are expressed as a percentage of the storage volume provided by the BMP. Calculations for determining storage volume are included in each BMP's specifications. Each BMP's performance on the water quality parameters of total suspended solids, nitrogen and bacteria are also included in the BMP summary table. Note that many BMPs whose main purpose is water quality treatment typically do not have enough volume control to manage larger storm events.

### **4.2.2 Site Applicability**

Certain BMPs are more appropriate than others in certain land uses. Table 4.1 describes the site applicability for each BMP for the following factors:

- Rural Use: This column indicates whether or not the stormwater management practice is typically suited for use in rural areas and on low-density development sites.

- **Suburban Use:** This column indicates whether or not the stormwater management practice is typically suited for use in suburban areas and on medium-density development sites.
- **Urban Use:** This column identifies the stormwater management practices that are typically suited for use in urban and ultra-urban areas where space is at a premium.
- **Construction Cost:** This column assesses the relative construction cost of each of the stormwater management practices.
- **Maintenance:** This column assesses the relative maintenance burden associated with each stormwater management practice. Note that all stormwater management practices require routine inspection and maintenance.

Table 4.1. Site applicability for BMPs.

BMP	Rural Use	Suburban Use	Urban Use	Construction Cost	Maintenance
Bioretention	Yes	Yes	Yes	Medium	Medium
Permeable Pavement	Maybe	Yes	Yes	High	High
Infiltration	Yes	Yes	Yes	Medium	Medium
Green Roof	Maybe	Yes	Yes	High	Low
Rainwater Harvesting	Yes	Yes	Yes	Medium	Medium
Disconnection	Yes	Yes	Maybe	Low	Low
Open Channels	Yes	Yes	No	Low-Medium	Medium
Filtration	Maybe	Yes	Yes	High	High
Dry Ponds	Yes	Yes	No	Low	Low
Wet Ponds	Yes	Yes	No	Low	Low
Stormwater Wetlands	Yes	Yes	No	Low	Medium

#### 4.2.3 Site Conditions & Physical Feasibility

While some BMPs can be applied almost anywhere, others require specific conditions to be most effective. Physical feasibility refers to the physical site conditions necessary to effectively design and install a BMP. Table 4.2 includes the feasibility factors listed below.

- **Contributing Drainage Area (CDA):** Volume of water received by a practice can affect BMP performance. This column indicates the contributing drainage areas that typically apply for each BMP.
- **Slope:** This column describes the influence that site slope can have on the performance of the BMP. It indicates the maximum slope on which the BMP should be installed.
- **Minimum Head:** This column provides an estimate of the minimum amount of elevation difference needed within the BMP, from the inflow to the outflow, to allow for gravity operation.
- **Minimum Depth to Seasonal High Water Table:** This column indicates the minimum distance that should be provided between the bottom of the stormwater management practice and the top of the water table.
- **Soils:** This column describes the influence that the underlying soils (i.e., hydrologic soil groups) can have on the performance of the stormwater management practice.

Table 4.2. Feasibility limitations for BMPs.

BMP	Contributing Drainage Area	Slope	Minimum Head	Minimum Depth to Water Table	Soils
Bioretention	Up to 2.5 acres	Up to 5% <sup>2</sup>	4 - 5 feet	0.5 feet	All soils <sup>3</sup>
Permeable Pavement	Up to 5 times practice surface area	Up to 5%	1 – 4 feet	0.5 feet	All soils <sup>3</sup>
Infiltration	Up to 2 acres	Up to 6% <sup>2</sup>	2 feet	0.5 feet	Must drain within 72 hours
Green Roof	Green roof area + 100%	Up to 30% <sup>4</sup>	N/A	N/A	N/A
Rainwater Harvesting	No limit	No limit	N/A	N/A	N/A
Disconnection	Up to 1,000 ft <sup>2</sup> per downspout	Up to 5%	N/A	N/A	All soils
Open Channels	Up to 2.5 acres	Up to 4% <sup>2</sup>	Varies	Varies	All soils
Filtration					

Irrigation from ponds is not included as a specific best management practice in this *Manual* but is included as Rainwater Harvesting (§4.5). Requirements and guidance for irrigation use of retained stormwater have been included in Hydrologic and Hydraulic Analysis (ARC requirements in §3.7.2); Ponds (§4.10); and Rainwater Harvesting Treatment and Management Requirements (Appendix J). The Rainwater Harvesting Calculator in Appendix K will be used to determine the SWRv credit for ponds used for irrigation, and then these ponds are entered in the Compliance Calculator in Appendix H as rainwater harvesting. Instructions for these entries are included in Appendix G Compliance Calculator Instructions.

Filtration	Up to 5 acres	Up to 6%	2 – 10 feet	0.5 feet	All soils
Storage Practices	Varies	No limit	5 feet	0.5 feet	All soils
Ponds	Greater than 10 acres <sup>1</sup>	Up to 15%	6 – 8 feet	No limit	Slow-draining soils preferred
Stormwater Wetlands	Varies	Up to 8% <sup>2</sup>	2 – 4 feet	No limit	Slow-draining soils preferred
<sup>1</sup> CDA can be smaller if practice intersects the water table. <sup>2</sup> Check dams may be necessary to create sufficient ponding volume. <sup>3</sup> Slow-draining soils may require an underdrain. <sup>4</sup> Roof slope.					

### 4.3 Bioretention

Bioretention				
<b>Definition:</b> Practices that capture and store stormwater runoff and pass it through a filter bed of engineered filter media composed of sand, soil, and organic matter. Filtered runoff may be collected and returned to the conveyance system or allowed to infiltrate into the soil.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small to Large	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1,2</sup>
		85%–100%	75%–100%	80%–100%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
Moderate	Moderate	High		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	No Underdrain	IWS	Standard
Quarterly	Every 2–3 years	100% of Sv	75% of Sv	60%
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Easily incorporated into new development</li><li>▪ High community acceptance</li><li>▪ Good for small, highly paved drainage areas (i.e. parking lots)</li></ul>		<ul style="list-style-type: none"><li>▪ Maximum CDA is 1 to 2.5 acres</li><li>▪ Requires pretreatment to prevent clogging</li><li>▪ Requires detailed landscape planning</li><li>▪ Not appropriate for steep slopes</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Pretreatment</li><li>▪ Conveyance system</li><li>▪ Ponding area</li><li>▪ Soils/Filter Media/Mulch</li><li>▪ Observation Well/Monitoring Port</li><li>▪ Plants</li></ul>		<ul style="list-style-type: none"><li>▪ Maximum ponding depth 18 inches</li><li>▪ Minimum filter media bed depth 18 inches</li><li>▪ Depth to seasonal high water table must be at least 6 inches below bottom of practice</li><li>▪ Underdrain system may be needed</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Mow turf cover periodically</li><li>▪ Replace mulch as needed to maintain depth of mulch</li></ul>		<ul style="list-style-type: none"><li>▪ Replace plant material, as needed</li><li>▪ Replace soil if it becomes clogged</li><li>▪ Clean conveyance system(s)</li></ul>		

*Credited pollutant load removal*

Bioretention areas, shallow depressional areas that are filled with an engineered soil media and are planted with trees, shrubs, and other herbaceous vegetation, are one of the most effective stormwater management practices that can be used to reduce post-construction stormwater runoff rates, volumes, and pollutant loads. They also provide a number of other benefits, including improved aesthetics, wildlife habitat, urban heat island mitigation, and improved air quality. See Figure 4.1 for an example image.

They are designed to capture and temporarily store stormwater runoff in the engineered soil media, where it is subjected to the hydrologic processes of evaporation and transpiration, before being

conveyed back into the storm drain system through an underdrain or allowed to infiltrate into the surrounding soils. The engineered soil media is comprised of sand, soil, and organic matter.

Typically, bioretention systems are not designed to provide stormwater detention of larger storms (e.g., 2-, 10-, 25-year), but in some circumstances that may be possible. Bioretention practices should generally be combined with a separate facility to provide those controls.



Figure 4.1. Bioretention in parking lot (photo credit: Center for Watershed Protection, Inc.).

**Definition.** Practices that capture and store stormwater runoff and pass it through a filter bed of engineered filter media composed of sand, soil, and organic matter. Filtered runoff may be collected and returned to the conveyance system or allowed to infiltrate into the soil. Design variants include the following:

- B-1 Bioretention
- B-2 Streetscape bioretention
- B-3 Engineered tree pits
- B-4 Stormwater planters
- B-5 Residential rain gardens (for single family homes)



There are three different bioretention design configurations:

- **No Underdrain.** Practices that can infiltrate the design storm volume within 72 hours, and therefore need no underdrain (see Figure 4.2).
- **Internal Water Storage (IWS).** Practices that include an infiltration sump/storage layer (see ) below the underdrain.
- **Standard.** Practices with underdrains (see Figure 4.4).

The particular design configuration to be implemented on a site is typically dependent on specific site conditions and the characteristics of the underlying soils. These criteria are further discussed in this chapter.

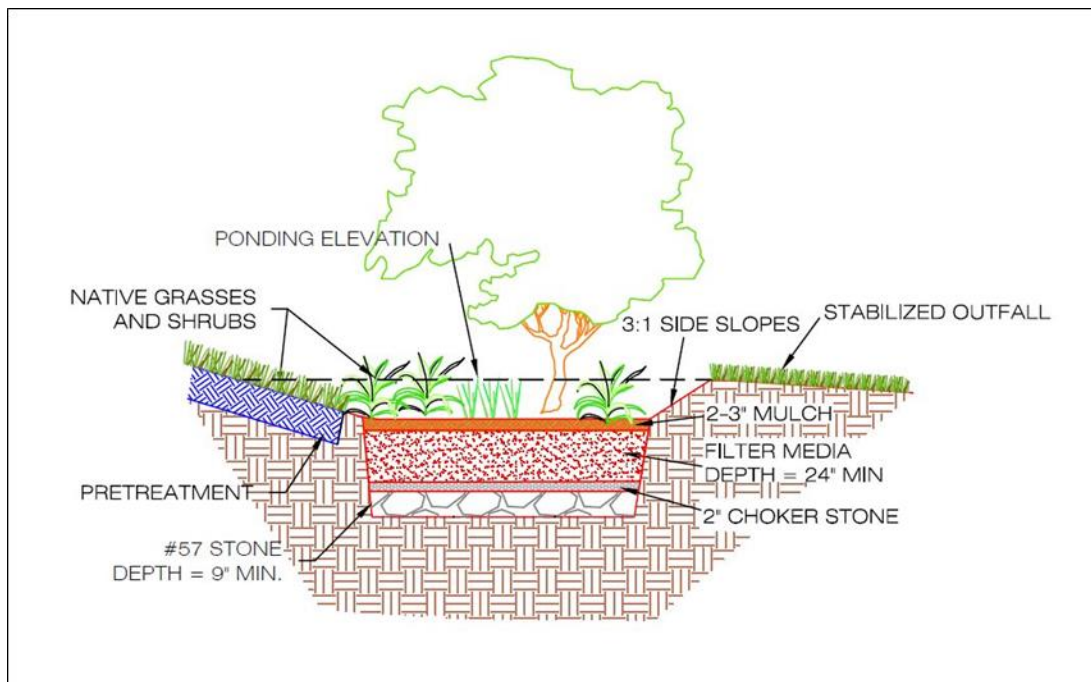


Figure 4.2. Example bioretention design without an underdrain.

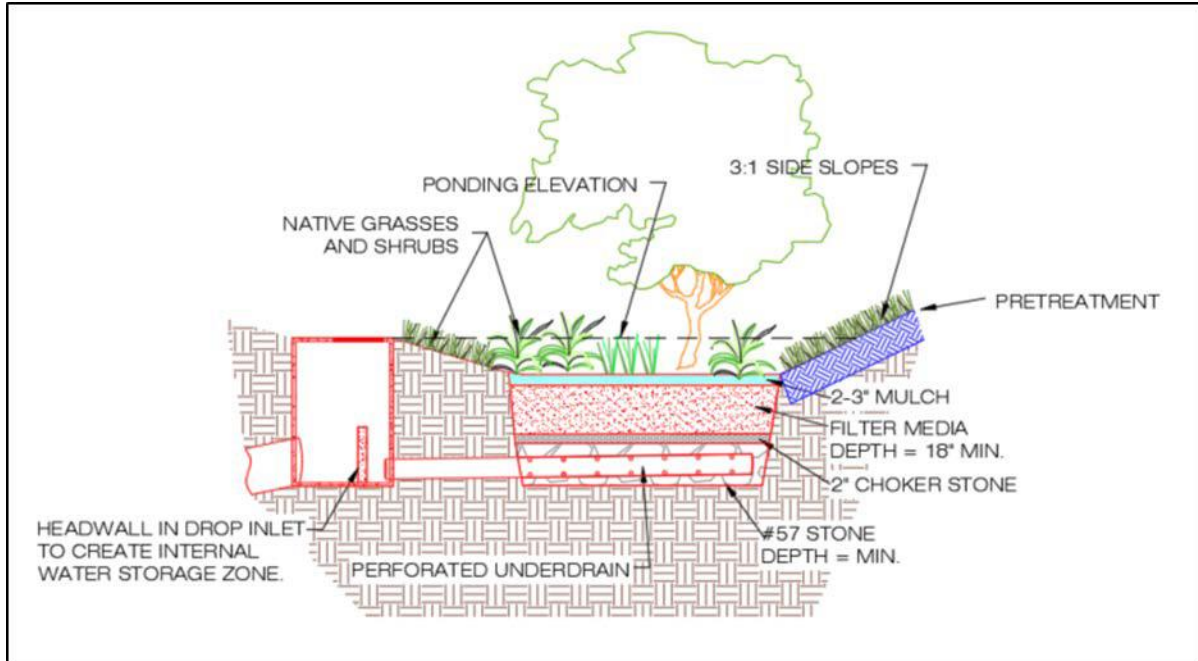


Figure 4.3. Example bioretention design with internal water storage (IWS).

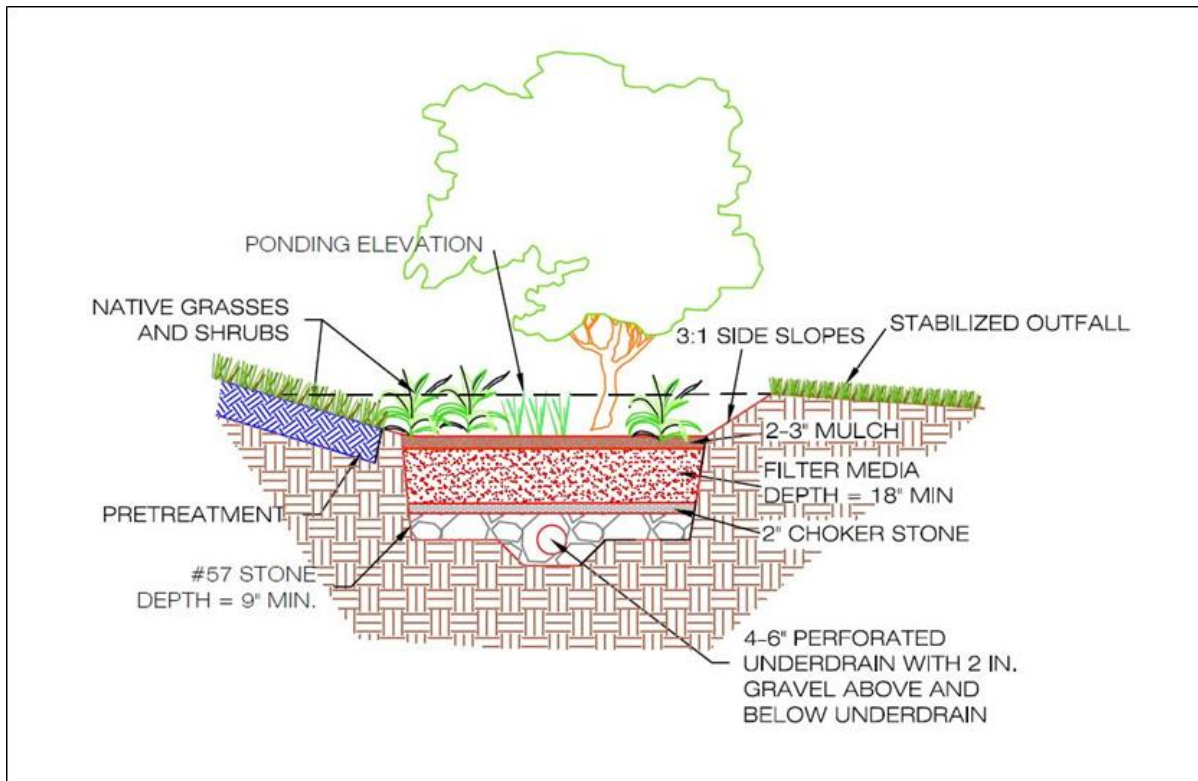


Figure 4.4. Example standard bioretention design.



Figure 4.5. Example streetscape bioretention.

#### **4.3.1 Bioretention Feasibility Criteria**

Bioretention can be applied in most soils or topography, since runoff simply percolates through an engineered soil bed and is infiltrated or returned to the stormwater system via an underdrain. Key constraints with bioretention include the following:

##### **Required Space**

Planners and designers can assess the feasibility of using bioretention facilities based on a simple relationship between the CDA and the corresponding bioretention surface area. The surface area is recommended to be approximately 3 to 6% of CDA, depending on the imperviousness of the CDA and the desired bioretention ponding depth.

##### **Site Topography**

Bioretention can be used for sites with a variety of topographic conditions, but it is best applied when the grade of the area immediately adjacent to the bioretention practice (within approximately 15 to 20 feet) is greater than 1% and less than 5%.

##### **Available Hydraulic Head**

Bioretention is fundamentally constrained by the invert elevation of the existing conveyance system to which the practice discharges (i.e., the bottom elevation needed to tie the underdrain from the bioretention area into the storm drain system). In general, 4 to 5 feet of elevation above this invert is

needed to accommodate the required ponding and filter media depths. If the practice does not include an underdrain or if an inverted or elevated underdrain design is used, less hydraulic head may be adequate.

### **Water Table**

Bioretention must be separated from the water table to ensure that groundwater does not intersect the filter bed. Mixing can lead to possible groundwater contamination or failure of the bioretention facility. A separation distance of no less than 0.5 feet is required between the bottom of the excavated bioretention area and the seasonally high groundwater table.

### **Tidal Impacts**

For systems with an underdrain, the underdrain should be located above the tidal mean high water elevation. For entirely infiltration-based systems, the bottom of the stone reservoir should be located above the mean high water elevation. Where this is not possible, portions of the practice below the tidal mean high water elevation cannot be included in the volume calculations. Also, salt-tolerant vegetation may be necessary in these areas.

### **Soils and Underdrains**

Soil conditions do not typically constrain the use of bioretention, although they do determine whether an underdrain is needed. Underdrains may be required if the measured permeability of the underlying soils is less than 0.3 inches per hour. When designing a bioretention practice, designers must verify soil permeability by using the on-site soil investigation methods provided in Appendix B for Geotechnical Information Requirements for Underground BMPs. Impermeable soils will require an underdrain.

For fill soil locations, geotechnical investigations are required to determine if it is necessary to use an impermeable liner and underdrain.

### **Contributing Drainage Area**

Bioretention cells work best with smaller CDAs, where it is easier to achieve flow distribution over the filter bed. The maximum CDA to a standard bioretention area (B-1) is 2.5 acres and can consist of up to 100% impervious cover. The CDA for smaller bioretention practices (B-2, B-3, B-4, and B-5) is a maximum of 1 acre. However, if hydraulic considerations are adequately addressed to manage the potentially large peak inflow of larger CDAs, such as off-line or low-flow diversions, or forebays, there may be case-by-case instances where the maximum CDAs can be adjusted. summarizes typical recommendations for bioretention CDAs.

Table 4.3. Maximum contributing drainage area (CDA) to bioretention.

Bioretention Type	Design Variants	Maximum CDA (acres of impervious cover)
Standard	B-1	2.5
Small-scale bioretention	B-2, B-3, B-4, and B-5	1.0

### **Pollutant Hotspot Land Uses**

Bioretention may not be an appropriate stormwater management practice for certain pollutant-generating sites. In areas where higher pollutant loading is likely (i.e. oils and greases from fueling stations or vehicle storage areas, sediment from un-stabilized pervious areas, or other pollutants from

industrial processes), appropriate pretreatment, such as an oil- water separator or filtering device must be provided. These pretreatment facilities should be monitored and maintained frequently to avoid negative impacts to the bioretention area and subsequent water bodies.

On sites with existing contaminated soils, infiltration is not allowed. An impermeable bottom liner and an underdrain system must be employed when a bioretention area will receive untreated hotspot runoff, and the No Underdrain design configuration cannot be used.

Bioretention can still be used to treat parts of the site that are outside of the hotspot area. For instance, roof runoff can go to bioretention while vehicular maintenance areas would be treated by a more appropriate hotspot practice.

### **No Irrigation or Baseflow**

The planned bioretention area should not receive baseflow, irrigation water, chlorinated wash-water or any other flows not related to stormwater. During the establishment period of the bioretention area, irrigation is allowed, however, to ensure plant survival. In addition, rain gardens or bioretention practices may be incorporated into the design of a Rainwater Harvesting System (See Section 4.7).

### **Setbacks**

To avoid the risk of seepage, stormwater cannot flow from the bioretention area reservoir layer to the traditional pavement base layer, existing structure foundations, or future foundations which may be built on adjacent properties.

Bioretention areas should be located at least:

- ❑ 10 feet from building foundations\*
- ❑ 10 feet from property lines
- ❑ 150 feet from private water supply wells
- ❑ 50 feet from septic systems

\*For building foundations, where the 10-foot setback is not possible, an impermeable liner may be used along the sides and bottom of the bioretention area (extending from the surface to the bottom of the practice and outward to meet the 10-foot setback) to prevent seepage or foundation damage.

### **Proximity to Utilities**

Designers should ensure that future tree canopy growth in the bioretention area will not interfere with existing overhead utility lines. When large site development is undertaken the expectation of achieving avoidance will be high. Conflicts may be commonplace on smaller sites and in the PROW. Consult with each utility company on recommended offsets, which will allow utility maintenance work with minimal disturbance to the bioretention system. Where conflicts cannot be avoided, follow these guidelines:

- ❑ Consider altering the location or sizing of the bioretention to avoid or minimize the utility conflict. Consider an alternate BMP type to avoid conflict.
- ❑ Use design features to mitigate the impacts of conflicts that may arise by allowing the bioretention and the utility to coexist. The bioretention design may need to incorporate impervious areas, through geotextiles or compaction, to protect utility crossings.
- ❑ Work with the utility to evaluate the relocation of the existing utility and install the optimum placement and sizing of the bioretention.

- ⑦ If utility functionality, longevity, and vehicular access to manholes can be assured, accept the bioretention design and location with the existing utility. Incorporate into the bioretention design sufficient soil coverage over the utility or general clearances or other features such as an impermeable liner to assure all entities the conflict is limited to maintenance.

When accepting utility conflict into the bioretention location and design, it is understood the bioretention will be temporarily impacted during utility work but the utility owner will replace the bioretention or, alternatively, install a functionally comparable bioretention according to the specifications in the current version of this Manual. If the bioretention is located in the PROW, the bioretention restoration will also conform with the State of South Carolina Department of Transportation design specifications.

### **Minimizing External Impacts**

Urban bioretention practices may be subject to higher public visibility, greater trash loads, pedestrian traffic, vandalism, and even vehicular loads. Designers should design these practices in ways that prevent, or at least minimize, such impacts. In addition, designers should clearly recognize the need to perform frequent landscaping maintenance to remove trash, check for clogging, and maintain vigorous vegetation. The urban landscape context may feature naturalized landscaping or a more formal design. When urban bioretention is used in sidewalk areas of high foot traffic, designers should not impede pedestrian movement or create a safety hazard. Designers may also install low fences, grates, or other measures to prevent damage from pedestrian short-cutting across the practices.

When bioretention will be included in public rights-of-way or spaces, design manuals and guidance developed by agencies or organizations other than Beaufort County Public Works Department may also apply (e.g., State Department of Transportation).

### **Economic Considerations**

Bioretention areas can be particularly cost effective when they are included in areas of the site already planned for landscaping.

#### **4.3.2 Bioretention Conveyance Criteria**

There are two basic design approaches for conveying runoff into, through, and around bioretention practices:

1. Off-line: Flow is split or diverted so that only the design storm or design flow enters the bioretention area. Larger flows bypass the bioretention treatment.
2. On-line: All runoff from the CDA flows into the practice. Flows that exceed the design capacity exit the practice via an overflow structure or weir.

If runoff is delivered by a storm drain pipe or is along the main conveyance system, the bioretention area should be designed off-line so that flows do not overwhelm or damage the practice.

### **Off-line Bioretention**

Overflows are diverted from entering the bioretention cell. Optional diversion methods include the following:

- Create an alternate flow path at the inflow point into the structure such that when the maximum ponding depth is reached, the incoming flow is diverted past the facility. In this case, the higher

flows do not pass over the filter bed and through the facility, and additional flow is able to enter as the ponding water filters through the filter media. With this design configuration, an overflow structure in the bioretention area is not required.

- Utilize a low-flow diversion or flow splitter at the inlet to allow only the design storm volume (i.e., the SWRv) to enter the facility (calculations must be made to determine the peak flow from the 85<sup>th</sup> or 95<sup>th</sup> percentile storm). This may be achieved with a weir, curb opening, or orifice for the target flow, in combination with a bypass channel or pipe. Using a weir or curb opening helps minimize clogging and reduces the maintenance frequency. With this design configuration, an overflow structure in the bioretention area is required (see on-line bioretention below).

### **On-line Bioretention**

An overflow structure must be incorporated into on-line designs to safely convey larger storms through the bioretention area (see Figure 4.6). The following criteria apply to overflow structures:

- An overflow shall be provided within the practice to pass storms greater than the design storm storage to a stabilized water course. A portion of larger events may be managed by the bioretention area so long as the maximum depth of ponding in the bioretention cell does not exceed 18 inches.
- The overflow device must convey runoff to a storm sewer, stream, or the existing stormwater conveyance infrastructure, such as curb and gutter or an existing channel.
- Common overflow systems within bioretention practices consist of an inlet structure, where the top of the structure is placed at the maximum ponding depth of the bioretention area, which is typically 6 to 18 inches above the surface of the filter bed.
- The overflow device should be scaled to the application. This may be a landscape grate or yard inlet for small practices or a commercial-type structure for larger installations.
- Sufficient depth must be provided between the top of the overflow device and the top of the bioretention area to ensure that the 25-year storm can be safely conveyed through the overflow device.
- The overflow associated with the 2- to 25-year design storms must be controlled so that velocities are non-erosive (generally less than 6 feet per second) at the outlet point, to prevent downstream erosion.



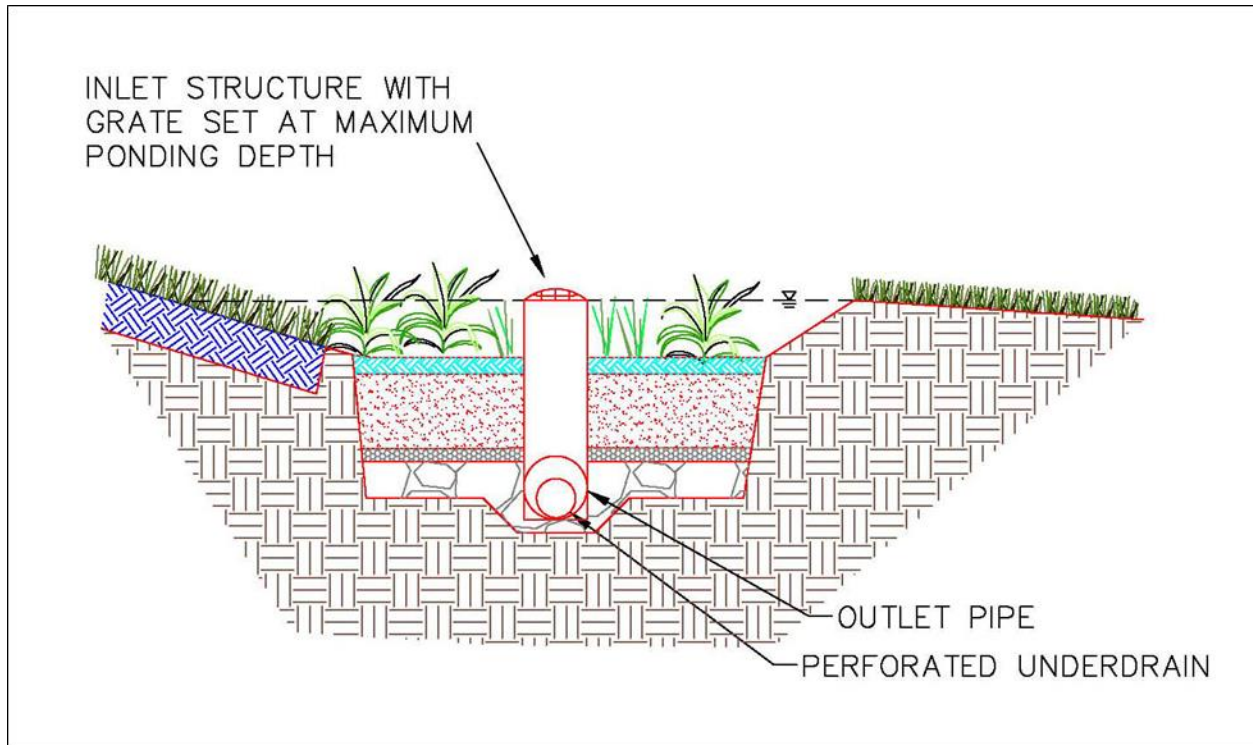


Figure 4.6. Example design of an on-line bioretention with an overflow structure.

#### 4.3.3 Bioretention Pretreatment Criteria

Pretreatment of runoff entering bioretention areas is necessary to trap coarse sediment particles before they reach and prematurely clog the filter bed. Pretreatment measures must be designed to evenly spread runoff across the entire width of the bioretention area. Several pretreatment measures are feasible, depending on the type of the bioretention practice and whether it receives sheet flow, shallow concentrated flow, or deeper concentrated flows. The following are appropriate pretreatment options:

##### **Standard Bioretention (B-1)**

- **Pretreatment Cells** (for channel flow). Similar to a forebay, this cell is located at piped inlets or curb cuts leading to the bioretention area and consists of an energy dissipator sized for the expected rates of discharge. It has a storage volume equivalent to at least 15% of the total storage volume (inclusive) with a recommended 2:1 length-to-width ratio. The cell may be formed by a wooden or stone check dam or an earthen or rock berm. Pretreatment cells do not need underlying engineered filter media, in contrast to the main bioretention cell. However, if the volume of the pretreatment cell will be included as part of the bioretention storage volume, the pretreatment cell must de-water between storm events. It cannot have a permanent ponded volume.
- **Grass Filter Strips** (for sheet flow). Grass filter strips that are perpendicular to incoming sheet flow extend from the edge of pavement, with a slight drop at the pavement edge, to the bottom of the bioretention basin at a 5H:1V slope or flatter. Alternatively, if the bioretention basin has side slopes that are 3H:1V or flatter, a 5-foot grass filter strip can be used at a maximum 5% (20H:1V) slope.
- **Stone Diaphragms** (for sheet flow). A stone diaphragm located at the edge of the pavement should be oriented perpendicular to the flow path to pretreat lateral runoff, with a 2- to 4-inch drop from



the pavement edge to the top of the stone. The stone must be sized according to the expected rate of discharge.

- **Gravel or Stone Flow Spreaders** (for concentrated flow). The gravel flow spreader is located at curb cuts, downspouts, or other concentrated inflow points, and should have a 2- to 4-inch elevation drop from a hard-edged surface into a gravel or stone diaphragm. The gravel must extend the entire width of the opening and create a level stone weir at the bottom or treatment elevation of the basin.
- **Filter System** (see Section 4.10 Filtering Systems). If using a filter system as a pretreatment facility, the filter will not require a separate pretreatment facility.
- **Innovative or Proprietary Structure**. An approved proprietary structure with demonstrated capability of reducing sediment and hydrocarbons may be used to provide pretreatment. Refer to Section 0 Proprietary Practices for information on approved proprietary structures.

Other pretreatment options may be appropriate, but they must trap coarse sediment particles and evenly spread runoff across the entire width of the bioretention area.

### **Small-Scale Bioretention (B-2, B-3, B-4, and B-5)**

- **Leaf Screens**. A leaf screen serves as part of the gutter system to keep the heavy loading of organic debris from accumulating in the bioretention cell.
- **Pretreatment Cells** (for channel flow). Pretreatment cells are located above ground or covered by a manhole or grate. Pretreatment cells are atypical in small-scale bioretention and are not recommended for residential rain gardens (B-5).
- **Grass Filter Strips** (for sheet flow). Grass filter strips are applied on residential lots, where the lawn area can serve as a grass filter strip adjacent to a rain garden.
- **Stone Diaphragm** (for either sheet flow or concentrated flow). The stone diaphragm at the end of a downspout or other concentrated inflow point should run perpendicular to the flow path to promote settling.

Note: stone diaphragms are not recommended for school settings.

- **Trash Racks** (for either sheet flow or concentrated flow). Trash racks are located between the pretreatment cell and the main filter bed or across curb cuts to allow trash to collect in specific locations and make maintenance easier.

### **4.3.4 Bioretention Design Criteria**

#### **Design Geometry**

Bioretention basins must be designed with an internal flow path geometry such that the treatment mechanisms provided by the bioretention are not bypassed or short-circuited. So that the bioretention area to have an acceptable internal geometry, the travel time from each inlet to the outlet should be maximized by locating the inlets and outlets as far apart as possible. In addition, incoming flow must be distributed as evenly as possible across the entire filter surface area.

#### **Inlets and Energy Dissipation**

Where appropriate, the inlet(s) to streetscape bioretention (B-2), engineered tree boxes (B-3), and stormwater planters (B-4) should be stabilized using No. 3 stone, splash block, river stone, or other acceptable energy dissipation measures. The following types of inlets are recommended:

- ❑ Downspouts to stone energy dissipators.
- ❑ Sheet flow over a depressed curb with a 3-inch drop.
- ❑ Curb cuts allowing runoff into the bioretention area.
- ❑ Covered drains that convey flows across sidewalks from the curb or downspouts.
- ❑ Grates or trench drains that capture runoff from a sidewalk or plaza area.
- ❑ Drop structures that appropriately dissipate water energy.

Inlets must be designed with sufficient width and slope to avoid unintended bypass. This is of particular concern for curb cuts on streetscape bioretention designs.

### **Ponding Depth**

The recommended surface ponding depth is 6 to 12 inches. Minimum surface ponding depth is 3 inches (averaged over the surface area of the BMP). Ponding depths can be increased to a maximum of 18 inches. However, when higher ponding depths are utilized, the design must consider carefully issues such as safety, fencing requirements, aesthetics, the viability and survival of plants, and erosion and scour of side slopes. This is especially true where bioretention areas are built next to sidewalks or other areas where pedestrians or bicyclists travel. Shallower ponding depths (typically 6 to 12 inches) are recommended for streetscape bioretention (B-2), engineered tree boxes (B-3), and stormwater planters (B-4).

### **Side Slopes**

Traditional bioretention areas (B-1) and residential rain gardens (B-5) should be constructed with side slopes of 3H:1V or flatter. In space-constrained areas, a drop curb design or a precast structure can be used to create a stable, vertical side wall. These drop curb designs should not exceed a vertical drop of more than 12 inches, unless safety precautions, such as railings, walls, grates, etc. are included.

### **Filter Media**

The filter media of a bioretention practice consists of an engineered soil mixture that has been carefully blended to create a filter media that maintains long-term permeability while also providing enough nutrients to support plant growth. The final filter media shall consist of a well-blended mixture of medium to coarse **sand**, **loam soil**, and an **organic amendment** (compost). The sand maintains the desired permeability of the media while the limited amount of loam soil and organic amendments are considered adequate to help support initial plant growth. It is anticipated that the gradual increase of organic material through natural processes will continue to support plant growth without the need to add fertilizer, and the root structure of maturing plants and the biological activity of the media will maintain sufficient long-term permeability.

The following is the recommended composition of the three media ingredients:

- **Sand (Fine Aggregate).** Sand should consist of silica-based medium to coarse sand and be angular or round in shape. The materials shall not be derived from serpentine, shall be free of surface coatings or any other deleterious materials, and shall contain less than 0.5% mica by weight when tested with ASTM C295, Standard Guide for Petrographic Examination of Aggregates for Concrete.

ASTM C-33 concrete sand will typically meet the requirements for the sand to be used in filter media. However, some samples of ASTM C-33 sand may have too high a fraction of fine sand and silt- and clay-sized particles to meet the final filter media particle size distribution requirements. In general, coarser gradations of ASTM C-33 will better meet the filter media particle size distribution and hydraulic conductivity requirements.

Any other materials, such as manufactured sand, limestone-based sands, or crushed glass, shall meet the required particle size distribution (of final filter media mixture) and be demonstrated as adequately durable when tested by AASHTO T-103 or T-104.

- **Loam Soil.** Loam soil is generally defined as the combination of sand-sized material, fines (silt and clay), and any associated soil organic matter. Since the objective of the specification is to carefully establish the proper blend of these ingredients in the final filter media, the designer (or contractor or materials supplier) must carefully select the topsoil source material so as not exceed the amount of any one ingredient.

Generally, a natural loamy sand, sandy loam, or loam (per the USDA Textural Triangle) A-horizon topsoil free of subsoil, large stones, earth clods, sticks, stumps, clay lumps, roots, viable noxious weed seed, plant propagules, brush, or other objectionable, extraneous matter or debris is suitable for the loam soil source material.

- **Organic Amendments.** Organic amendments shall consist of stable, well-composted, natural, carbon-containing organic materials such as leaf mulch, peat moss, humus, or yard waste (consistent with the material specifications found in Appendix C Soil Compost Amendment Requirements). The material shall be free of debris such as plastics, metal, concrete, stones larger than ½ inch, larger branches and roots, and wood chips over 1 inch in length or diameter.

### **Complete Filter Media**

The complete filter media shall consist of a pug milled or mechanically blended mix of the three source materials. Mixing the filter media on site with excavation or loading equipment is not sufficient to achieve the required blending. The resulting filter media must meet the following particle size composition:

- 80%–90% sand
- 10%–20% silt and clay
- ☐ Maximum 10% clay

The particle size analysis must be conducted on the mineral fraction only or following **appropriate treatments to remove organic matter before particle size analysis. Note: The above percentages are based on weight rather than volume.**

**Additionally, the final filter media mix must either meet the grain size distribution indicated in Table 4.4, or have a saturated hydraulic conductivity of 2 to 6 inches per hour according to test procedure ASTM D2434 when compacted (at 60% to 80% optimum moisture content) to a minimum of 86% of the maximum density as determined by AASHTO T 99 (ASTM, 2006).**

Table 4.4. Filter media grain size distribution.

Sieve Type	Particle Size (mm)	Percent Passing (%)
-	8.0	100
No. 5	4.0	92–100
No. 10	2.0	72–100
No. 18	1.0	43–95
No. 35	0.5	20–65
No. 60	0.25	11–37
No. 140	0.105	10–25
No. 270	0.053	10–20
-	0.002	0–10

The filter media shall also meet the following criteria (see summary in Table 4.5):

- ☐ Organic content shall be between 3.0% and 5.0% by weight;
- ☐ pH shall be between 6.0 and 7.5;
- ☐ Cation exchange capacity (CEC) shall be a minimum of 5 meq/100g or cmol+/kg;
- ☐ Phosphorus content shall meet one of the following:
  - P-Index between 10 and 30;
  - 15 mg/kg Mehlich I Extraction;
  - 18 to 40 mg/kg Mehlich III Extraction; and
- ☐ Soluble salts shall be less than 500 ppm or less than 0.5 mmhos/cm.

Notes:

1. P-Index is an agronomic test used in North Carolina to indicate the potential for P leaching from soil. The test method has been revised to add P concentration to facilitate local lab testing. The value of the P-Index is the correlation between the CEC and P concentrations: higher CEC indicates greater adsorption sites within the media, thus increasing the ability to fix P within the soil, thereby allowing higher P concentrations without leaching. While P-Index may be a better overall representation of P, the test method may not be readily available.

Tests for organic content, CEC, soluble salts, and pH are referenced to be in accordance with Recommended Soil Testing Procedures from the Southeastern United States, Current Edition, Southern Cooperative Series Bulletin No. 419. Use the following tests from Southern Cooperative Series Bulletin No. 419:

- (a) Test for soil content by loss of weight on ignition
- (b) Test for soil CEC by exchangeable acidity method
- (c) Test for soluble salts shall be by the 1:2 (v:v) soil:water Extract Method
- (d) Test for pH by the SMP method

Table 4.5. Summary of filter media criteria for bioretention.

Filter Media Criterion	Description	Standard(s)
General Composition	Filter media must have the proper proportions of sand, loam soil, and organic amendments to promote plant growth, drain at the proper rate, and filter pollutants.	80%–90% sand; 10%–20% soil fines; maximum of 10% clay; and 3%–5% organic content  Must meet final filter media grain size distribution OR have a saturated hydraulic conductivity of 2–6 inches per hour
Sand	Medium to coarse aggregate	Based on final filter media grain size distribution
Loam Soil	Loamy sand, sandy loam, or loam	USDA Textural Triangle
Organic Amendments	Stable, well-composted, natural, carbon-containing organic materials such as leaf mulch, peat moss, humus, or yard waste.	Appendix C
P-Index or Phosphorus (P) Content	Filter media with high P levels will export P through the media and potentially to downstream conveyances or receiving waters.	P-Index of 10–30 or P content = 5–15 mg/kg (Mehlich I) or 18–40 mg/kg (Mehlich III)
Cation Exchange Capacity (CEC)	The CEC is determined by the amount of soil fines and organic matter. Higher CEC will promote pollutant removal.	CEC > 5 milliequivalents per 100 grams
pH	Soil pH influences nutrient availability and microbial populations.	Between 6.0 and 7.5
Soluble Salts	Filter media with high levels of soluble salts can injure or kill plants.	Less than 500 ppm or less than 0.5 mmhos/cm.

In cases where greater removal of specific pollutants is desired, additives with documented pollutant removal benefits, such as water treatment residuals, alum, iron, or other materials, may be included in the filter media if accepted by Beaufort County Public Works Department.

### **Filter Media Depth**

The filter media bed depth must be a minimum of 18 inches for the No Underdrain or Standard designs. The media depth must be 24 inches or greater for the IWS design **In order to receive the full credit for bacteria removal a minimum media depth of 24” is required.** The media depth must not exceed 6.0

feet. Turf, perennials, or shrubs should be used instead of trees to landscape shallower filter beds. See Table 4.7 and Table 4.8 for a list of recommended native plants.

### **Surface Cover**

Mulch is the recommended surface cover material, but other materials may be substituted, as described below:

- **Mulch.** A 2- to 3-inch layer of mulch on the surface of the filter bed enhances plant survival, suppresses weed growth, pretreats runoff before it reaches the filter media, and prevents rapid evaporation of rainwater. Shredded hardwood bark mulch, aged for at least 6 months, is recommended/required for surface cover, as it retains a significant amount of pollutants and typically will not float away. The maximum depth of the mulch layer is 3 inches.
- **Alternative to Mulch Cover.** In some situations, designers may consider alternative surface covers, such as turf, native groundcover, erosion control matting (e.g., coir or jute matting), river stone, or pea gravel. The decision regarding the type of surface cover to use should be based on function, expected pedestrian traffic, cost, and maintenance. When alternative surface covers are used, methods to discourage pedestrian traffic should be considered. Stone or gravel are not recommended in parking lot applications, since they increase soil temperature and have low water-holding capacity.
- **Media for Turf Cover.** One adaptation suggested for use with turf cover is to design the filter media primarily as a sand filter with organic content only at the top. Compost, as specified in Appendix C Soil Compost Amendment Requirements, tilled into the top layers will provide organic content for the vegetative cover. If grass is the only vegetation, the ratio of organic matter in the filter media composition may be reduced.

### **Choking Layer**

A 2- to 4-inch layer of choker stone (e.g., typically ASTM D448 No. 8 or No. 89 washed gravel) should be placed beneath the filter media and over the underdrain stone.

### **Geotextile**

If the available head is limited, or the depth of the practice is a concern, geotextile fabric may be used in place of the choking layer. An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements, and has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability must be used. Geotextile fabric may be used on the sides of bioretention areas as well.

### **Underdrains**

Many bioretention designs will require an underdrain (see Section 4.3.1 Bioretention Feasibility Criteria). The underdrain should be a 4- or 6-inch perforated schedule 40 PVC pipe, or equivalent corrugated HDPE for small bioretention BMPs, with three or four rows of 3/8-inch perforations at 6 inches on center. The underdrain must be encased in a layer of clean, double washed ASTM D448 No. 57 or smaller (No. 68, 8, or 89) stone. The maximum depth of the underdrain stone layer combined with the choking layer is 12 inches, and it cannot extend beyond the surface dimensions of the bioretention filter media. The underdrain must be sized so that the bioretention BMP fully drains within 72 hours or less.

Multiple underdrains may be necessary for bioretention areas wider than 40 feet, and each underdrain is recommended to be located no more than 20 feet from the next pipe or the edge of the bioretention.

For long and narrow applications, a single underdrain running the length of the bioretention is sufficient. Each underdrain must include a cleanout pipe (minimum 4 inches in diameter).

All bioretention practices should include at least one observation well and/or cleanout pipe (minimum 4 inches in diameter). The observation wells should be tied into any of the Ts or Ys in the underdrain system and must extend upward above the surface of the bioretention area.

### **Internal Water Storage (IWS)**

In cases where limited head is a site constraint and the bioretention must be designed to be relatively shallow (e.g., depth to groundwater, relatively flat sites, or other factors), or where increased nitrogen removal is desired, an internal water storage design that creates an infiltration sump below the underdrain can be used. The internal water storage zone may be created by an upturned elbow in the underdrain, a weir in the outlet structure, or other means that create a permanently saturated depth above the underdrain. The internal water storage zone must be kept at least 12 inches below the surface of the bioretention area. For more information on this design consult North Carolina Stormwater Design Manual Chapter C-2. (NCDEQ, 2017)

### **Observation Wells**

All bioretention practices must include at least one observation well consisting of a well-anchored, 4- to 6-inch diameter PVC pipe (see Figure 4.7). For standard and IWS bioretention designs, the non-perforated observation wells should be tied into any of the Ts or Ys in the underdrain system and must extend upward above the ponding level. These observation wells can also double as cleanouts. Observation wells for bioretention designs without underdrains should be perforated in the gravel layer only and also must extend upward to the top of ponding.

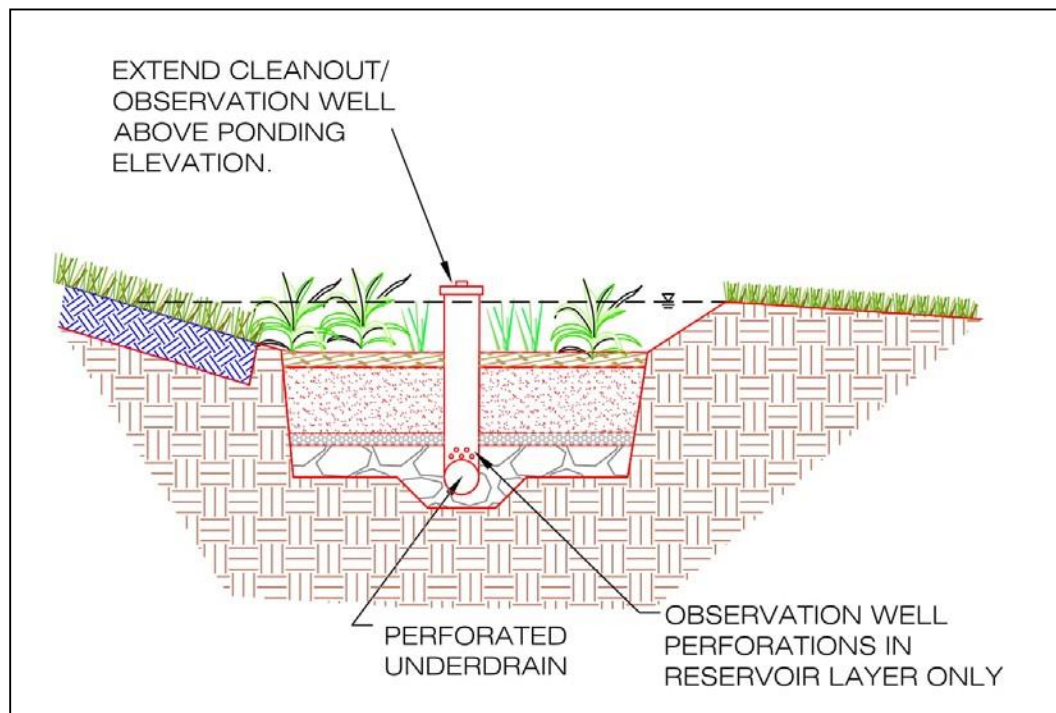


Figure 4.7. Example design of a bioretention with an observation well/cleanout device.

**Underground Storage Layer (optional)**

For IWS bioretention designs, an underground storage layer consisting of chambers, perforated pipe, stone, or other acceptable material can be incorporated below the filter media layer and underdrain to increase the storage for larger storm events. Unlike the underdrain stone layer, this storage layer can be extended beyond the surface dimensions of the bioretention filter media if additional storage volume is needed. The underground storage layer may be designed to provide detention for the 2- to 25-year, or 100-year storms, as needed. The depth and volume of the storage layer will depend on the target storage volumes needed to meet the applicable detention criteria. Suitable conveyance must also be provided to ensure that the storage is fully utilized without overflow of the bioretention area.

**Impermeable Liner (optional)**

An impermeable liner is not typically required, although it may be utilized for Standard designs in fill applications where deemed necessary by a geotechnical investigation, on sites with contaminated soils, or on the sides of the practice to protect adjacent structures from seepage. Use a PVC geomembrane liner or equivalent of an appropriate thickness (follow manufacturer's instructions for installation). Field seams must be sealed according to the liner manufacturer's specifications. A minimum 6-inch overlap of material is required at all seams.

**Material Specifications**

Recommended material specifications for bioretention areas are shown in Table 4. 6.



Table 4.6. Bioretention material specifications.

Material	Specification	Notes
Filter Media	<ul style="list-style-type: none"> <li>See Table 4.5 and Table 4.6</li> </ul>	Minimum depth of 24 inches (18 inches for standard design). To account for settling/compaction, it is recommended that 110% of the plan volume be utilized.
Mulch Layer	Use aged, shredded hardwood bark mulch	Lay a 2- to 3-inch layer on the surface of the filter bed.
Alternative Surface Cover	Use river stone or pea gravel, coir and jute matting, or turf cover.	Lay a 2- to 3-inch layer of to suppress weed growth.
Topsoil for Turf Cover	Loamy sand or sandy loam texture, with less than 5% clay content, pH corrected to between 6 and 7, and an organic matter content of at least 2%.	3-inch tilled into surface layer.
Geotextile or Choking Layer	An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability must be used	Can use in place of the choking layer where the depth of the practice is limited. Geotextile fabric may be used on the sides of bioretention areas as well.
	Lay a 2- to 4-inch layer of choker stone (e.g., typically No.8 or No.89 washed gravel) over the underdrain stone.	
Underdrain Stone	1-inch diameter stone must be double-washed and clean and free of all fines (e.g., ASTM D448 No. 57 or smaller stone).	At least 2 inches above and below the underdrain.
Storage Layer (optional)	To increase storage for larger storm events, chambers, perforated pipe, stone, or other acceptable material can be incorporated below the filter media layer.	
Impermeable Liner (optional)	Where appropriate, use a PVC Geomembrane liner or equivalent material of an appropriate thickness.	
Underdrains, Cleanouts, and Observation Wells	Use 4- or 6-inch rigid schedule 40 PVC pipe, or equivalent corrugated HDPE for small bioretention BMPs, with three or four rows of 3/8-inch perforations at 6 inches on center. Multiple underdrains may be necessary for bioretention areas wider than 40 feet, and each underdrain is recommended to be located no more than 20 feet from the next pipe or the edge of the bioretention.	Lay the perforated pipe under the length of the bioretention cell and install non-perforated pipe as needed to connect with the storm drain system or to daylight in a stabilized conveyance. Install T's and Y's as needed, depending on the underdrain configuration. Extend cleanout pipes to the surface of ponding.
Plant Materials	See Section 4.3.5 Bioretention Landscaping Criteria	Establish plant materials as specified in the landscaping plan and the recommended plant list.

## **Signage**

Bioretention units in highly urbanized areas should be stenciled or otherwise permanently marked to designate it as a structural BMP. The stencil or plaque should indicate (1) its water quality purpose, (2) that it may pond briefly after a storm, and (3) that it is not to be disturbed except for required maintenance.

## **Specific Design Issues for Streetscape Bioretention (B-2)**

Streetscape bioretention is installed in the road right-of-way either in the sidewalk area or in the road itself. In many cases, streetscape bioretention areas can also serve as traffic-calming or street-parking control devices. The basic design adaptation is to move the raised concrete curb closer to the street or in the street, and then create inlets or curb cuts that divert street runoff into depressed vegetated areas within the right-of-way. Roadway stability can be a design issue where streetscape bioretention practices are installed. Designers should consult design standards pertaining to roadway drainage. It may be necessary to provide an impermeable liner on the road-side of the bioretention area to keep water from saturating the road's sub-base. Streetscape bioretention in the PROW should comply with State Department of Transportation requirements, where applicable.

## **Specific Design Issues for Engineered Tree Boxes (B-3)**

Engineered tree boxes are installed in the sidewalk zone near the street where urban street trees are normally installed (see Figure 4.8). The soil volume for the tree pit is increased and used to capture and treat stormwater. Treatment is increased by using a series of connected tree planting areas together in a row. The surface of the enlarged planting area may be mulch, grates, permeable pavers, or conventional pavement. The large and shared rooting space and a reliable water supply increase the growth and survival rates in this otherwise harsh planting environment. Engineered tree boxes in the PROW should comply with State Department of Transportation requirements, where applicable.

When designing engineered tree boxes, the following criteria may apply.

- ⑦ Engineered tree box designs sometimes cover portions of the filter media with pervious pavers or cantilevered sidewalks (see Figure 4.9). In these situations, the following design considerations must be incorporated:
  - The filter media must be connected beneath the surface so that stormwater and tree roots can share this space.
  - As with all bioretention areas, a minimum surface ponding depth of 3 inches, averaged over the surface area of the bioretention area, is required. For example, if the additional surface area under the pavement doubles the overall surface area, then the ponding depth will need to be at least 6 inches.
  - Sand based structural soil (SBSS) may be considered as bioretention filter media if it meets the same phosphorus content limits. However, if the SBSS is to be compacted beyond the State Standards' maximum compaction for bioretention, it shall be assigned a porosity of 0.10. The State Standards call for bioretention soil to be compacted to 84% maximum dry density while SBSS is to be compacted to 93%.
- ⑦ Installing an engineered tree pit grate over filter bed media is one possible solution to prevent pedestrian traffic and trash accumulation.

- ❑ Low, wrought iron fences can help restrict pedestrian traffic across the tree pit bed and serve as a protective barrier if there is a drop-off from the pavement to the micro-bioretentation cell.
- ❑ A removable grate may be used to allow the tree to grow through it.
- ❑ Each tree needs a minimum rootable soil volume as described in Section 4.14.12 Tree Planting and Preservation.
- ❑ See Section 4.14.2 Planting Trees for further guidance and requirements on tree planting.

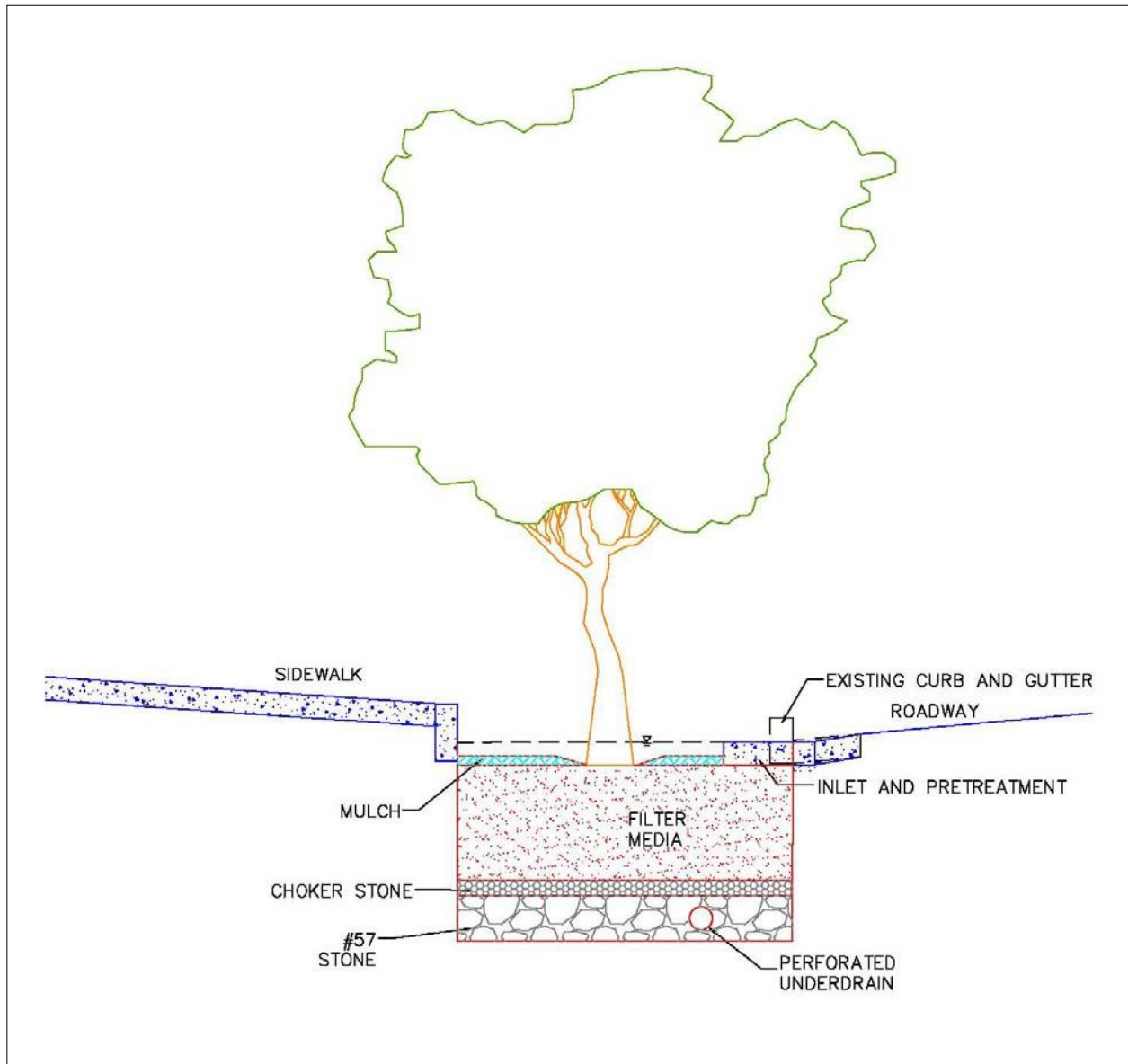


Figure 4.8. Example design of a tree box.

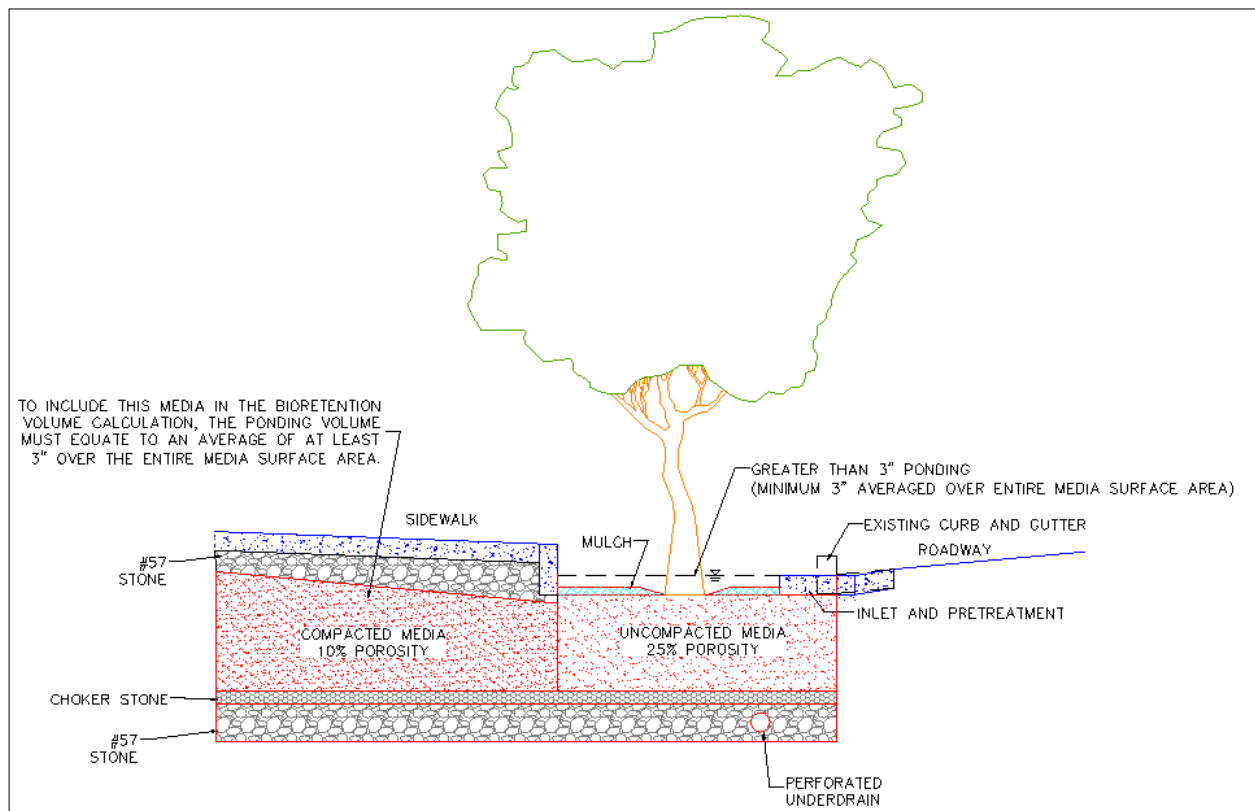


Figure 4.9. Example design of a tree box with compacted media extending below sidewalk.

#### **Specific Design Issues for Stormwater Planters (B-4)**

Stormwater planters are a useful option to disconnect and treat rooftop runoff, particularly in ultra-urban areas. Stormwater planters combine an aesthetic landscaping feature with a functional form of stormwater treatment. Stormwater planters generally receive runoff from adjacent rooftop downspouts and are landscaped with plants that tolerate periods of both drought and inundation. The two basic design variations for stormwater planters are the infiltration planter and the filter planter. A filter planter is illustrated in Figure 4.10.

An infiltration planter filters rooftop runoff through soil in the planter followed by infiltration into soils below the planter. Infiltration planters should be placed at least 10 feet away from a building to prevent possible flooding or basement seepage damage.

A filter planter does not allow for infiltration and is constructed with a watertight concrete shell or an impermeable liner on the bottom to prevent seepage. Since a filter planter is self-contained and does not infiltrate into the ground, it can be installed right next to a building. Runoff is captured and temporarily ponded above the planter bed. Overflow pipes are installed to discharge runoff when maximum ponding depths are exceeded, to avoid water spilling over the side of the planter. In addition, an underdrain is used to carry runoff to the storm sewer system.

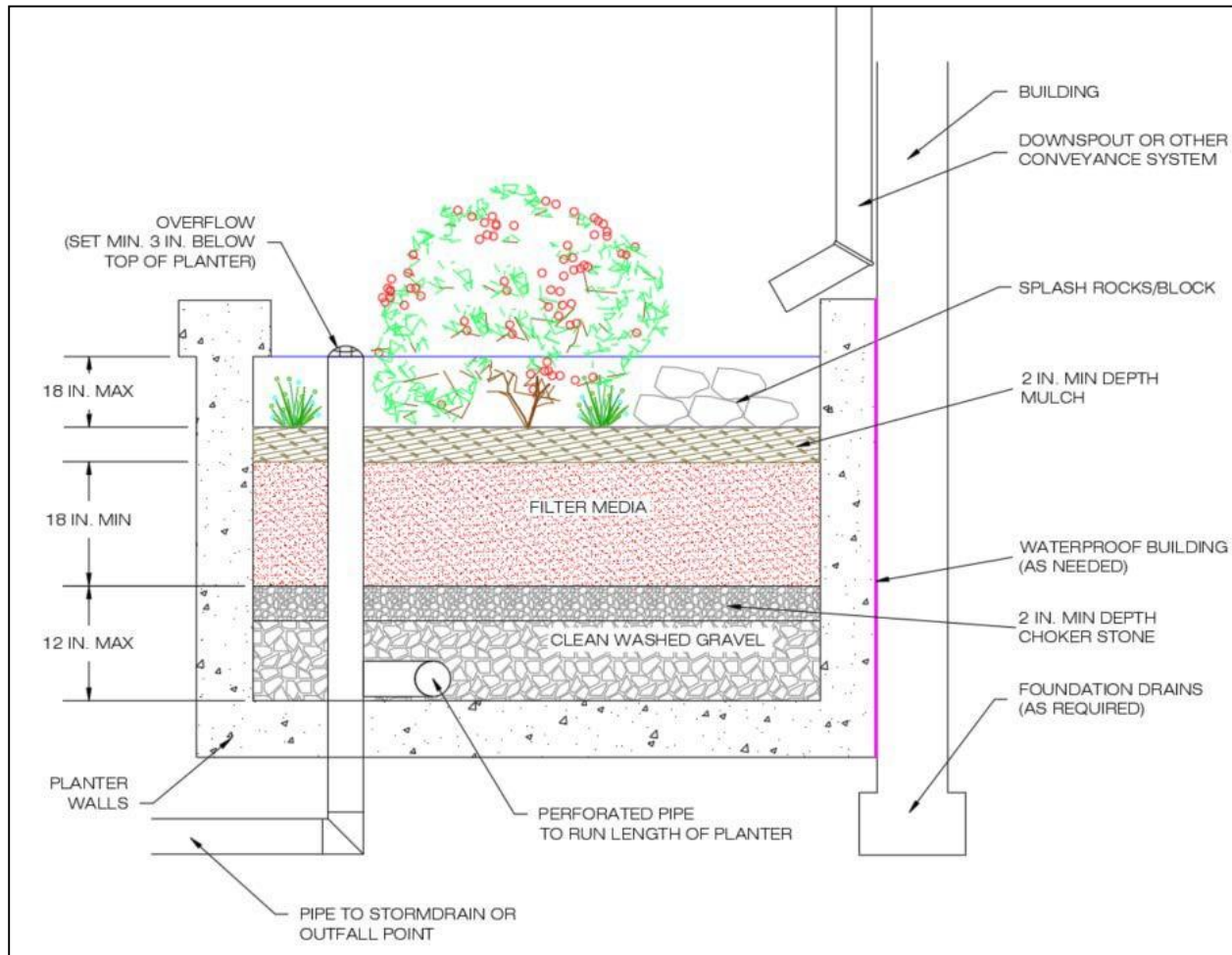


Figure 4.10. Example design of a stormwater planter (B-4).

Plant materials must be capable of withstanding moist and seasonally dry conditions. The planter can be constructed of stone, concrete, brick, wood, or other durable material. If treated wood is used, care should be taken so that trace metals and creosote do not leach out of the planter.

### **Specific Design Issues for Residential Rain Gardens (B-5)**

For some residential applications, front, side, and/or rear yard bioretention may be an attractive option. This form of bioretention captures roof, lawn, and driveway runoff from low- to medium- density residential lots in a depressed area (i.e., 6 to 12 inches) between the home and the primary stormwater conveyance system (i.e., roadside ditch or pipe system).

### **BMP Sizing**

Bioretention is typically sized to capture the SWRV or larger design storm volumes in the surface ponding area, filter media, and gravel reservoir layers of the BMP.

Total storage volume of the BMP is calculated using Equation 4.1.

Equation 4.1. Bioretention storage volume.

$$S_v = SA_{\text{bottom}} \times d_{\text{media}} \times \eta_{\text{media}} + SA_{\text{bottom}} \times d_{\text{gravel}} \times \eta_{\text{gravel}} + (SA_{\text{average}} \times d_{\text{ponding}})$$

Where:

- $S_v$  = Total storage volume of bioretention (cubic feet)  
 $SA_{\text{bottom}}$  = Bottom surface area of bioretention (square feet)  
 $d_{\text{media}}$  = Depth of filter media, including mulch later (ft)  
 $\eta_{\text{media}}$  = Effective porosity of the filter media (typically 0.25)  
 $d_{\text{gravel}}$  = Depth of the underdrain and underground storage gravel layer, including choker stone (ft)  
 $\eta_{\text{gravel}}$  = Effective porosity of the gravel layer (typically 0.4)  
 $SA_{\text{average}}$  = Average surface area of the bioretention (square feet), where  $SA_{\text{top}}$  is the surface area of the top of the bioretention

$$SA_{\text{average}} = \frac{SA_{\text{bottom}} + SA_{\text{top}}}{2}$$

- $d_{\text{ponding}}$  = Maximum ponding depth of bioretention (ft)

Equation 4.1 can be modified if the storage depths of the filter media, gravel layer, or ponded water vary in the actual design or with the addition of any surface or subsurface storage components (e.g., additional area of surface ponding, subsurface storage chambers, etc.). The maximum depth of ponding in the bioretention must not exceed 18 inches. If storage practices will be provided off-line or in series with the bioretention area, the storage practices should be sized using the guidance in Section 4.11, and section 4.9 Storage Practices.

Note: In order to increase the storage volume of a bioretention area, the ponding surface area may be increased beyond the filter media surface area. However, the top surface area of the practice (i.e., at the top of the ponding elevation) may not be more than twice the size of the surface area of the filter media ( $SA_{\text{bottom}}$ ).

For bioretention designs without an underdrain, the storage volume must infiltrate within 72 hours, as in Equation 4.2.

Equation 4.2. Bioretention infiltration rate check equation.

$$S_{v_{\text{infiltrate}}} = \frac{SA_{\text{bottom}}(K_{\text{sat}} \times t_d)}{12}$$

$S_{v_{\text{infiltrate}}}$ =	Storage volume that will infiltration within 72 hours (cubic feet)
$SA_{\text{bottom}}$ =	Bottom surface area of bioretention (square feet)
$K_{\text{sat}}$ =	Field-verified saturated hydraulic conductivity for the native soils (ft/day)
$t_d$ =	Drawdown time (3 days)

If  $S_{v_{infiltrate}}$  is greater than or equal to  $S_v$ , then the entire  $S_v$  will infiltrate within 72 hours. If it is not, the storage volume of the bioretention area should be reduced accordingly.

Bioretention can be designed to address, in whole or in part, the detention storage needed to comply with channel protection and/or flood control requirements. The  $S_v$  can be counted as part of the 2- to 25-year runoff volumes to satisfy stormwater quantity control requirements.

#### 4.3.5 Bioretention Landscaping Criteria

Landscaping is critical to the performance and function of bioretention areas. Therefore, a landscaping plan shall be provided for bioretention areas.

Minimum plan elements include the proposed bioretention template to be used, delineation of planting areas, and the planting plan including the following:

- ☐ Common and botanical names of the plants used
- ☐ Size of planted materials
- ☐ Mature size of the plants
- ☐ Light requirements
- ☐ Maintenance requirements
- ☐ Source of planting stock
- ☐ Any other specifications
- ☐ Planting sequence

It is recommended that the planting plan be prepared by a qualified landscape architect professional (e.g., licensed professional landscape architect, certified horticulturalist) to tailor the planting plan to the site-specific conditions.

Native plant species are preferred over non-native species, but some ornamental species may be used for landscaping effect if they are not aggressive or invasive. Some popular native species that work well in bioretention areas and are commercially available can be found in Table 4.7 and Table 4.8.

The degree of landscape maintenance that can be provided will determine some of the planting choices for urban bioretention areas. Plant selection differs if the area will be frequently mowed, pruned, and weeded, in contrast to a site that will receive minimum annual maintenance. In areas where less maintenance will be provided and where trash accumulation in shrubbery or herbaceous plants is a concern, consider a “turf and trees” landscaping model where the turf is mowed along with other turf areas on the site. Spaces for herbaceous flowering plants can be included.

Table 4.7. Bioretention-appropriate plants: perennial and grass

Scientific Name	Common Name	Wetland Indicator <sup>1</sup>	Inundation Tolerance	Salt Tolerance	Notes
<i>Aletris farinosa</i>	White Colicroot	FAC	Moist soil	None	
<i>Andropogon gerardii</i>	Big Bluestem	FAC	No	Moderate	
<i>Aquilegia canadensis</i>	Wild Columbine	FACU	No	None	
<i>Asclepias incarnata</i>	Swamp Milkweed	OBL	Saturated	None	
<i>Asclepias lanceolata</i>	Red Milkweed	OBL	Wet soils	Moderate / brackish	
<i>Aster novae-angliae</i>	New England Aster	FACW	Moist soils, yes	Yes	
<i>Athyrium filix-femina</i>	Lady Fern	FAC	Moist to wet soils	None	
<i>Canna glauca</i>	Water Canna	OBL	Moist to wet soils	None	
<i>Canna flaccida</i>	Golden Canna	OBL	Moist to wet soils	None	
<i>Carex stricta</i>	Tussock Sedge	OBL	Saturated, 0-6"	None	
<i>Chasmanthium latifolium</i>	River Oats	FAC	Moist soils	None	
<i>Chelone glabra</i>	White Turtlehead	OBL	Moist to wet soils		
<i>Conoclinium coelestinum</i>	Blue Mistflower	FAC	Moist to Wet soils		
<i>Crinum americanum</i>	Southern Swamp Lily	OBL	Saturated		
<i>Dulichium arundinaceum</i>	Threeway Sedge	OBL	Saturated, shallow	None	
<i>Echinodorus cordifolius</i>	Creeping Burhead	OBL	Saturated, shallow		
<i>Equisetum hyemale</i>	Scouring Rush	FACW	Saturated, shallow		
<i>Eupatorium fistulosum</i>	Joe Pye Weed	FACW	Moist to Wet Soils		
<i>Geranium maculatum</i>	Spotted Geranium	FACU	Moist Soils		



Scientific Name	Common Name	Wetland Indicator <sup>1</sup>	Inundation Tolerance	Salt Tolerance	Notes
<i>Helianthus angustifolius</i>	Swamp Sunflower, Narrowleaf Sunflower	FACW	Wet Soils		
<i>Hibiscus coccineus</i>	Scarlet Swamp Hibiscus	OBL	Saturated, shallow		
<i>Hibiscus moscheutos</i>	Rose Mallow, Hibiscus	OBL	Saturated, shallow	Low	
<i>Hymenocallis caroliniana</i>	Spider Lily	OBL	Saturated, shallow	None	
<i>Iris versicolor</i>	Virginia Iris	OBL	Shallow	None	
<i>Juncus effuses</i>	Common Rush	OBL	Shallow <6"	Low	
<i>Liatris spicata</i>	Gayfeather, Blazing Star	FAC	Moist Soils	Low	
<i>Lobelia cardinalis</i>	Cardinal Flower	FACW	Moist to Wet Soils	None	
<i>Lobelia siphilitica</i>	Blue Lobelia	OBL	Moist to wet soils		
<i>Lysimachia ciliata</i>	Fringed Loosestrife	FACW	Moist to wet soils, seasonal flooding		
<i>Mimulus ringens</i>	Allegheny Monkeyflower	OBL	Saturated, shallow		
<i>Onoclea sensibilis</i>	Sensitive Fern	FACW	Moist to wet soils		
<i>Osmunda cinnamomea</i>	Cinnamon Fern	FACW	Moist to wet soils	Low	
<i>Osmunda spectabilis</i>	Royal Fern	OBL	Moist to wet soils	None	
<i>Orontium aquaticum</i>	Golden Club	OBL	Up to 10"		
<i>Panicum virgatum</i>	Switch Grass	FAC	Moist soil	Moderate	
<i>Peltandra virginica</i>	Green Arrow Arum	OBL	Shallow < 1'	Low (< 2 ppt)	
<i>Pontederia cordata</i>	Pickernelweed	OBL	Shallow < 1'	Low (< 3 ppt)	
<i>Physostegia virginiana</i>	Obedient Plant	FACW	Moist soil		
<i>Polygonatum biflorum</i>	Great Solomon's Seal	FACU	Moist soil		

Scientific Name	Common Name	Wetland Indicator <sup>1</sup>	Inundation Tolerance	Salt Tolerance	Notes
<i>Rhynchospora colorata</i>	Starrush Whitetop	FACW	Saturated		
<i>Rudbeckia laciniata</i>	Cutleaf Coneflower	FACW	Moist soil	None	
<i>Sagittaria latifolia</i>	Common Arrowhead, Duck Potato	OBL	Up to 2.0'	None	
<i>Saururus cernuus</i>	Lizard's Tail	OBL	Shallow < 4"	None	
<i>Schizachyrium scoparium</i>	Little Bluestem	FACU	Moist soil	None	
<i>Schoenoplectus tabernaemontani</i>	Softstem Bulrush	OBL	Wet soil to standing water	Fresh or Brackish	
<i>Solidago sempervirens</i>	Seaside Goldenrod	FACW	Yes	High	
<i>Sorghastrum nutans</i>	Indiangrass	FACU	Moist soil	Moderate	
<i>Spartina alterniflora</i>	Saltmarsh Cordgrass	OBL	Yes	High	
<i>Spartina bakeri</i>	Sand cordgrass	FACW	Moist to wet soils	Fresh - Saline	
<i>Spartina patens</i>	Saltmeadow Cordgrass	FACW	Wet soils	High	
<i>Thalia dealbata</i>	Powdery Alligator-flag	OBL	up to 1.5'	Yes	
<i>Tradescantia virginiana</i>	Virginia Spiderwort	FAC	Moist soils	None	
<i>Vernonia noveboracensis</i>	Ironweed	FACW	Moist soils	None	

1. Wetland Indicator Notes:

FAC = Facultative, equally likely to occur in wetlands or non-wetlands (estimated probability 34%–66%).

FACU = Facultative Upland, usually occurs in non-wetlands (estimated probability 67%–99%), but occasionally found on wetlands (estimated probability 1%–33%).

FACW = FACW Facultative Wetland, usually occurs in wetlands (estimated probability 67%–99%), but occasionally found in non-wetlands.

OBL = Obligate Wetland, occurs almost always (estimated probability 99%) under natural conditions in wetlands

Table 4.8. Bioretention-appropriate plants: shrubs and bushes

Scientific Name	Common Name	Wetland Indicator <sup>1</sup>	Inundation Tolerance	Salt Tolerance	Notes
<i>Baccharis halimifolia</i>	Groundsel Tree, Salt Myrtle	FAC	Wet soils	High	
<i>Callicarpa americana</i>	Beautyberry	FACU	Moist soils	None	
<i>Cephalanthus occidentalis</i>	Button Bush	OBL	Up to 3 ft	Low	
<i>Clethra alnifolia</i>	Summersweet Sweet Pepperbush	FACW	Moist to wet soils	None	
<i>Cyrilla racemiflora</i>	Swamp Titi	FACW	Moist to wet soils	Low	
<i>Hamamelis virginiana</i>	Witch Hazel	FACU	Moist to wet soils	None	
<i>Hypericum prolificum</i>	Shrubby St. John's Wort	FAC	Moist soils, flood tolerant	None	
<i>Ilex glabra</i>	Inkberry	FACW	Wet soils, flood tolerant	Moderate	
<i>Ilex verticillata</i>	Winterberry Holly	FACW	Moist to wet soils	None	
<i>Ilex vomitoria</i>	Yaupon Holly	FAC	Moist soils	Moderate	
<i>Itea virginica</i>	Virginia Sweetspire	FACW	Moist to wet soils	None	
<i>Kosteletzkya virginica</i>	Seashore Mallow	OBL	Moist to wet soils	Moderate	
<i>Lindera benzoin</i>	Spicebush	FACW	Seasonal inundation	None	
<i>Myrica cerifera</i>	Wax Myrtle	FAC	Moist to wet soils	Moderate	
<i>Photinia pyrifolia</i>	Red Chokeberry	FACW	Moist soils	Low	
<i>Rhododendron canescens</i>	Dwarf Azalea	FACW	Moist soils	None	
<i>Rhododendron viscosum</i>	Swamp Azalea	OBL	Wet soil	None	
<i>Rosa carolina</i>	Carolina Rose	FACU	Moist to wet soils	Moderate	
<i>Sabal minor</i>	Dwarf Palmetto	FACW	Moist to wet soils	None	
<i>Sambucus canadensis</i>	Elderberry	FACW	Moist to wet soils	None	

Scientific Name	Common Name	Wetland Indicator <sup>1</sup>	Inundation Tolerance	Salt Tolerance	Notes
<i>Serenoa repens</i>	Saw Palmetto	FACU	Occasionally wet	None	
<i>Vaccinium corymbosum</i>	Highbush Blueberry	FACW	Wet soil	High	
<i>Viburnum dentatum</i>	Arrowwood	FAC	Moist to wet	None	

1. Wetland Indicator Notes:

FAC = Facultative, equally likely to occur in wetlands or non-wetlands (estimated probability 34%–66%).

FACU = Facultative Upland, usually occurs in non-wetlands (estimated probability 67%–99%), but occasionally found on wetlands (estimated probability 1%–33%).

FACW = FACW Facultative Wetland, usually occurs in wetlands (estimated probability 67%–99%), but occasionally found in non-wetlands.

OBL = Obligate Wetland, occurs almost always (estimated probability 99%) under natural conditions in wetlands.

Planting recommendations for bioretention facilities are as follows:

- The primary objective of the planting plan is to cover as much of the surface areas of the filter bed as quickly as possible. Herbaceous or ground cover layers are as or more important than more widely spaced trees and shrubs.
- Native plant species should be specified over non-native species.
- Plants should be selected based on a specified zone of hydric tolerance and must be capable of surviving both wet and dry conditions (“Wet footed” species should be planted near the center, whereas upland species do better planted near the edge).
- Woody vegetation should not be located at points of inflow; trees should not be planted directly above underdrains but should be located closer to the perimeter.
- Shrubs and herbaceous vegetation should generally be planted in clusters and at higher densities (i.e., 5 feet on-center and 1 to 1.5 feet on-center, respectively).
- If trees are part of the planting plan, a tree density of approximately one tree per 250 square feet (i.e., 15 feet on-center) is recommended.
- Designers should also remember that planting holes for trees must be at least 3 feet deep to provide enough soil volume for the root structure of mature trees. This applies even if the remaining filter media layer is shallower than 3 feet.
- Tree species should be those that are known to survive well in the compacted soils and the polluted air and water of an urban landscape.
- If trees are used, plant shade-tolerant ground covers within the dripline.

#### 4.3.6 Bioretention Construction Sequence

##### **Soil Erosion and Sediment Controls**

The following soil erosion and sediment control guidelines must be followed during construction:

- All bioretention areas must be fully protected by silt fence or construction fencing.
- Bioretention areas intended to infiltrate runoff must remain outside the limits of disturbance during construction to prevent soil compaction by heavy equipment and loss of design infiltration rate.
  - Where it is infeasible keep the proposed bioretention areas outside of the limits of disturbance, there are several possible remedies for the impacted area. If excavation in the proposed bioretention area can be restricted, then the remediation can be achieved with deep tilling practices. This is only possible if in situ soils are not disturbed any deeper than 2 feet above the final design elevation of the bottom of the bioretention. In this case, when heavy equipment activity has ceased, the area is excavated to grade, and the impacted area must be tilled to a depth of 12 inches below the bottom of the bioretention.
  - Alternatively, if it is infeasible to keep the proposed bioretention areas outside of the limits of disturbance, and excavation of the area cannot be restricted, then infiltration tests will be required prior to installation of the bioretention to ensure that the design infiltration rate is still present. If tests reveal the loss of design infiltration rates, then deep tilling practices may be used in an effort to restore those rates. In this case further testing must be done to establish design rates exist before the bioretention area can be installed.
  - Finally, if it is infeasible to keep the proposed bioretention areas outside of the limits of disturbance, excavation of the area cannot be restricted, and infiltration tests reveal design rates cannot be restored, then a resubmission of the SWMP will be required.
- Bioretention areas must be clearly marked on all construction documents and grading plans.
- Large bioretention applications may be used as small sediment traps or basins during construction. However, these must be accompanied by notes and graphic details on the soil erosion and sediment control plan specifying that:
  - (1) the maximum excavation depth of the trap or basin at the construction stage must be at least 1 foot higher than the post-construction (final) invert (bottom of the facility), and
  - (2) the facility must contain an underdrain.

The plan must also show the proper procedures for converting the temporary sediment control practice to a permanent bioretention BMP, including dewatering, cleanout, and stabilization.

##### **Bioretention Installation**

The following is a typical construction sequence to properly install a bioretention basin. These steps may be modified to reflect different bioretention applications or expected site conditions:

#### **1. Stabilize Contributing Drainage Area**

Construction of the bioretention area may only begin after the entire CDA has been stabilized with vegetation. It may be necessary to block certain curb or other inlets while the bioretention area is being constructed. The proposed site should be checked for existing utilities prior to any excavation.

## **2. Preconstruction Meeting**

The designer, the installer, and Beaufort County Public Works Department inspector may have a preconstruction meeting, checking the boundaries of the CDA and the actual inlet elevations to ensure they conform to original design. Since other contractors may be responsible for constructing portions of the site, it is quite common to find subtle differences in site grading, drainage and paving elevations that can produce hydraulically important differences for the proposed bioretention area. The designer should clearly communicate, in writing, any project changes determined during the preconstruction meeting to the installer and the inspector. Material certifications for aggregate, filter media, and any geotextiles should be submitted for approval to the inspector at the preconstruction meeting.

## **3. Install Soil Erosion and Sediment Control Measures to Protect the Bioretention**

Temporary soil erosion and sediment controls (e.g., diversion dikes, reinforced silt fences) are needed during construction of the bioretention area to divert stormwater away from the bioretention area until it is completed. Special protection measures, such as erosion control fabrics, may be needed to protect vulnerable side slopes from erosion during the construction process.

## **4. Install Pretreatment Cells**

Any pretreatment cells should be excavated first and then sealed to trap sediment.

## **5. Avoid Impact of Heavy Installation Equipment**

Excavators or backhoes should work from the sides to excavate the bioretention area to its appropriate design depth and dimensions. Excavating equipment should have scoops with adequate reach so they do not have to sit inside the footprint of the bioretention area. Contractors should use a cell construction approach in larger bioretention basins, whereby the basin is split into 500- to 1,000-square foot temporary cells with a 10- to 15-foot earth bridge in between, so that cells can be excavated from the side.

## **6. Promote Infiltration Rate**

It may be necessary to rip the bottom soils to a depth of 6 to 12 inches to promote greater infiltration.

## **7. Order of Materials**

If using a geotextile fabric, place the fabric on the sides of the bioretention area with a 6-inch overlap on the sides. If a stone storage layer will be used, place the appropriate depth of No. 57 stone (clean, double washed) on the bottom, install the perforated underdrain pipe, pack No. 57 stone at least 2 inches above the underdrain pipe, and add the choking layer or appropriate geotextile layer as a filter between the underdrain and the filter media layer. If no stone storage layer is used, start with at least 2 inches of No. 57 stone on the bottom and proceed with the layering as described above.

## **8. Layered Installation of Media**

Apply the media in 12-inch lifts until the desired top elevation of the bioretention area is achieved. Wait a few days to check for settlement and add additional media, as needed, to achieve the design elevation.

Note: The batch receipt confirming the source of the filter media should be submitted to the Beaufort County Public Works Department inspector.

## 9. Prepare Filter Media for Plants

Prepare planting holes for any trees and shrubs, install the vegetation, and water accordingly. Install any temporary irrigation.

## 10. Planting

Install the plant materials as shown in the landscaping plan, and water them as needed.

## 11. Secure Surface Area

Place the surface cover (i.e., mulch, river stone, or turf) in both cells, depending on the design. If coir or jute matting will be used in lieu of mulch, the matting will need to be installed prior to planting (Step 10), and holes or slits will have to be cut in the matting to install the plants.

## 12. Inflows

If curb cuts or inlets are blocked during bioretention installation, unblock these after the CDA and side slopes have good vegetative cover. It is recommended that unblocking curb cuts and inlets take place after two to three storm events if the CDA includes newly installed asphalt, since new asphalt tends to produce a lot of fines and grit during the first several storms.

## 13. Final Inspection

Conduct the final construction inspection using a qualified professional, providing Beaufort County Public Works Department with an as-built, then log the GPS coordinates for each bioretention facility, and submit them for entry into the maintenance tracking database.

## 14. Construction Supervision

Supervision during construction is recommended to ensure that the bioretention area is built in accordance with the approved design and this specification. Qualified individuals should use detailed inspection checklists that include sign-offs at critical stages of construction, to ensure that the contractor's interpretation of the plan is consistent with the designer's intentions.

Construction phase inspection checklist can be found in Appendix E Construction Inspection Checklists.

### 4.3.7 Bioretention Maintenance Criteria

When bioretention practices are installed, it is the owner's responsibility to ensure they, or those managing the practice:

- (1) be educated about their routine maintenance needs,
- (2) understand the long-term maintenance plan, and
- (3) be subject to a maintenance covenant or agreement, as described below.

Maintenance of bioretention areas should be integrated into routine landscape maintenance tasks. If landscaping contractors will be expected to perform maintenance, their contracts should contain specifics on unique bioretention landscaping needs, such as maintaining elevation differences needed for ponding, proper mulching, sediment and trash removal, and limited use of fertilizers and pesticides.

Maintenance tasks and frequency will vary depending on the size and location of the bioretention, the landscaping template chosen, and the type of surface cover in the practice. A generalized summary of common maintenance tasks and their frequency is provided in Table 4.9.

Table 4.9. Typical maintenance tasks for bioretention practices.

Frequency	Maintenance Tasks
Upon establishment	<ul style="list-style-type: none"> <li>For the first 6 months following construction, the practice and CDA should be inspected at least twice after storm events that exceed 0.5 inch of rainfall. Conduct any needed repairs or stabilization.</li> <li>Inspectors should look for bare or eroding areas in the CDA or around the bioretention area and make sure they are immediately stabilized with grass cover.</li> <li>One-time, spot fertilization may be needed for initial plantings.</li> <li>Watering is needed once a week during the first 2 months, and then as needed during first growing season (April through October), depending on rainfall.</li> <li>Remove and replace dead plants. Up to 10% of the plant stock may die off in the first year, so construction contracts should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction.</li> </ul>
At least 4 times per year	<ul style="list-style-type: none"> <li>Mow grass filter strips and bioretention with turf cover</li> <li>Check curb cuts and inlets for accumulated grit, leaves, and debris that may block inflow</li> </ul>
Twice during growing season	<ul style="list-style-type: none"> <li>Spot weed, remove trash, and rake the mulch</li> </ul>
Annually	<ul style="list-style-type: none"> <li>Conduct a maintenance inspection</li> <li>Supplement mulch in devoid areas to maintain a 3-inch layer</li> <li>Prune trees and shrubs</li> <li>Remove sediment in pretreatment cells and inflow points</li> </ul>
Once every 2–3 years	<ul style="list-style-type: none"> <li>Remove sediment in pretreatment cells and inflow points</li> <li>Remove and replace the mulch layer</li> </ul>
As needed	<ul style="list-style-type: none"> <li>Add reinforcement planting to maintain desired vegetation density</li> <li>Remove invasive plants using recommended control methods</li> <li>Remove any dead or diseased plants</li> <li>Stabilize the CDA to prevent erosion</li> </ul>

Standing water is the most common problem outside of routine maintenance. If water remains on the surface for more than 72 hours after a storm, adjustments to the grading may be needed or underdrain repairs may be needed. The surface of the filter bed should also be checked for accumulated sediment or a fine crust that builds up after the first several storm events. There are several methods that can be used to rehabilitate the filter. These are listed below, starting with the simplest approach and ranging to more involved procedures (i.e., if the simpler actions do not solve the problem):

- Open the underdrain observation well or cleanout and pour in water to verify that the underdrains are functioning and not clogged or otherwise in need of repair. The purpose of this check is to see if there is standing water all the way down through the soil. If there is standing water on top, but not in the underdrain, then there is a clogged soil layer. If the underdrain and stand pipe indicates standing water, then the underdrain must be clogged and will need to be cleaned out.
- Remove accumulated sediment and till 2 to 3 inches of sand into the upper 6 to 12 inches of soil.



- Install sand wicks from 3 inches below the surface to the underdrain layer. This reduces the average concentration of fines in the media bed and promotes quicker drawdown times. Sand wicks can be installed by excavating or auguring (i.e., using a tree auger or similar tool) down to the top of the underdrain layer to create vertical columns that are then filled with a clean open-graded coarse sand material (e.g., ASTM C-33 concrete sand or similar approved sand mix for bioretention media). A sufficient number of wick drains of sufficient dimension should be installed to meet the design dewatering time for the facility.
- Remove and replace some or all of the filter media.

### **Maintenance Inspections**

It is recommended that a qualified professional: state law states anyone that can stamp a set of plans (surveyors, engineers, landscape architects) conduct a spring maintenance inspection and cleanup at each bioretention area. Maintenance inspections should include information about the inlets, the actual bioretention facility (sediment buildup, outlet conditions, etc.), and the state of vegetation (water stressed, dead, etc.) and are intended to highlight any issues that need or may need attention to maintain stormwater management functionality. Reporting to the Beaufort County Public Works Department may be required to be submitted on an annual basis.

Maintenance inspection checklists for bioretention areas and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

### **Waste Material**

Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### **4.3.8 Bioretention Stormwater Compliance Calculations**

Bioretention performance varies depending on the design configuration of the system.

### **No Underdrain**

Bioretention designs with no underdrain are credited with 100% retention for the storage volume (Sv) provided by the practice as well as 100% TSS, TN, and bacteria removal (Table 4.10).

Table 4.10. Retention and pollutant removal for bioretention practices without underdrains.

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

### **Internal Water Storage (IWS)**

Bioretention designs with IWS are credited with 75% retention for the storage volume (Sv) provided by the practice as well as 85% TSS, 85% TN, and 80% bacteria removal (Table 4.11).

Table 4.11. Retention and pollutant removal for bioretention practices with IWS design.

Retention	= 75%
TSS Removal	= 85%
TN Removal	= 85%
Bacteria Removal	= 80%

**Standard**

Standard bioretention designs are credited with 60% retention for the storage volume (Sv) provided as well as 85% TSS, 75% TN, and 80% bacteria removal. (Table 4.12).

Table 4.12. Retention and pollutant removal for standard bioretention practices.

Retention	= 60%
TSS Removal	= 85%
TN Removal	= 75%
Bacteria Removal	= 80%

The practice must be sized using the guidance detailed in Section 4.1.4 Bioretention Design Criteria.

Note: Additional retention can be achieved if trees are utilized as part of a bioretention area (see Section 4.14 Tree Planting and Preservation).

Bioretention also contributes to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume (Sv) from the total runoff volume for the 2-year through the 100-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

#### 4.4 Permeable Pavement Systems

Permeable Pavement Systems				
<b>Definition:</b> Paving systems that capture and temporarily store the SWRv by filtering runoff through voids in an alternative pavement surface into an underlying stone reservoir. Filtered runoff may be collected and returned to the conveyance system or allowed to partially (or fully) infiltrate into the soil.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		80-100%	45-100%	30-100%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
High	High	Moderate		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	Standard Design		Enhanced Design
2-4 times per year	Every 2-3 years	30%		100%
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Reduces runoff volume, attenuates peak runoff rate and outflow</li><li>▪ Reduces slick surfaces during rain</li><li>▪ Water quality enhancement from filtration of stormwater</li></ul>		<ul style="list-style-type: none"><li>▪ Sediment-laden runoff can clog pervious pavement, causing it to fail</li><li>▪ Incorrect installation practices can clog pores</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Open graded pavement mix or pavers with open surfaces</li><li>▪ Bedding course</li><li>▪ Open-graded base material</li><li>▪ Underdrain (where required)</li><li>▪ Subgrade with minimal compaction</li></ul>		<ul style="list-style-type: none"><li>▪ Same basic considerations as any paved area</li><li>▪ Infiltration rate of native soil determines applicability and need for underdrain</li><li>▪ Depth to seasonal high water table must be at least 6 inches below bottom of practice</li><li>▪ Not appropriate for heavy or high traffic areas</li><li>▪ Accessibility, aesthetics, maintainability</li></ul>		
Installation Considerations		Maintenance Activities		
<ul style="list-style-type: none"><li>▪ Proper construction sequencing and installation is crucial to ensure proper functioning</li><li>▪ Subgrade cannot be overly compacted</li></ul>		<ul style="list-style-type: none"><li>▪ Vacuum or jet wash to increase pavement life and avoid clogging</li><li>▪ Ensure that contributing area is clear of debris and sediment.</li></ul>		

<sup>1</sup>Credited pollutant load removal

Permeable pavement systems represent alternative paving surfaces that capture and temporarily store the design volume by filtering runoff through voids in the pavement surface into an underlying stone reservoir (see Figure 4.11). Filtered runoff may be collected and returned to the conveyance system, or it may be allowed to infiltrate into the soil.

Permeable pavement systems may also provide stormwater detention of larger storms (e.g., 2- to 25-year).

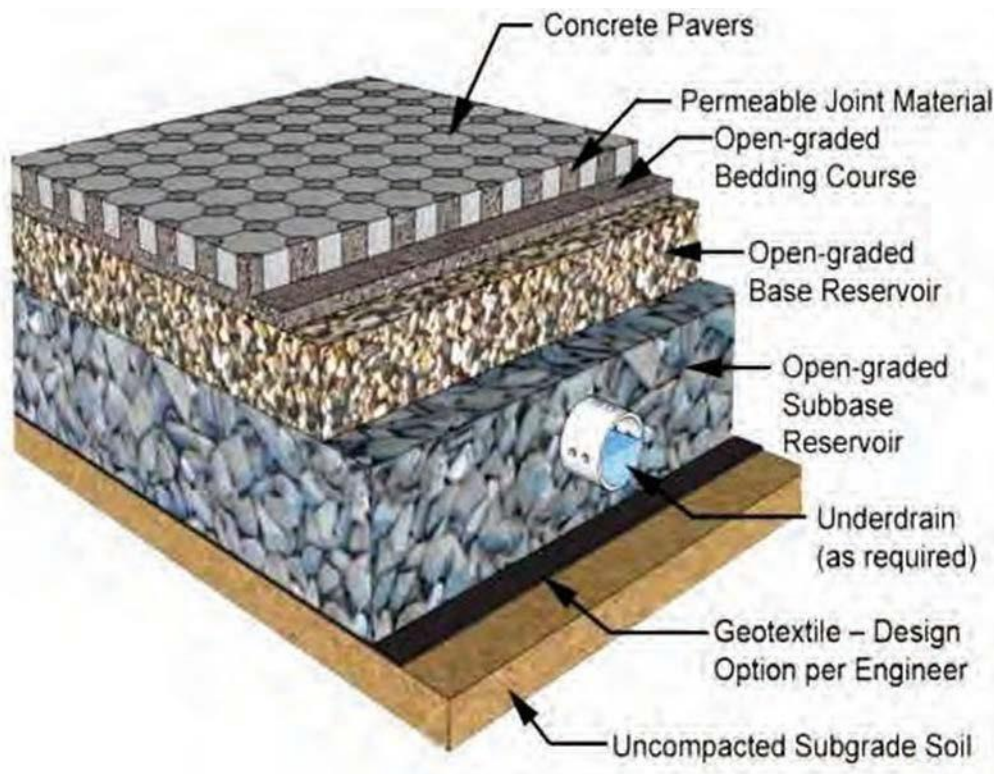


Figure 4.11. Cross-section of permeable pavement (source: ICPI).

### **Definition**

This is a paving system that captures and temporarily stores the SWRV by filtering runoff through voids in an alternative pavement surface into an underlying stone reservoir. Filtered runoff may be collected and returned to the conveyance system or allowed to infiltrate into the soil.

Design variants include the following:

- P-1 Porous asphalt (PA)
- P-2 Pervious concrete (PC)
- P-3 Permeable pavers (PP)

Other surface material variations of permeable pavement that can be part of a permeable pavement system, such as porous rubber, plastic grid pavers, and synthetic turf systems are also encompassed in this section.

### **Porous Asphalt**

Porous asphalt (also known as pervious asphalt) consists of a special open-graded surface course bound together by asphalt cement. The open-graded surface course in a typical porous asphalt installation is 3 to 7 inches thick and has a void ratio of between 15% and 20%. Porous asphalt is thought to have a limited ability to maintain its structure and permeability during hot summer months and, consequently,

is currently not recommended for use in coastal South Carolina. If it is used on a development site in the coastal region, it should be carefully monitored and maintained over time.

### **Pervious Concrete**

Pervious concrete (also known as porous concrete) is similar to conventional concrete in structure and form but consists of a special open-graded surface course, typically 4 to 8 inches thick, that is bound together with Portland cement. This open-graded surface course has a void ratio of 15% to 25% (conventional concrete pavement has a void ratio of between 3% and 5%), which gives it a high permeability that is often many times more than that of the underlying native soils, and allows rainwater and stormwater runoff to rapidly pass through it and into the underlying stone reservoir. Although this particular type of permeable pavement surface may not require an underlying base layer to support traffic loads, site planning and design teams may wish to provide it to increase the stormwater storage capacity provided by a pervious concrete system.

### **Permeable Pavers**

Permeable pavers (PP) are solid structural units (e.g., blocks, bricks) that are installed in a way that provides regularly spaced openings through which stormwater runoff can rapidly pass through the pavement surface and into the underlying stone reservoir. The regularly spaced openings, which generally make up between 8% and 20% of the total pavement surface, are typically filled with pea gravel (i.e., ASTM D 448 Size No. 8, 3/8 inch to 1/8 inch). Typical PP systems consist of the pavers, a 1.5- to 3-inch thick fine gravel bedding layer and an underlying stone reservoir.

### **Design Configurations**

There are two types of permeable pavement design configurations:

- **Standard Design**  
Practice with a standard underdrain design and no infiltration sump or water quality filter (see Figure 4.12).
- **Enhanced Design**  
Practice with underdrains that contain a water quality filter layer and an infiltration sump beneath the underdrain sized to drain the design storm in 48 hours (see Figure 4.13) or practices with no underdrains that can infiltrate the entire design storm volume in 48 hours (see Figure 4.14).

The particular design configuration to be implemented on a site is typically dependent on specific site conditions and the characteristics of the underlying soils. These criteria are further discussed below.

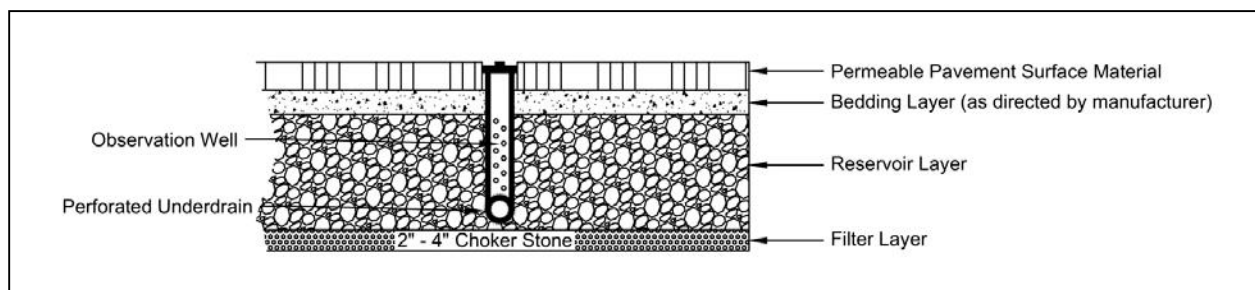


Figure 4.12. Cross-section of a standard permeable pavement design.

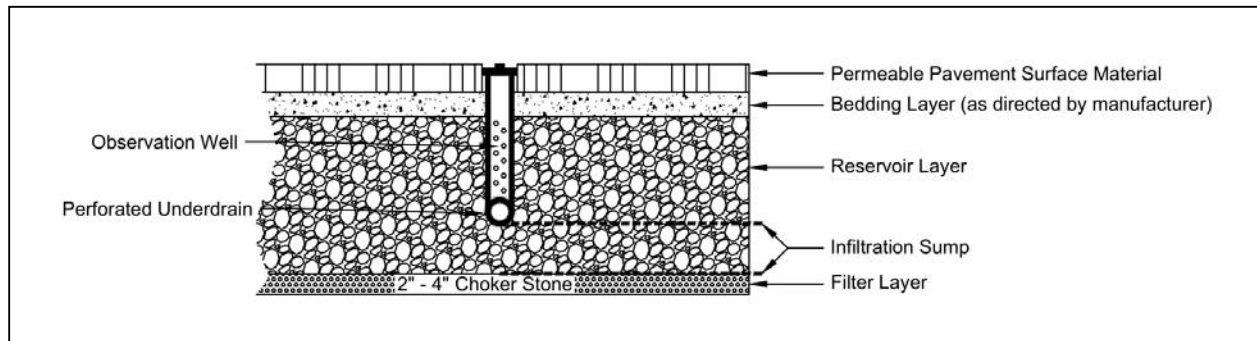


Figure 4.13. Cross-section of an enhanced permeable pavement design with an underdrain.

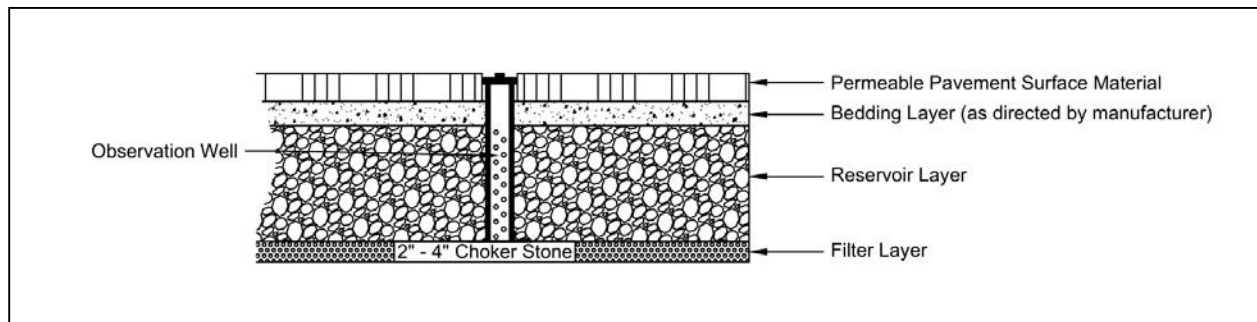


Figure 4.14. Cross-section of an enhanced permeable pavement design without an underdrain.

#### 4.4.1 Permeable Pavement Feasibility Criteria

Since permeable pavement has a very high retention capability, it should always be considered as an alternative to conventional pavement. Permeable pavement is subject to the same feasibility constraints as most infiltration practices, as described below.

##### Required Space

A prime advantage of permeable pavement is that it does not normally require additional space at a new development or redevelopment site, which can be important for tight sites or areas where land prices are high.

##### Soils

Soil conditions do not typically constrain the use of permeable pavement, although they do determine whether an underdrain is needed. Underdrains may be required if the measured permeability of the underlying soils is less than 0.5 inches per hour (although utilization of an infiltration sump may still be feasible). When designing an infiltrating permeable pavement practice, designers must verify soil

permeability by using the on-site soil investigation methods provided in Appendix B Geotechnical Information Requirements for Underground BMPs. Impermeable soils will require an underdrain.

In fill soil locations, geotechnical investigations are required to determine if the use of an impermeable liner and underdrain are necessary or if the use of an infiltration sump is permissible (see Section 4.4.4 Permeable Pavement Design Criteria).

### **Contributing Drainage Area**

The portion of the CDA that does not include the permeable pavement may not exceed 5 times the surface area of the permeable pavement (2 times is recommended) and it should be as close to 100% impervious as possible to reduce sediment loading.

### **Pavement Surface Slope**

Steep pavement surface slopes can reduce the stormwater storage capability of permeable pavement and may cause shifting of the pavement surface and base materials. The permeable pavement slope must be less than 5%. Designers may consider using a terraced design for permeable pavement in areas with steeper slopes (3%–5%). In all cases, designs must ensure that the slope of the pavement does not lead to flow occurring out of the stone reservoir layer onto lower portions of the pavement surface.

### **Minimum Hydraulic Head**

The elevation difference needed for permeable pavement to function properly is generally nominal, although 1 to 4 feet of head from the pavement surface to the underdrain outlet is typically necessary. This value may vary based on several design factors, such as required storage depth and underdrain location.

### **Minimum Depth to Water Table**

A high groundwater table may cause runoff to pond at the bottom of the permeable pavement system. Therefore, a minimum vertical distance of 0.5 feet (preferably 2 feet) must be provided between the bottom of the permeable pavement installation (i.e., the bottom invert of the reservoir layer) and the seasonal high water table.

### **Tidal Impacts**

For systems with an underdrain, the underdrain should be located above the tidal mean high water elevation. For entirely infiltration-based systems, the bottom of the stone reservoir should be located above the mean high water elevation. Where this is not possible, portions of the practice below the tidal mean high water elevation cannot be included in the volume calculations.

### **Setbacks**

To avoid the risk of seepage, stormwater cannot flow from the permeable pavement reservoir layer to the traditional pavement base layer, existing structure foundations, or future foundations which may be built on adjacent properties. Setbacks to structures and property lines must be at least 10 feet and adequate waterproofing protection must be provided for foundations and basements. Where the 10-foot setback is not possible, an impermeable liner may be used along the sides and bottom of the permeable pavement practice (extending from the surface to the bottom of the practice and outward to meet the 10-foot setback).

### **Proximity to Utilities**

Interference with underground utilities should be avoided if possible. When large site development is undertaken the expectation of achieving avoidance will be high. Conflicts may be commonplace on smaller sites and in the public right-of-way (PROW). Consult with each utility company on recommended offsets, which will allow utility maintenance work with minimal disturbance to the permeable pavement. Permeable pavement in the public right-of-way (PROW) must conform with the State of South Carolina Department of Transportation design specifications. Where conflicts cannot be avoided, follow these guidelines:

- ❑ Consider altering the location or sizing of the permeable pavement to avoid or minimize the utility conflict. Consider an alternate BMP type to avoid conflict.
- ❑ Use design features to mitigate the impacts of conflicts that may arise by allowing the permeable pavement and the utility to coexist. The permeable pavement design may need to incorporate impervious areas, through geotextiles or compaction, to protect utility crossings.
- ❑ Work with the utility company to evaluate the relocation of the existing utility and install the optimum placement and sizing of the permeable pavement.
- ❑ If utility functionality, longevity, and vehicular access to manholes can be assured, accept the permeable pavement design and location with the existing utility. Design sufficient soil coverage over the utility or general clearances or other features, such as an impermeable liner, to assure all entities that the conflict is limited to maintenance.

When accepting utility conflict into the permeable pavement location and design, it is understood the permeable pavement will be temporarily impacted during utility work, but the utility owner will replace the permeable pavement or, alternatively, install functionally comparable permeable pavement according to the specifications in the current version of this guidebook. Restoration of permeable pavement that is located in the PROW will also conform with the State of South Carolina Department of Transportation design specifications.

### **Pollutant Hotspot Land Uses**

Permeable pavement is not appropriate for certain pollutant-generating sites. In areas where higher pollutant loading is likely (i.e. oils and greases from fueling stations or vehicle storage areas, sediment from un-stabilized pervious areas, or other pollutants from industrial processes), appropriate pretreatment, such as an oil-water separator or filtering device must be provided, or the areas should be diverted from the permeable pavement.

On sites with existing contaminated soils, infiltration is not allowed. Permeable pavement areas must include an impermeable liner, and the Enhanced Design configuration cannot be used.

### **High Loading Situations**

Permeable pavement is not intended to treat sites with high sediment or trash/debris loads, since such loads will cause the practice to clog and fail. Sites with considerable pervious area (e.g., newly established turf and landscaping) can be considered high loading sites and the pervious areas should be diverted if possible, from the permeable pavement area. If unavoidable, pretreatment measures, such as a gravel or a sod filter strip should be employed (see Section 4.4.3 Permeable Pavement Pretreatment Criteria).



## **High Speed Roads**

Permeable pavement should not be used for high speed roads, although it has been successfully applied for low speed residential streets, parking lanes, and roadway shoulders.

## **Economic Considerations**

Permeable pavement tends to be expensive relative to other practices, but when the cost of land and traditional paving are included in the calculations, permeable pavement becomes much more competitive. Permeable pavement is very space-efficient, since it combines a useful pavement surface with stormwater management for runoff and, in standard design configurations, water quality treatment.

### **4.4.2 Permeable Pavement Conveyance Criteria**

Permeable pavement designs must include methods to convey larger storms (e.g., 2- to 25-year) to the storm drain system. Conveyance methods include the following:

- Place an overdrain—a horizontal perforated pipe near the top of the reservoir layer—to pass excess flows after water has filled the base.
- Increase the thickness of the top of the reservoir layer by as much as 6 inches to increase storage (i.e., create freeboard). The design computations used to size the reservoir layer often assume that no freeboard is present.
- Create underground detention within the reservoir layer of the permeable pavement system. Reservoir storage may be augmented by corrugated metal pipes, plastic or concrete arch structures, etc.
- Route overflows to another detention or conveyance system.
- Set the storm drain inlets flush with the elevation of the permeable pavement surface to effectively convey excess stormwater runoff past the system. The design should also make allowances for relief of unacceptable ponding depths during larger rainfall events.

### **4.4.3 Permeable Pavement Pretreatment Criteria**

Pretreatment for most permeable pavement applications is not necessary. Additional pretreatment is recommended if the pavement receives runoff from adjacent pervious areas. For example, a gravel or sod filter strip can be placed adjacent to pervious (landscaped) areas to trap coarse sediment particles before they reach the pavement surface in order to reduce clogging.

### **4.4.4 Permeable Pavement Design Criteria**

## **Type of Surface Pavement**

The type of pavement should be selected based on a review of the pavement specifications and properties and designed according to the product manufacturer's recommendations.

## **Pavement Bottom Slope**

For unlined designs, the bottom slope of a permeable pavement installation should be as flat as possible (i.e., 0% longitudinal and lateral slopes) to enable even distribution and infiltration of stormwater. On sloped sites, internal check dams or barriers, as shown in Figure 4.15 can be incorporated into the subsurface to encourage infiltration. Barriers may be constructed of concrete, earthen berms, impermeable membranes, or low permeability geotextile. In this type of design, the depth of the infiltration sump would be the depth behind the check dams. The depth and spacing of the barriers are

dependent upon the underlying slope and the saturated hydraulic conductivity, as any water retained by the flow barriers must infiltrate within 48 hours. If an underdrain will be used in conjunction with the flow barriers, it can be installed over the top of the barriers, or parallel to the barriers with an underdrain in each cell.

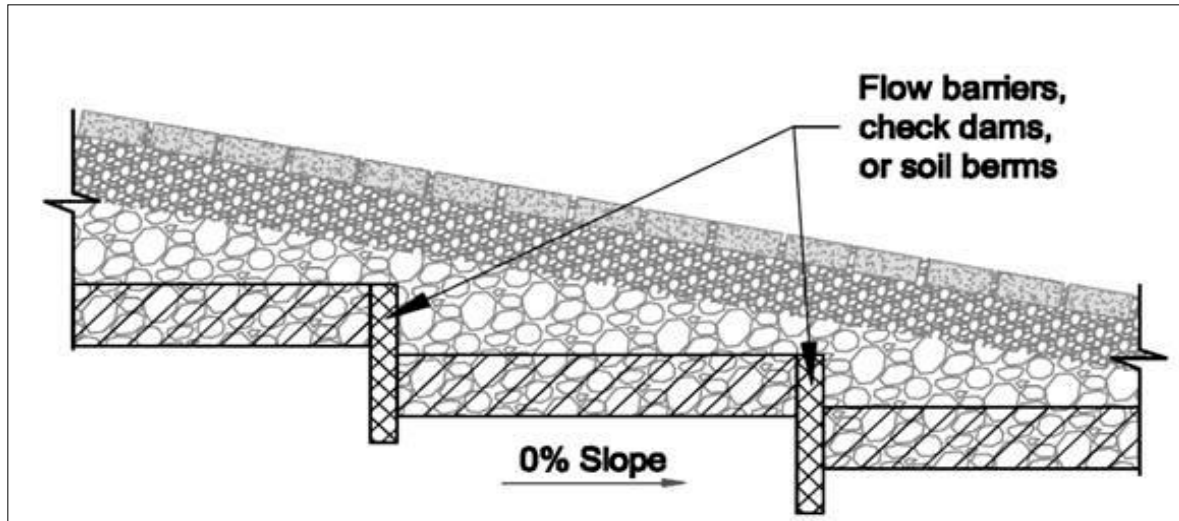


Figure 4.15. Use of flow barriers to encourage infiltration on sloped sites.

#### **Internal Geometry and Drawdowns**

##### ▪ **Rapid Drawdown**

Permeable pavement must be designed so that the target storage volume is detained in the reservoir for as long as possible, 36 to 48 hours, before completely discharging through an underdrain. A minimum orifice size of 1 inch is recommended regardless of the calculated drawdown time.

Note: A 48-hour maximum drawdown time is utilized for permeable pavement rather than the 72-hour value used for other BMPs. This shorter drawdown time, in accordance with industry standards, is intended to ensure that the subgrade does not stay saturated for too long and cause problems with the pavement.

##### ▪ **Infiltration Sump**

To promote greater retention for permeable pavement located on marginal soils, an infiltration sump can be installed to create a storage layer below the underdrain invert. This design configuration is discussed further below.

#### **Reservoir Layer**

The reservoir layer consists of the stone underneath the pavement section and above the bottom filter layer or underlying soils, including the optional infiltration sump. The total thickness of the reservoir layer is determined by runoff storage needs, the saturated hydraulic conductivity of in-situ soils, structural requirements of the pavement sub-base, depth to water table, and frost depth conditions (see Section 4.4.1 Permeable Pavement Feasibility Criteria). A geotechnical engineer should be consulted regarding the suitability of the soil subgrade.

- The reservoir below the permeable pavement surface should be composed of clean, double-washed stone aggregate and sized for both the storm event to be treated and the structural requirements of

the expected traffic loading. Additional chamber structures may also be used to create larger storage volumes.

- The storage layer may consist of clean, double-washed No. 57 stone, although No. 2 stone is preferred because it provides additional structural stability. Other appropriate materials may be used if accepted by the Beaufort County Public Works Department.
- The bottom of the reservoir layer should be completely flat so that runoff will be able to infiltrate evenly through the entire surface. The use of terracing and check dams is permissible.

### **Underdrains**

Most permeable pavement designs will require an underdrain (see Section 4.4.1 Permeable Pavement Feasibility Criteria). Underdrains can also be used to keep detained stormwater from flooding permeable pavement during extreme rain events. Multiple underdrains are typically necessary for permeable pavement wider than 40 feet, and each underdrain is recommended to be located 20 feet or less from the next pipe or the edge of the permeable pavement. For long and narrow applications, a single underdrain running the length of the permeable pavement is sufficient. The underdrain should be perforated schedule 40 PVC pipe (corrugated HDPE may be used for smaller load-bearing applications), with three or four rows of 3/8-inch perforations at 6 inches on center. The underdrain must be encased in a layer of clean, double-washed No. 57 stone, with a minimum 2-inch cover over the top of the underdrain. The underdrain system must include a flow control to ensure that the reservoir layer drains slowly (within 36 to 48 hours).

- The underdrain outlet can be fitted with a flow-reduction orifice within a weir or other easily inspected and maintained configuration in the downstream manhole as a means of regulating the stormwater detention time. The minimum diameter of any orifice is 1 inch. The designer should verify that the volume will draw down completely within 36 to 48 hours.
- On infiltration designs, an underdrain(s) can be installed and capped at the downstream structure as an option for future use if maintenance observations indicate a reduction in the soil permeability.

### **Observation Wells**

All permeable pavement practices must include observation wells. The observation well is used to observe the rate of drawdown within the reservoir layer following a storm event and to facilitate periodic inspection and maintenance. The observation well should consist of a well-anchored, perforated 4- to 6-inch diameter PVC pipe. There should be no perforation within 1 foot of the surface. If the permeable pavement has an underdrain, tie the observation well into any Ts or Ys in the underdrain system. The observation well should extend vertically to the bottom of the reservoir layer and extend upwards to be flush with the surface (or just under pavers) with a lockable cap.

### **Infiltration Sump (optional, required for enhanced designs with an underdrain)**

For unlined permeable pavement systems, an optional upturned elbow or elevated underdrain configuration can be used to promote greater retention for permeable pavement located on marginal soils. The infiltration sump must be installed to create a storage layer below the underdrain or upturned elbow invert. The depth of this layer must be sized so that the design storm can infiltrate into the subsoils in a 48-hour period. The bottom of the infiltration sump must be at least 0.5 feet above the seasonally high water table. The inclusion of an infiltration sump is not permitted for designs with an impermeable liner. In fill soil locations, geotechnical investigations are required to determine if the use of an infiltration sump is permissible.

**Filter Layer (optional)**

To protect the bottom of the reservoir layer from intrusion by underlying soils, a filter layer can be used. The underlying native soils should be separated from the stone reservoir by a 2- to 4-inch layer of choker stone (e.g., No. 8).

**Geotextile (optional)**

Geotextile fabric is another option to protect the bottom of the reservoir layer from intrusion by underlying soils, although some practitioners recommend avoiding the use of fabric beneath permeable pavements since it may become a future plane of clogging within the system. Geotextile fabric is still recommended to protect the excavated sides of the reservoir layer, in order to prevent soil piping. An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude higher (10 times) than the soil subgrade permeability must be used.

**Impermeable Liner**

An impermeable liner is not typically required, although it may be utilized in fill applications where deemed necessary by a geotechnical investigation, on sites with contaminated soils, or on the sides of the practice to protect adjacent structures from seepage. Use a PVC geomembrane liner or equivalent of an appropriate thickness (follow manufacturer's instructions for installation). Field seams must be sealed according to the liner manufacturer's specifications. A minimum 6-inch overlap of material is required at all seams.

**Material Specifications**

Permeable pavement material specifications vary according to the specific pavement product selected. A general comparison of different permeable pavements is provided in Table 4.13, but designers should consult manufacturer's technical specifications for specific criteria and guidance. Table 4.14 provides general material specifications for the component structures installed beneath the permeable pavement. Note that the size of stone materials used in the reservoir and filter layers may differ depending on the type of surface material.

Table 4.13. Permeable pavement specifications for a variety of typical surface materials.

Material	Specification	Notes
Permeable Pavers (PP)	Void content, thickness, and compressive strength vary based on type and manufacturer Open void fill media: aggregate, topsoil and grass, coarse sand, etc.	Reservoir layer required to support the structural load.
Pervious Concrete (PC)	Void content: 15–20% Thickness: Typically 4–8 inches Compressive strength: 2.8–28 MPa Open void fill media: None	May not require a reservoir layer to support the structural load, but a layer may be included to increase the storage or infiltration. Requires certified supplier and installer.
Porous Asphalt (PA)	Void content: 15–20% Thickness: Typically 3–7 inches (depending on traffic load) Open void fill media: None	Reservoir layer required to support the structural load. Requires certified supplier and installer.

Table 4.14. Material specifications for typical layers beneath the surface of permeable pavements.

Material	Specification	Notes
Bedding Layer	PC: 3–4 inches of No. 57 stone if No. 2 stone is used for Reservoir Layer PA: 3–4 inches of No. 57 stone PP: Follow manufacturer specifications	ASTM D448 size No. 57 stone (i.e., 1/2 to 1 1/2 inches in size). Must be double-washed and clean and free of all fines.
Reservoir Layer	PC: No. 57 stone or No. 2 stone PA: No. 2 stone PP: Follow manufacturer specifications	ASTM D448 size No. 57 stone (i.e., 1/2 to 1 1/2 inches in size); No. 2 Stone (i.e., 3/4 to 3 inches in size). Depth is based on the pavement structural and hydraulic requirements. Must be double-washed and clean and free of all fines. Other appropriate materials may be used if accepted by Beaufort County Public Works Department.
Underdrain	Use 4- to 6-inch diameter perforated PVC pipe (or equivalent corrugated HDPE may be used for smaller load-bearing applications), with 3 or 4 rows of 3/8-inch perforations at 6 inches on center. Perforated pipe installed for the full length of the permeable pavement cell, and non-perforated pipe, as needed, is used to connect with the storm drain system. T's and Y's should be installed as needed, depending on the underdrain configuration. Extend cleanout pipes to the surface.	
Infiltration Sump (optional)	An aggregate storage layer below the underdrain invert. The material specifications are the same as Reservoir Layer.	
Filter Layer (optional)	The underlying native soils should be separated from the stone reservoir by a 2- to 4-inch layer of choker stone (e.g., No. 8).	
Geotextile (optional)	Use an appropriate geotextile fabric for both sides and/or bottom that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude higher than (10 times) the soil subgrade permeability. Low-permeability geotextile fabric may be used as a check dam material.	
Impermeable Liner (optional)	Where appropriate, use PVC geomembrane liner or equivalent.	
Observation Well	Use a perforated 4- to 6-inch vertical PVC pipe (AASHTO M-252) with a lockable cap, installed flush with the surface.	

### **Permeable Pavement Sizing**

The thickness of the reservoir layer is determined by both a structural and hydraulic design analysis. The reservoir layer serves to retain stormwater and to support the design traffic loads for the pavement. Permeable pavement structural and hydraulic sizing criteria are discussed below.

### Structural Design

If permeable pavement will be used in a parking lot or other setting that involves vehicles, the pavement surface must be able to support the maximum anticipated traffic load. The structural design process will vary according to the type of pavement selected, and the manufacturer's specific recommendations should be consulted. The thickness of the permeable pavement and reservoir layer must be sized to support structural loads and to temporarily store the design storm volume (i.e., the water quality, channel protection, and/or flood control volumes). On most new development and redevelopment sites, the structural support requirements will dictate the depth of the underlying stone reservoir.

The structural design of permeable pavements involves consideration of four main site elements:

- ❑ Total traffic
- ❑ In situ soil strength
- ❑ Environmental elements
- ❑ Bedding and reservoir layer design

The resulting structural requirements may include the thickness of the pavement, filter, and reservoir layer. Designers should note that if the underlying soils have a low California Bearing Ratio (less than 4%), they may need to be compacted to at least 95% of the Standard Proctor Density, which may limit their use for infiltration.

Designers should determine structural design requirements by consulting transportation design guidance sources, such as the following:

- ❑ ASCE/T&DI/ICPI 68-18 Permeable Interlocking Concrete Pavement (2018)
- ❑ AASHTO Guide for Design of Pavement Structures (1993)
- ❑ AASHTO Supplement to the Guide for Design of Pavement Structures (1998)

**Hydraulic Design.** Permeable pavement is typically sized to store the SWRV or larger design storm volumes in the reservoir layer. The storage volume in the pavements must account for the underlying saturated hydraulic conductivity and outflow through any underdrains. The design storm should be routed through the pavement to accurately determine the required reservoir depth. The depth of the reservoir layer or infiltration sump needed to store the design storm can be determined by using Equation 4.3.

Equation 4.3. Reservoir layer or infiltration sump depth.

$$d_p = \frac{\left( \frac{P \times R_{v1} \times CDA}{A_p} \right) - (K_{sat} \times t_f)}{r}$$

Where:

- $d_p$  = Depth of the reservoir layer, or depth of the infiltration sump for enhanced designs with underdrains (ft)
- $P$  = Rainfall depth for the SWRV or other design storm (ft)
- $R_{v1}$  = 0.95 (runoff coefficient for impervious cover)

- CDA = Total contributing drainage area, including permeable pavement surface area (square feet)
- $A_p$  = Permeable pavement surface area (square feet)
- $K_{sat}$  = Field-verified saturated hydraulic conductivity for subgrade soils (ft/day). If an impermeable liner is used in the design, then this value is 0
- $t_f$  = Time to fill the reservoir layer (days; assume 2 hours or 0.083 day)
- $\eta_r$  = 0.4 (effective porosity for the reservoir layer)

This equation makes the following design assumptions:

- ② The CDA does not contain pervious areas.
- ② If the subgrade will be compacted to meet structural design requirements of the pavement section, the measured saturated hydraulic conductivity shall be based on measurement of the subgrade soil subjected to the compaction requirements.

The depth of the reservoir layer cannot be less than the depth required to meet the pavement structural requirement. The depth of the reservoir layer may need to be increased to meet structural or larger storage requirements.

For infiltration designs without underdrains or designs with infiltration sumps, the captured volume must drain from the practice within 48 hours. Equation 4.4 can be used to determine the drawdown time in the reservoir layer or infiltration sump.

Equation 4.4. Drawdown time.

$$t_d = \frac{d_p \times \eta_r}{K_{sat}}$$

Where:

- $t_d$  = Drawdown time (days)
- $d_p$  = Depth of the reservoir layer, or depth of the infiltration sump for enhanced designs with underdrains (ft)
- $\eta_r$  = 0.4 (effective porosity for the reservoir layer)
- $K_{sat}$  = Field-verified saturated hydraulic conductivity for subgrade soils (ft/day). If an impermeable liner is used in the design, then this value is 0

For designs with underdrains, the captured volume must drain in 36-48 hours. The drawdown time should be determined using the hydrologic routing or modeling procedures used for detention systems with the depth and head adjusted for the porosity of the aggregate.

The total storage volume provided by the practice,  $S_v$ , should be determined using Equation 4.5.

Equation 4.5. Permeable pavement storage volume.

$$S_v = A_p[(d_p \times \eta_r) + K_{sat} \times t_f]$$

Where:

- $S_v$  = Storage volume (cubic feet)
- $d_p$  = Depth of the reservoir layer, or depth of the infiltration sump for enhanced designs with underdrains (ft)
- $\eta_r$  = 0.4 (effective porosity for the reservoir layer)
- $A_p$  = Permeable pavement surface area (square feet)
- $K_{sat}$  = Field-verified saturated hydraulic conductivity for subgrade soils (ft/day). If an impermeable liner is used in the design, then this value is 0
- $t_f$  = Time to fill the reservoir layer (days; assume 2 hours or 0.083 day)

### **Detention Storage Design**

Permeable pavement can also be designed to address, in whole or in part, the detention storage for larger storm events. The designer can model various approaches by factoring in storage within the stone aggregate layer (including chamber structures that increase the available storage volume), expected infiltration, and any outlet structures used as part of the design. Routing calculations can also be used to provide a more accurate solution of the peak discharge and required storage volume.

Once runoff passes through the surface of the permeable pavement system, designers should calculate outflow pathways to handle subsurface flows. Subsurface flows can be regulated using underdrains, the volume of storage in the reservoir layer, the bed slope of the reservoir layer, and/or a control structure at the outlet (see Section 4.4.2 Permeable Pavement Conveyance Criteria).

#### **4.4.5 Permeable Pavement Landscaping Criteria**

Permeable pavement does not have any landscaping needs. However, large-scale permeable pavement applications should be carefully planned to integrate the typical landscaping features of a parking lot, such as trees and islands, in a manner that maximizes runoff treatment and minimizes the risk that sediment, mulch, grass clippings, leaves, and other plant matter will inadvertently clog the paving surface. Bioretention areas (see Section 4.3 Bioretention) may be a good design option to meet these landscaping goals.

#### **4.4.6 Permeable Pavement Construction Sequence**

Experience has shown that proper installation is critical to the effective operation of a permeable pavement system.

### **Soil Erosion and Sediment Controls**

The following soil erosion and sediment control guidelines must be followed during construction:

- ② All permeable pavement areas must be fully protected from sediment intrusion by silt fence or construction fencing, particularly if they are intended to infiltrate runoff.
- ② Permeable pavement areas intended to infiltrate runoff must remain outside the limits of disturbance during construction to prevent soil compaction by heavy equipment and loss of design infiltration rate (unless the area has been determined to have a low California Bearing Ratio and will require compaction during the permeable pavement construction phase). Where it is infeasible to keep the proposed permeable pavement areas outside of the limits of disturbance, there are several possible remedies for the impacted area.
  - If excavation in the proposed permeable pavement areas can be restricted, then remediation can be achieved with deep tilling practices. This is only possible if in situ soils



- are not disturbed any deeper than 2 feet above the final design elevation of the bottom of the aggregate reservoir course. In this case, when heavy equipment activity has ceased, the area is excavated to grade, and the impacted area must be tilled to a depth of 12 inches below the bottom of the reservoir layer.
- Alternatively, if it is infeasible to keep the proposed permeable pavement areas outside of the limits of disturbance, and excavation of the area cannot be restricted, then infiltration tests will be required prior to installation of the permeable pavement to ensure that the design infiltration rate is still present. If tests reveal the loss of design infiltration rates, then deep tilling practices may be used in an effort to restore those rates. In this case, further testing must be done before the permeable pavement can be installed to establish that design rates have been achieved.
  - Finally, if it is infeasible to keep the proposed permeable pavement areas outside of the limits of disturbance, excavation of the area cannot be restricted, and infiltration tests reveal design rates cannot be restored, then a resubmission of the SWMP will be required.
- ⑦ Permeable pavement areas must be clearly marked on all construction documents and grading plans.
  - ⑦ During construction, care should be taken to avoid tracking sediments onto any permeable pavement surface to avoid post-construction clogging and long-term maintenance issues.
  - ⑦ Any area of the site intended ultimately to be a permeable pavement area with an infiltration component should not be used as the site of a temporary sediment trap or basin. If locating a temporary sediment trap or basin on an area intended for permeable pavement is unavoidable, the remedies are similar to those discussed for heavy equipment compaction.
  - ⑦ If it is possible, restrict the invert of the sediment trap or basin to at least 1 foot above the final design elevation of the bottom of the aggregate reservoir course of the proposed permeable pavement. Then remediation can be achieved with proper removal of trapped sediments and deep tilling practices.
  - ⑦ An alternate approach to deep tilling is to use an impermeable liner to protect the in situ soils from sedimentation while the sediment trap or basin is in use.
  - ⑦ In each case, all sediment deposits in the excavated area must be carefully removed prior to installing the sub-base, base, and surface materials. The plan must also show the proper procedures for converting the temporary sediment control practice to a permeable pavement BMP, including dewatering, cleanout, and stabilization.

### **Permeable Pavement Installation**

The following is a typical construction sequence to properly install permeable pavement, which may need to be modified depending on the particular type of permeable pavement that is being installed.

#### **1. Stabilize Contributing Drainage Area**

Construction of the permeable pavement should only begin after the entire CDA has been stabilized. The proposed site should be checked for existing utilities prior to any excavation. Do not install the system in rain.

#### **2. Install Soil Erosion and Sediment Control Measures for the Permeable Pavement**

As noted above, temporary soil erosion and sediment controls are needed during installation to divert stormwater away from the permeable pavement area until it is completed. Special protection measures,

such as erosion control fabrics, may be needed to protect vulnerable side slopes from erosion during the excavation process. The proposed permeable pavement area must be kept free from sediment during the entire construction process. Construction materials contaminated by sediment must be removed and replaced with clean material.

### **3. Minimize Impact of Heavy Installation Equipment**

Where possible, excavators or backhoes should work from the sides to excavate the reservoir layer to its appropriate design depth and dimensions. For small pavement applications, excavating equipment should have arms with adequate extension so they do not have to work inside the footprint of the permeable pavement area (to avoid compaction). Contractors can utilize a cell construction approach, whereby the proposed permeable pavement area is split into 500- to 1,000-square foot temporary cells with a 10- to 15-foot-wide earth bridge in between, so cells can be excavated from the side. Excavated material should be placed away from the open excavation so as to not jeopardize the stability of the side walls.

### **4. Promote Infiltration Rate**

The native soils along the bottom of the permeable pavement system should be scarified or tilled to a depth of 3 to 4 inches prior to the placement of the filter layer or geotextile fabric. In large-scale paving applications with weak soils, the soil subgrade may need to be compacted to 95% of the Standard Proctor Density to achieve the desired load-bearing capacity.

Note: This may reduce or eliminate the infiltration function of the installation, and it must be addressed during hydrologic design.

### **5. Order of Materials**

Geotextile fabric should be installed on the sides of the reservoir layer (and the bottom if the design calls for it). Geotextile fabric strips should overlap down-slope by a minimum of 2 feet and be secured a minimum of 4 feet beyond the edge of the excavation. Where the filter layer extends beyond the edge of the pavement (to convey runoff to the reservoir layer), install an additional layer of geotextile fabric 1 foot below the surface to prevent sediment from entering into the reservoir layer. Excess geotextile fabric should not be trimmed until the site is fully stabilized.

### **6. Install Base Material Components**

Provide a minimum of 2 inches of aggregate above and below the underdrains. The up-gradient end of underdrains in the reservoir layer should be capped. Where an underdrain pipe is connected to a structure, there shall be no perforations within 1 foot of the structure. Ensure there are no perforations in clean-outs and observation wells within 1 foot of the surface.

### **7. Stone Media**

Spread 6-inch lifts of the appropriate clean, double-washed stone aggregate (usually No. 2 or No. 57 stone). Place at least 4 inches of additional aggregate above the underdrain, and then compact it using a vibratory roller in static mode until there is no visible movement of the aggregate. Do not crush the aggregate with the roller.

### **8. Reservoir Media**

Install the desired depth of the bedding layer, depending on the type of pavement, as indicated in Table 4.14.

### **9. Paving Media**

Paving materials shall be installed in accordance with manufacturer or industry specifications for the particular type of pavement.

### **10. Installation of Porous Asphalt**

The following has been excerpted from various documents, most notably Jackson (2007):

- Install porous asphalt pavement similarly to regular asphalt pavement. The pavement should be laid in a single lift over the filter course. The laying temperature should be between 230°F and 260°F, with a minimum air temperature of 50°F, to ensure the surface does not stiffen before compaction.
- Complete compaction of the surface course when the surface is cool enough to resist a 10-ton roller. One or two passes of the roller are required for proper compaction. More rolling could cause a reduction in the porosity of the pavement.
- The mixing plant must provide certification of the aggregate mix, abrasion loss factor, and asphalt content in the mix. Test the asphalt mix for its resistance to stripping by water using ASTM D1664. If the estimated coating area is not above 95%, additional anti-stripping agents must be added to the mix.
- Transport the mix to the site in a clean vehicle with smooth dump beds sprayed with a non-petroleum release agent. The mix shall be covered during transportation to control cooling.
- Test the full permeability of the pavement surface by application of clean water at a rate of at least 5 gallons per minute over the entire surface. All water must infiltrate directly, without puddle formation or surface runoff.
- Inspect the facility 18 to 30 hours after a significant rainfall (0.5 inch or greater) or artificial flooding to determine if the facility is draining properly.

### **11. Pervious Concrete Installation**

The basic installation sequence for pervious concrete is outlined by the National Ready Mixed Concrete Association (NRMCA; NRMCA, 2004). Concrete installers are required to be certified by a recognized pervious concrete installers training program, such as the Pervious Concrete Contractor Certification Program offered by the NRMCA. The basic installation procedure is as follows:

- Drive the concrete truck as close to the project site as possible.
- Water the underlying aggregate (reservoir layer) before the concrete is placed, so the aggregate does not draw moisture from the freshly laid pervious concrete.
- After the concrete is placed, approximately 3/8 to 1/2 inches is struck off, using a vibratory screed. This is to allow for compaction of the concrete pavement.
- Compact the pavement with a steel pipe roller. Care should be taken to ensure over-compaction does not occur.
- Cut joints for the concrete to a depth of 1/4 inch.
- The curing process is very important for pervious concrete. Concrete installers should follow manufacturer specifications to the extent allowed by on-site conditions when curing pervious concrete. This typically requires covering the pavement with plastic sheeting within 20 minutes of the strike-off and may require keeping it covered for at least 7 days. Do not allow traffic on the pavement during the curing period.
- Remove the plastic sheeting only after the proper curing time. Inspect the facility 18 to 30 hours after a significant rainfall (0.5 inch or greater) or artificial flooding, to determine if the facility is draining properly.

## 12. Permeable Interlocking Concrete Paver Installation

The basic installation process is described in greater detail by Smith (2006):

- Place edge restraints for open-jointed pavement blocks before the bedding layer and pavement blocks are installed. Permeable interlocking concrete pavement systems require edge restraints to prevent vehicle loads from moving the paver blocks. Edge restraints may be standard curbs or gutter pans, or precast or cast-in-place reinforced concrete borders a minimum of 6 inches wide and 18 inches deep, constructed with Class A3 concrete. Edge restraints along the traffic side of a permeable pavement block system are recommended.
- Place the double-washed No. 57 stone in a single lift. Level the filter course and compact it into the reservoir course beneath with at least four passes of a 10-ton steel drum static roller until there is no visible movement. The first two passes are in vibratory mode, with the final two passes in static mode. The filter aggregate should be moist to facilitate movement into the reservoir course.
- Place and screed the bedding course material (typically No. 8 stone).
- Fill gaps at the edge of the paved areas with cut pavers or edge units. When cut pavers are needed, cut the pavers with a paver splitter or masonry saw. Cut pavers no smaller than 1/3 of the full unit size.
- Pavers may be placed by hand or with mechanical installers. Fill the joints and openings with stone. Joint openings must be filled with ASTM D448 No. 8 stone; although, No. 8P or No. 9 stone may be used where needed to fill narrower joints. Remove excess stones from the paver surface.
- Compact and seat the pavers into the bedding course with a minimum low-amplitude 5,000-pound-foot, 75- to 95-Hz plate compactor.
- Do not compact within 6 feet of the unrestrained edges of the pavers.
- The system must be thoroughly swept by a mechanical sweeper or vacuumed immediately after construction to remove any sediment or excess aggregate.
- Inspect the area for settlement. Any blocks that settle must be reset and re-inspected.
- Inspect the facility 18 to 30 hours after a significant rainfall (0.5 inch or greater) or artificial flooding to determine whether the facility is draining properly.

## 13. Construction Supervision

Supervision before, during, and after construction by a qualified professional is recommended to ensure permeable pavement is built in accordance with these specifications. ASTM test C1781 or C1701 must be performed to ensure initial pavement permeability of at least 6 inches per hour. Inspection checklists that require sign-offs by qualified individuals should be used at critical stages of construction to ensure the contractor's interpretation of the plan is consistent with the designer's intent.

Construction phase inspection checklist for permeable pavement practices can be found in Appendix E Construction Inspection Checklists.

Some common pitfalls can be avoided by careful construction supervision that focuses on the following key aspects of permeable pavement installation:

- Store materials in a protected area to keep them free from mud, dirt, and other foreign materials.
- The CDA should be stabilized prior to directing water to the permeable pavement area.
- Check the aggregate material to confirm it is clean and washed, meets specifications and is installed to the correct depth. Aggregate loads that do not meet the specifications or do not appear to be sufficiently washed may be rejected.
- Check elevations (i.e., the invert of the underdrain, inverts for the inflow, and outflow points) and the surface slope.
- Make sure the permeable pavement surface is even, runoff spreads evenly across it, and the storage bed drains within 48 hours.
- Ensure caps are placed on the upstream (but not the downstream) ends of the underdrains.
- Inspect the pretreatment structures (if applicable) to make sure they are properly installed and working effectively.
- Once the final construction inspection has been completed, log the GPS coordinates for each facility and submit them for entry into the BMP maintenance tracking database.

Runoff diversion structures are recommended to protect larger permeable pavement applications from early runoff-producing storms, particularly when up-gradient conventional asphalt areas drain to the permeable pavement. This can help reduce the input of fine particles often produced shortly after conventional asphalt is laid.

#### **4.4.7 Permeable Pavement Maintenance Criteria**

Maintenance is a required and crucial element to ensure the long-term performance of permeable pavement. The most frequently cited maintenance problem is surface clogging caused by organic matter and sediment. Periodic street sweeping will remove accumulated sediment and help prevent clogging; however, it is also critical to ensure that surrounding land areas remain stabilized.

The following tasks must be avoided on all permeable pavements:

- Sanding
- Resealing
- Resurfacing
- Power washing
- Storage of mulch or soil materials
- Construction staging on unprotected pavement

It is difficult to prescribe the specific types or frequency of maintenance tasks that are needed to maintain the hydrologic function of permeable pavement systems over time. The frequency of maintenance will depend largely on the pavement use, traffic loads, and the surrounding land use.

One preventative maintenance task for large-scale applications (e.g., parking lots) involves vacuum sweeping on a frequency consistent with the use and loadings encountered in the site. Many experts

consider an annual, dry-weather sweeping in the spring months to be important. The contract for sweeping should specify that a vacuum sweeper be used that does not use water spray, since spraying may lead to subsurface clogging. Typical maintenance tasks are outlined in Table 4.15.

Table 4.15. Typical maintenance tasks for permeable pavement practices.

Frequency	Maintenance Tasks
After installation	<ul style="list-style-type: none"> <li>For the first 6 months following construction, the practice and CDA should be inspected at least twice after storm events that exceed 0.5 inch of rainfall. Conduct any needed repairs or stabilization.</li> </ul>
Once every 1–2 months during the growing season	<ul style="list-style-type: none"> <li>Mow grass in grid paver applications (clippings should be removed from the pavement area).</li> </ul>
As needed	<ul style="list-style-type: none"> <li>Stabilize the CDA to prevent erosion.</li> <li>Remove any soil or sediment deposited on pavement.</li> <li>Replace or repair any pavement surfaces that are degenerating or spalling.</li> </ul>
2–4 times per year (depending on use)	<ul style="list-style-type: none"> <li>Mechanically sweep pavement with a standard street sweeper to prevent clogging.</li> </ul>
Annually	<ul style="list-style-type: none"> <li>Conduct a maintenance inspection</li> <li>Remove weeds as needed.</li> </ul>
Once every 2–3 years	<ul style="list-style-type: none"> <li>Remove any accumulated sediment in pretreatment cells and inflow points.</li> </ul>
If clogged	<ul style="list-style-type: none"> <li>Conduct maintenance using a regenerative street sweeper or a vacuum sweeper</li> <li>Replace any necessary joint material.</li> </ul>

When permeable pavements are installed on private residential lots, homeowners will need to (1) be educated about their routine maintenance needs and (2) understand the long-term maintenance plan.

It is recommended that a qualified professional conduct a spring maintenance inspection and cleanup at each permeable pavement site, particularly at large-scale applications. Maintenance inspection checklists for permeable pavements and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

### **Waste Material**

Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

### **4.4.8 Permeable Pavement Stormwater Compliance Calculations**

Permeable pavement retention credit varies depending on the design configuration of the system.

### **Enhanced Designs**

These permeable pavement applications have an infiltration sump and water-quality filter, but no underdrain. Enhanced designs are credited with 100% retention for the storage volume (Sv) provided by the practice as well as 100% TSS, TN, and bacteria removal (Table 4.16).

Table 4.16. Retention and pollutant removal for enhanced permeable pavement practices.

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

Note: If using an infiltration sump design, only the volume stored in the sump can be counted as the Enhanced Design Storage Volume (Sv). Any volume stored in the practice above the sump is counted as a standard design. When using the SoLoCo Compliance Calculator, the Sv of the infiltration sump should be entered into the cell "Storage Volume Provided by BMP" in the Permeable Pavement – Enhanced row. Permeable Pavement – Standard should then be selected as the downstream practice. Next, in the Permeable Pavement - Standard row, the Sv provided above the infiltration sump should be entered into the cell "Storage Volume Provided by BMP."

#### **Standard Designs**

These permeable pavement applications have an underdrain, but no infiltration sump or water quality filter. Standard designs are credited with 30% retention for the storage volume (Sv) provided as well as 80% TSS, 45% TN, and 30% bacteria removal. (Table 4.17).

Table 4.17. Retention and pollutant removal for standard permeable pavement practices.

Retention	= 30%
TSS Removal	= 80%
TN Removal	= 45%
Bacteria Removal	= 30%

The practice must be sized using the guidance detailed in Section 4.2.4 Permeable Pavement Design Criteria.

Permeable pavement also contributes to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume (Sv) achieved by the practice from the total runoff volumes for the 2-year through the 100-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.





#### 4.5 Infiltration Practices

Infiltration				
<b>Definition:</b> Practices that capture and temporarily store the design storm volume before allowing it to infiltrate into the soil over a three-day period.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		100%	100%	100%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
Moderate	Moderate	High		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	Basin	Trench	
Quarterly	Every 5-10 years	100%	100%	
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Excellent in impervious CDAs</li><li>▪ Helps restore pre-development hydrologic conditions through groundwater recharge</li><li>▪ Reduces runoff rates, volumes, and pollutant loads</li><li>▪ Attractive landscaping features</li><li>▪ Good for small sites with porous soils</li></ul>		<ul style="list-style-type: none"><li>▪ CDA should be less than 2 acres.</li><li>▪ Potential for groundwater contamination</li><li>▪ High clogging potential;</li><li>▪ Not for sites with fine soils (clays/silts) in CDA</li><li>▪ Geotechnical testing required</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Pretreatment</li><li>▪ Conveyance system</li><li>▪ Ponding area</li><li>▪ Soils/Filter Media/Mulch</li><li>▪ Observation Well/Monitoring Port</li><li>▪ Plants</li></ul>		<ul style="list-style-type: none"><li>▪ Depth to seasonal high water table must be at least 6 inches below bottom of practice</li><li>▪ Must infiltrate within 72 hours</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Inspect for clogging</li></ul>		<ul style="list-style-type: none"><li>▪ Replace soil/stone if it becomes clogged</li><li>▪ Clean conveyance system(s)</li></ul>		

<sup>1</sup>Credited pollutant load removal

Infiltration practices are suitable for use in residential and other urban areas where field measured soil infiltration rates are sufficient. To prevent possible groundwater contamination, infiltration must not be utilized at sites designated as stormwater hotspots. If properly designed, they can provide significant reductions in post-construction stormwater runoff rates, volumes, and pollutant loads on development sites (Figure 4.16)



Figure 4.16. Infiltration practice in median strip.

**Definition**

Practices that capture and temporarily store the design storm volume before allowing it to infiltrate into the soil over a three-day period. Infiltration practices use temporary surface or underground storage to allow incoming stormwater runoff to exfiltrate into underlying soils. Runoff first passes through multiple pretreatment mechanisms to trap sediment and organic matter before it reaches the practice. As the stormwater penetrates the underlying soil, chemical and physical adsorption processes remove pollutants. Infiltration practices are suitable for use in residential and other urban areas where field-verified saturated hydraulic conductivity is sufficient.

Design variants include the following:

- I-1 Infiltration trench
- I-2 Infiltration basin

### **Infiltration Trenches**

Infiltration trenches are excavated trenches filled with stone. Stormwater runoff is captured and temporarily stored in the stone reservoir, where it is allowed to infiltrate into the surrounding and underlying native soils. Infiltration trenches can be used to “receive” stormwater runoff from contributing drainage areas of up to 2 acres in size and should only be used on development sites where sediment loads can be kept relatively low (see Figure 4.17 and Figure 4.18).

### **Infiltration Basins**

Infiltration basins are shallow, landscaped excavations filled with an engineered soil mix. They are designed to capture and temporarily store stormwater runoff in the engineered soil mix, where it is subjected to the hydrologic processes of evaporation and transpiration, before being allowed to infiltrate into the surrounding soils. They are essentially non-underdrained bioretention areas and should also only be used on drainage areas up to 5 acres where sediment loads can be kept relatively low (Figure 4.19).

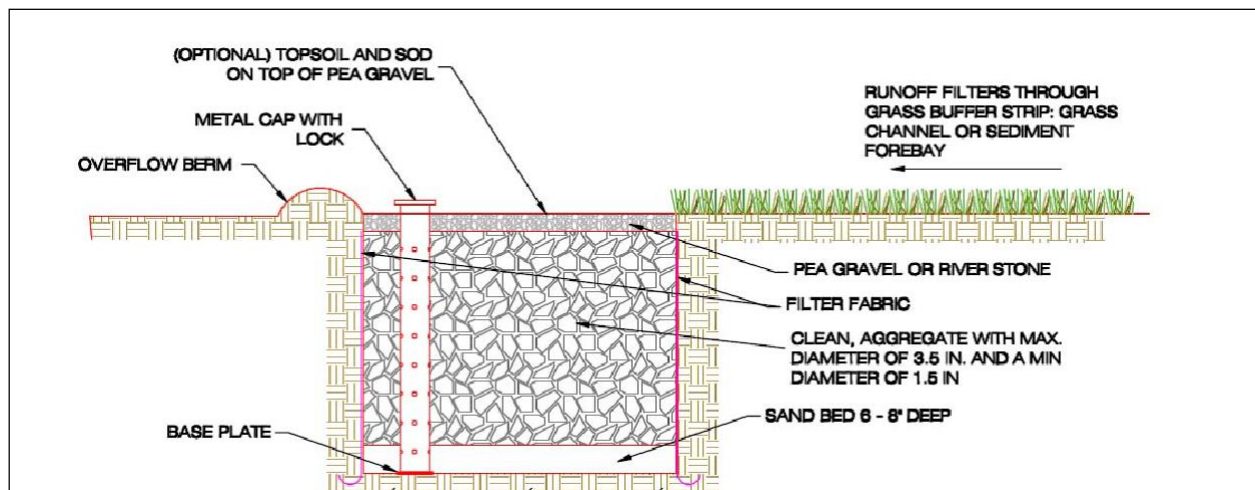


Figure 4.17. Example design of an infiltration trench.

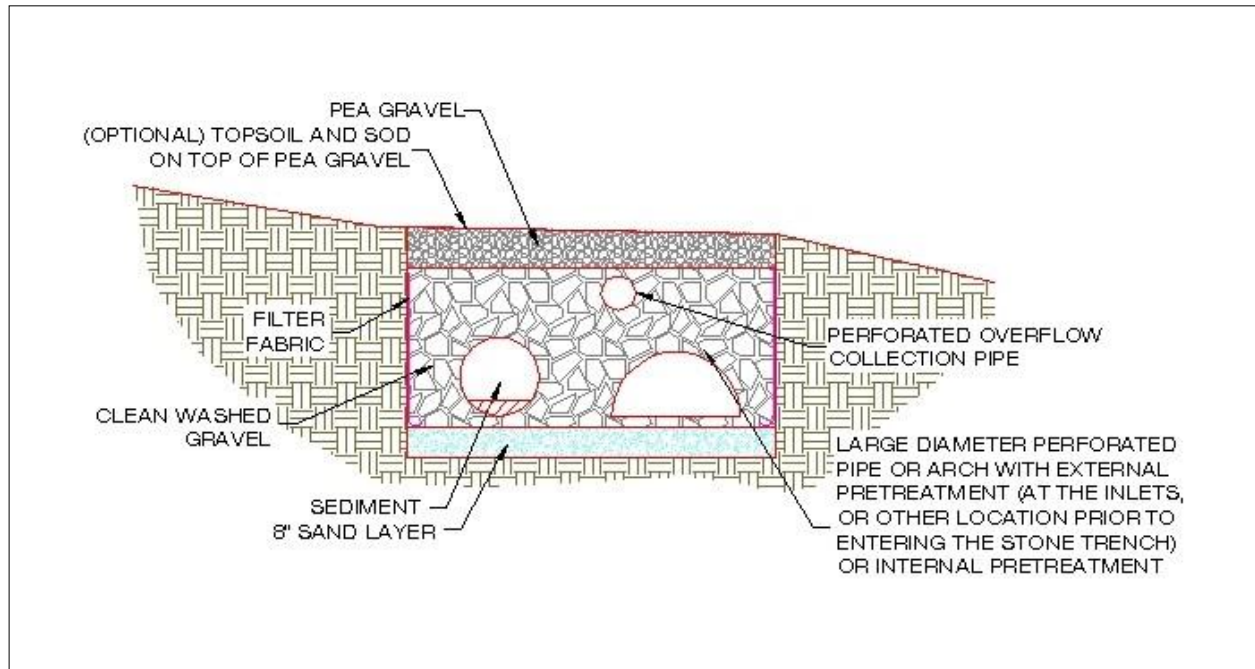


Figure 4.18. Example design of an infiltration practice with supplemental pipe storage.

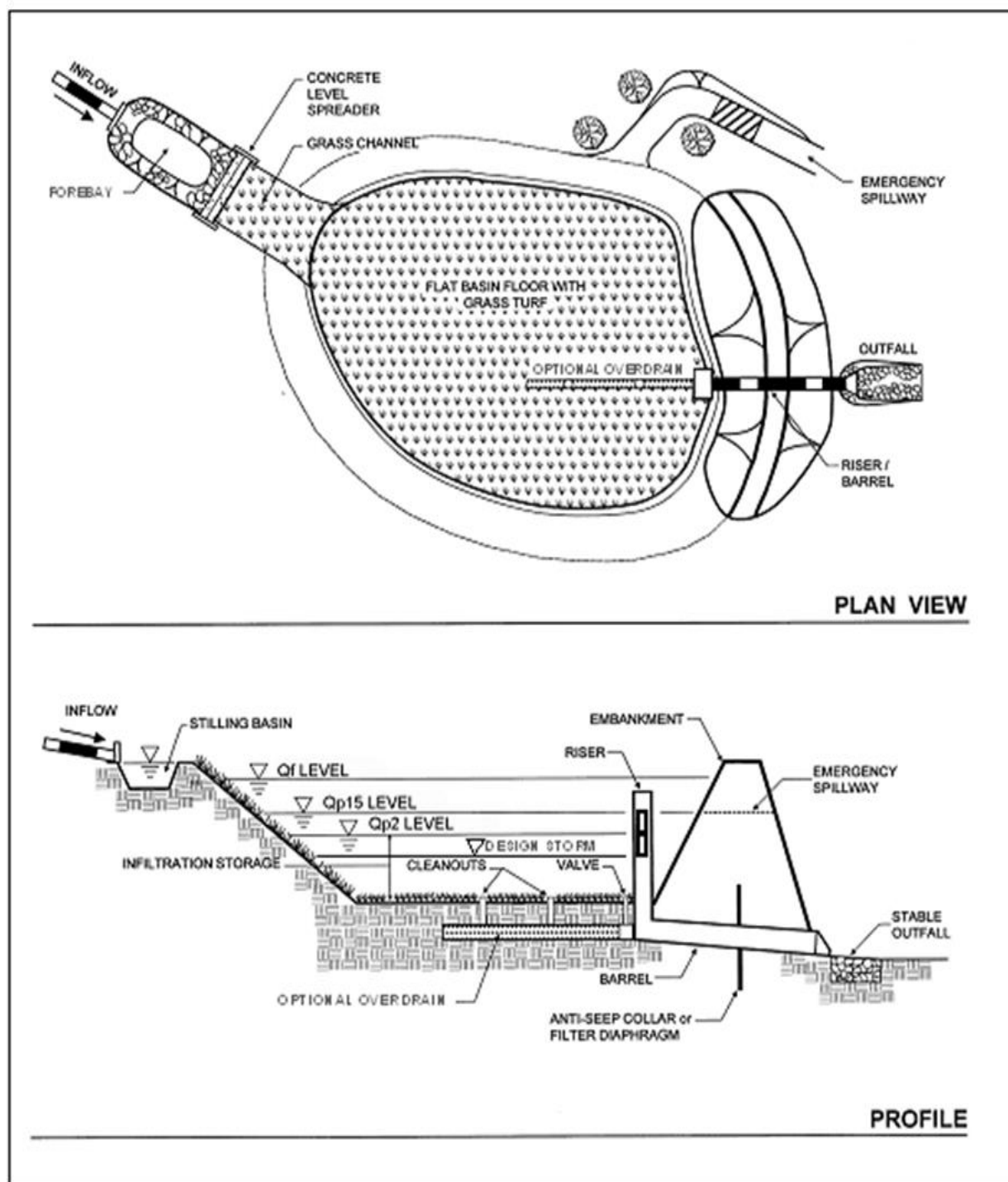


Figure 4.19. Example design of an infiltration basin.

#### **4.5.1 Infiltration Feasibility Criteria**

Infiltration practices have very high storage and retention capabilities when sited and designed appropriately. Designers should evaluate the range of soil properties during initial site layout and seek to configure the site to conserve and protect the soils with the greatest recharge and infiltration rates. In particular, areas of HSG A or B soils, shown on the U.S. Department of Agriculture's NRCS soil surveys, should be considered as primary locations for infiltration practices. Additional information about soil and infiltration are described in more detail later in this section. During initial design phases, designers should carefully identify and evaluate constraints on infiltration, as follows:

##### **Underground Injection Control for Class V Wells**

In order for an infiltration practice to avoid classification as a Class V well, which is subject to regulation under the Federal Underground Injection Control program, the practice must be wider than the practice is deep. If an infiltration practice is "deeper than its widest surface dimension" or if it includes an underground distribution system, then it will likely be considered a Class V injection well. Class V injection wells are subject to permit approval by the U.S. Environmental Protection Agency (EPA).

##### **Contributing Drainage Area**

The maximum CDA to an individual infiltration practice should be less than 2 acres and as close to 100% impervious as possible. The design, pretreatment, and maintenance requirements will differ depending on the size of the infiltration practice.

##### **Site Topography**

The infiltration practice shall not be located on slopes greater than 6%, although check dams or other devices may be employed to reduce the effective slope of the practice. Further, unless slope stability calculations demonstrate otherwise, infiltration practices should be located a minimum horizontal distance of 200 feet from down-gradient slopes greater than 20%.

##### **Minimum Hydraulic Head**

Two or more feet of head may be needed to promote flow through infiltration practices.

##### **Minimum Depth to Water Table**

A minimum vertical distance of 0.5 feet must be provided between the bottom of the infiltration practice.

##### **Tidal Impacts**

The bottom of an infiltration practice should be located above the tidal mean high water elevation. Where this is not possible, portions of the practice below the tidal mean high water elevation cannot be included in the volume calculations.

##### **Soils**

Initially, soil infiltration rates can be estimated from NRCS soil data for feasibility purposes, but designers must verify soil permeability by using the on-site soil investigation methods provided in Appendix B Geotechnical Information Requirements for Underground BMPs for their design.

### **Use on Urban Fill Soils/Redevelopment Sites**

Sites that have been previously graded or disturbed do not typically retain their original soil permeability due to compaction. Therefore, such sites are often not good candidates for infiltration practices unless the geotechnical investigation shows that a sufficient saturated hydraulic conductivity exists.

### **Dry Weather Flows**

Infiltration practices should not be used on sites receiving regular dry-weather flows from sump pumps, irrigation water, chlorinated wash-water, or flows other than stormwater.

### **Setbacks**

To avoid the risk of seepage, stormwater cannot flow from infiltration practices to traditional pavement base layer, existing structure foundations, or future foundations which may be built on adjacent properties. Setbacks to structures and property lines must be at least 10 feet and adequate waterproofing protection must be provided for foundations and basements. Where the 10-foot setback is not possible, an impermeable liner may be used along the sides and bottom of the infiltration area (extending from the surface to the bottom of the practice and outward to meet the 10-foot setback). Areas where the liner blocks infiltration should be excluded from surface area calculations for the practice. In locations where the surface soil consists of highly permeable soils with little separation of the infiltration trench or basin bottom, the extent of ground water mounding should be considered. Mounding can occur in areas where infiltrating water intersects a groundwater table and the rate of water entering the subsurface is greater than the rate at which water is conveyed away from the infiltration system (MPCA, 2019). Ground water mounding may impact building foundations, soil stability, underground utilities and potentially on-site treatment systems (septic leach beds).

All setbacks must be verified by a professional geotechnical engineer registered in the State of South Carolina.

### **Proximity to Utilities**

Interference with underground utilities should be avoided, if possible. When large site development is undertaken the expectation of achieving avoidance will be high. Conflicts may be commonplace on smaller sites and in the PROW. Consult with each utility company on recommended offsets, which will allow utility maintenance work with minimal disturbance to the infiltration BMP. Infiltration BMPs in the PROW will also conform with the State of South Carolina Department of Transportation design specifications. Where conflicts cannot be avoided, follow these guidelines:

- Consider altering the location or sizing of the infiltration BMP to avoid or minimize the utility conflict. Consider an alternate BMP type to avoid conflict.
- Use design features to mitigate the impacts of conflicts that may arise by allowing the infiltration BMP and the utility to coexist. The infiltration BMP design may need to incorporate impervious areas, through geotextiles or compaction, to protect utility crossings. Other key design features may need to be moved, added, or deleted.
- Evaluate the relocation of the existing utility and install an optimally placed and sized infiltration BMP.
- If utility functionality, longevity and vehicular access to manholes can be assured, accept the infiltration BMP design and location with the existing utility. Incorporate into the infiltration BMP design sufficient soil coverage over the utility or general clearances or other features such as an impermeable linear to assure all entities the conflict is limited to maintenance.

Note: When accepting utility conflict into the infiltration BMP location and design, it is understood the infiltration BMP will be temporarily impacted during utility work. At the conclusion of this work, the utility owner will replace the infiltration BMP or, alternatively, install a functionally comparable infiltration BMP according to the specifications in the current version of this guidebook. If the infiltration BMP is located in the PROW the infiltration BMP restoration will also conform with the State of South Carolina Department of Transportation design specification.

### **Pollutant Hotspots and High Loading Situations**

Infiltration practices are not intended to treat sites with high sediment or trash or debris loads, because such loads will cause the practice to clog and fail. Infiltration practices must be avoided at potential stormwater hotspots that pose a risk of groundwater contamination. In areas where higher pollutant loading is likely (i.e. oils and greases from fueling stations or vehicle storage areas, sediment from un-stabilized pervious areas, or other pollutants from industrial processes), appropriate pretreatment, such as an oil-water separator or filtering device must be provided. These pretreatment facilities should be monitored and maintained frequently to avoid negative impacts to the infiltration area and groundwater.

On sites with existing contaminated soils, infiltration is not allowed.

### **Economic Considerations**

Infiltration practices do require a designated space on the site, which in space-constrained areas, may reduce available building space. However, infiltration practices have a relatively low construction cost, and high space efficiency. In some cases, they can even be incorporated into the detention design or landscaped areas

#### **4.5.2 Infiltration Conveyance Criteria**

The nature of the conveyance and overflow to an infiltration practice depends on the scale of infiltration and whether the facility is on-line or off-line. Where possible, conventional infiltration practices should be designed off-line to avoid damage from the erosive velocities of larger design storms. If runoff is delivered by a storm drain pipe or along the main conveyance system, the infiltration practice shall be designed as an off-line practice. Pretreatment shall be provided for storm drain pipes and conveyance systems discharging directly to infiltration systems.

### **Off-line Infiltration**

Overflows can either be diverted from entering the infiltration practice or dealt with via an overflow inlet. Optional overflow methods include the following:

- Utilize a low-flow diversion or flow splitter at the inlet to allow only the design SWRV to enter the facility. This may be achieved with a weir or curb opening sized for the target flow, in combination with a bypass channel. Using a weir or curb opening helps minimize clogging and reduces the maintenance frequency (further guidance on determining the peak flow rate will be necessary in order to ensure proper design of the diversion structure).
- Use landscaping type inlets or standpipes with trash guards as overflow devices.

### **On-line Infiltration**

An overflow structure must be incorporated into on-line designs to safely convey the 25-year storm through the infiltration area. Mechanisms such as elevated drop inlets and overflow weirs are examples of how to direct high flows to a non-erosive down-slope overflow channel, stabilized water course, or storm sewer system designed to convey the 25-year design storm.



#### 4.5.3 Infiltration Pretreatment Criteria

Every infiltration system shall have pretreatment mechanisms to protect the long-term integrity of the infiltration rate. One of the following techniques must be installed to pretreat 100% of the inflow in every facility:

- Grass channel
- Grass filter strip (minimum 20 feet and only if sheet flow is established and maintained)
- Forebay or sump pit (must accommodate a minimum 15% of the design storm volume)
- Gravel diaphragm (minimum 1 foot deep and 2 feet wide and only if sheet flow is established and maintained)
- Filter system (see Section 4.10 Filtering Systems) If using a filter system as a pretreatment facility, the sand filter will not require its own separate pretreatment facility.
- A proprietary structure with demonstrated capability of reducing sediment and hydrocarbons may be used to provide pretreatment. Refer to Section 0 Proprietary Practices.

If the basin serves a CDA greater than 20,000 square feet, a forebay, sump pit, filter system, or proprietary practice must be used for pretreatment.

Exit velocities from the pretreatment chamber shall not be erosive (above 6 fps) during the 25-year design storm and flow from the pretreatment chamber should be evenly distributed across the width of the practice (e.g., using a level spreader).

#### 4.5.4 Infiltration Design Criteria Geometry

Where possible, an infiltration practice should be designed to be wider than it is deep, to avoid classification as a Class V injection well.

##### Practice Slope

The bottom of an infiltration practice should be flat (i.e., 0% longitudinal and lateral slopes) to enable even distribution and infiltration of stormwater.

##### Infiltration Basin Geometry

The maximum vertical depth to which runoff may be ponded over an infiltration basin is 24 inches. The side-slopes should be no steeper than 4H:1V.

##### Surface Cover (optional)

Designers may choose to install a layer of topsoil and grass above the infiltration practice.

##### Surface Stone

A 3-inch layer of clean, washed river stone or No. 8 or 89 stone should be installed over the stone layer.

##### Stone Layer

Stone layers must consist of clean, washed aggregate with a maximum diameter of 3.5 inches and a minimum diameter of 1.5 inches.

##### Observation Wells

All infiltration practices must include at least one observation well. The observation well is used to observe the rate of drawdown within the infiltration practice following a storm event and to facilitate periodic inspection and maintenance. The observation well should consist of a well-anchored, perforated 4- to 6-inch diameter PVC pipe. There should be no perforation within 1 foot of the surface. The observation well should extend vertically to the bottom of the stone layer and extend upward to the top of ponding.

#### **Underground Storage (optional)**

In the underground mode, runoff is stored in the voids of the stones and infiltrates into the underlying soil matrix. Perforated corrugated metal pipe, plastic pipe, concrete arch pipe, or comparable materials can be used in conjunction with the stone to increase the available temporary underground storage. In some instances, a combination of filtration and infiltration cells can be installed in the floor of a dry extended detention (ED) pond.

#### **Overflow Collection Pipe (Overdrain)**

An optional overflow collection pipe can be installed in the stone layer to convey collected runoff from larger storm events to a downstream conveyance system.

#### **Trench Bottom**

To protect the bottom of an infiltration trench from intrusion by underlying soils, a sand layer must be used. The underlying native soils must be separated from the stone layer by a 6- to 8-inch layer of coarse sand (e.g., ASTM C-33, 0.02–0.04 inches in diameter).

#### **Geotextile Fabric**

An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability must be used. This layer should be applied only to the sides of the practice.

#### **Material Specifications**

Recommended material specifications for infiltration areas are shown in Table 4.18.

Table 4.18. Infiltration practice material specifications.

Material	Specification	Notes
Surface Layer (optional)	Topsoil and grass layer	
Surface Stone	Install a 3-inch layer of river stone or pea gravel.	Provides an attractive surface cover that can suppress weed growth.
Stone Layer	Clean, double-washed aggregate with a maximum diameter of 3.5 inches and a minimum diameter of 1.5 inches.	
Observation Well	Install a vertical 6-inch Schedule 40 PVC perforated pipe, with a lockable cap and anchor plate.	Install one per 50 feet of length of infiltration practice.
Overflow Collection Pipe (optional)	Use 4- or 6-inch rigid schedule 40 PVC pipe, with three or four rows of 3/8-inch perforations at 6 inches on center.	
Trench Bottom	Install a 6- to 8-inch sand layer (e.g., ASTM C-33, 0.02–0.04 inches in diameter)	
Geotextile Fabric (sides only)	An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability must be used.	

### Practice Sizing

The proper approach for designing infiltration practices is to avoid forcing a large amount of infiltration into a small area. Therefore, individual infiltration practices that are limited in size due to soil permeability and available space need not be sized to achieve the full design storm volume (SWR<sub>v</sub>) for the CDA, as long as other stormwater treatment practices are applied at the site to meet the remainder of the design storm volume.

Several equations (see following page) are needed to size infiltration practices. The first equations establish the maximum depth of the infiltration practice, depending on whether it is a surface basin (Equation 4.6) or trench with an underground reservoir (Equation 4.7)

Equation 4.6. Maximum surface basin depth for infiltration basins.

$$d_{\max} = K_{\text{sat}} \times t_d$$

Equation 4.7. Maximum underground reservoir depth for infiltration trenches.

$$d_{\max} = \frac{(K_{\text{sat}} \times t_d)}{\eta_r}$$

Where:

- $d_{\max}$  = Maximum depth of the infiltration practice (ft)
- $K_{\text{sat}}$  = Field-verified saturated hydraulic conductivity for the native soils (ft/day)
- $t_d$  = Maximum drawdown time (days, normally 3 days)
- $\eta_r$  = Available porosity of the stone reservoir (assume 0.4)

These equations make the following design assumptions:

- **Stone Layer Porosity**

A porosity value of 0.4 shall be used in the design of stone reservoirs, although a larger value may be used if perforated corrugated metal pipe, plastic pipe, concrete arch pipe, or comparable materials are installed within the reservoir.

- **Rapid Drawdown**

Infiltration practices must be sized so that the design volume infiltrates within 72 hours, to prevent nuisance ponding conditions.

Designers should compare these results to the maximum allowable depths in Table 4.19 and use whichever value is less for the subsequent design.

Table 4.19. Maximum facility depth for infiltration practices.

Mode of Entry	Scale of Infiltration		
	Micro Infiltration (250–2,500 ft²)	Small Scale Infiltration (2,500–20,000 ft²)	Conventional Infiltration (20,000–100,000 ft²)
Surface Basin	1.0	1.5	2.0
Underground Reservoir	3.0	5.0	varies

Once the maximum depth is known, calculate the surface area needed for an infiltration practice using Equation 4.8 or Equation 4.9.

Equation 4.8. Surface basin surface area for infiltration basins.

$$SA = \frac{\text{DesignStorm}}{d + (K_{\text{sat}} \times t_f)}$$

Equation 4.9. Underground reservoir surface area for infiltration trenches.

$$SSSS = \frac{DDDDDDDDSSSSSSSS}{(\eta_{ITT} \times dd) + (0.5 \times KK_{SSSSSS} \times Dd_{ff})}$$

Where:

SA = Surface area (square feet)

DesignStorm = SWRv or other design storm volume (e.g., portion of the SWRv; cubic feet)

 $\eta_r =$  Available porosity of the stone reservoir (assume 0.4)

d = Infiltration depth (feet; maximum depends on the scale of infiltration and the results of Equation 4.6 or Equation 4.7)

$K_{sat}$  = Field-verified saturated hydraulic conductivity for the native soils (ft/day)

$t_f$  = Time to fill the infiltration facility (days; typically 2 hours or 0.083 days)

The storage volume ( $S_v$ ) captured by the infiltration practice is defined as the volume of water that is fully infiltrated through the practice (i.e., no overflow). Designers may choose to infiltrate less than the full design storm ( $SWR_v$ ). In this case, the design volume captured must be treated as the  $S_v$  of the

practice (see Section 4.5.4 Infiltration Design Criteria).  $S_v$  can be determined by rearranging Equation 4.8 and Equation 4.9 to yield Equation 4.10 and Equation 4.11.

Equation 4.10. Storage volume for surface basin area for infiltration basins.

$$S_v = SA \times [d + (K_{sat} \times t_f)]$$

Equation 4.11. Storage volume for underground reservoir surface area for infiltration trenches.

$$S_v = SA \times [(\eta_r \times d) + (K_{sat} \times t_f)]$$

Infiltration practices can also be designed to address, in whole or in part, the detention storage needed to comply with channel protection and/or flood control requirements. The designer can model various approaches by factoring in storage within the stone aggregate layer, any perforated corrugated metal pipe, plastic pipe, concrete arch pipe, or comparable materials installed within the reservoir, expected infiltration, and any outlet structures used as part of the design. Routing calculations can also be used to provide a more accurate solution of the peak discharge and required storage volume.

#### 4.5.5 Infiltration Landscaping Criteria

Infiltration trenches can be effectively integrated into the site plan and aesthetically designed with adjacent native landscaping or turf cover, subject to the following additional design considerations:

- ② Infiltration practices should not be installed until all up-gradient construction is completed and pervious areas are stabilized with dense and healthy vegetation, unless the practice can be kept off-line so it receives no runoff until construction and stabilization is complete.
- ② Vegetation associated with the infiltration practice buffers should be regularly maintained to limit organic matter in the infiltration device and maintain enough vegetation to prevent soil erosion from occurring.

#### 4.5.6 Infiltration Construction Sequence

Infiltration practices are particularly vulnerable to failure during the construction phase for two reasons. First, if the construction sequence is not followed correctly, construction sediment can clog the practice. Second, loading from heavy construction equipment can result in compaction of the soil, which can then reduce the soil's infiltration rate. For this reason, a careful construction sequence needs to be followed.

During site construction, the following protective measures are absolutely critical:

- ② All areas proposed for infiltration practices should be fully protected from sediment intrusion by silt fence or construction fencing, particularly if they are intended to infiltrate runoff.
- ② Avoid excessive compaction by preventing construction equipment and vehicles from traveling over the proposed location of the infiltration practice. To accomplish this, areas intended to infiltrate runoff must remain outside the limits of disturbance during construction.
- ② When this is unavoidable, there are several possible remedies for the impacted area.
  - If excavation at the impacted area can be restricted then remediation can be achieved with deep tilling practices. This is only possible if in situ soils are not disturbed below 2 feet above the final design elevation of the bottom of the infiltration practice. In this case, when heavy equipment activity has ceased, the area is excavated to grade, and the impacted area must be tilled a minimum of 12 inches below the bottom of the infiltration practice.

- Alternatively, if it is infeasible to keep the proposed infiltration practice outside of the limits of disturbance, and excavation of the area cannot be restricted, then infiltration tests will be required prior to installation of the infiltration practice to ensure that the design infiltration rate is still present. If tests reveal the loss of design infiltration rates then deep tilling practices may be used in an effort to restore those rates. In this case further testing must be done to establish design rates exist before the infiltration practice can be installed.
  - Finally, if it is infeasible to keep the proposed permeable pavement areas outside of the limits of disturbance, excavation of the area cannot be restricted, and infiltration tests reveal design rates cannot be restored, then a resubmission of the SWMP will be required.
- ⑦ Any area of the site intended ultimately to be an infiltration practice should not be used as the site of a temporary sediment trap or basin. If locating a sediment trap or basin on an area intended for infiltration is unavoidable, the remedies are similar to those discussed for heavy equipment compaction. If it is possible, restrict the invert of the sediment trap or basin to at least 2 feet above the final design elevation of the bottom of the proposed infiltration practice. Then remediation can be achieved with proper removal of trapped sediments and deep tilling practices. An alternate approach to deep tilling is to use an impermeable linear to protect the in situ soils from sedimentation while the sediment trap or basin is in use. In each case, all sediment deposits must be carefully removed prior to installing the infiltration practice.
  - ⑦ Keep the infiltration practice off-line until construction is complete. Prevent sediment from entering the infiltration site by using super silt fence, diversion berms, or other means. In the soil erosion and sediment control plan, indicate the earliest time at which stormwater runoff may be directed to a conventional infiltration basin. The soil erosion and sediment control plan must also indicate the specific methods to be used to temporarily keep runoff from the infiltration site.
  - ⑦ Upland CDAs need to be completely stabilized with a well-established layer of vegetation prior to commencing excavation for an infiltration practice.

### **Infiltration Installation**

The actual installation of an infiltration practice is done using the following steps:

#### **1. Avoid Impact of Heavy Installation Equipment**

Excavate the infiltration practice to the design dimensions from the side using a backhoe or excavator. The floor of the pit should be completely level, but equipment should be kept off the floor area to prevent soil compaction.

#### **2. Hang Geotextile Walls**

Install geotextile fabric on the trench sides. Large tree roots should be trimmed flush with the sides of infiltration trenches to prevent puncturing or tearing of the geotextile fabric during subsequent installation procedures. When laying out the geotextile, the width should include sufficient material to compensate for perimeter irregularities in the trench and for a 6-inch minimum overlap at the top of the trench. The geotextile fabric itself should be tucked under the sand layer on the bottom of the infiltration trench. Stones or other anchoring objects should be placed on the fabric at the trench sides, to keep the trench open during windy periods. Voids may occur between the fabric and the excavated sides of a trench. Natural soils should be placed in all voids, to ensure the fabric conforms smoothly to the sides of excavation.

### **3. Promote Infiltration Rate**

Scarify the bottom of the infiltration practice and spread 6 inches of sand on the bottom as a filter layer.

### **4. Observation Wells**

Anchor the observation well(s) and add stone to the practice in 1-foot lifts.

### **5. Stabilize Surrounding Area**

Use sod, where applicable, to establish a dense turf cover for at least 10 feet around the sides of the infiltration practice, to reduce erosion and sloughing.

### **Construction Supervision**

Supervision during construction is recommended to ensure that the infiltration practice is built in accordance with the approved design and this specification. Qualified individuals should use detailed inspection checklists to include sign-offs at critical stages of construction, to ensure that the contractor's interpretation of the plan is consistent with the designer's intentions.

### **4.5.7 Infiltration Maintenance Criteria**

Maintenance is a crucial and required element that ensures the long-term performance of infiltration practices. The most frequently cited maintenance problem for infiltration practices is clogging of the stone layer by organic matter and sediment. The following design features can minimize the risk of clogging:

#### **Stabilized CDA**

Infiltration systems may not receive runoff until the entire CDA has been completely stabilized.

#### **Observation Well**

Infiltration practices must include an observation well to facilitate periodic inspection and maintenance. Design criteria must include an anchored 6-inch diameter perforated PVC pipe fitted with a lockable cap installed flush with the ground surface.

#### **No Geotextile Fabric on Bottom**

Avoid installing geotextile fabric along the bottom of infiltration practices. Experience has shown that geotextile fabric is prone to clogging. However, permeable geotextile fabric should be installed on the trench sides to prevent soil piping.

#### **Direct Maintenance Access**

Access must be provided to allow personnel and heavy equipment to perform atypical maintenance tasks, such as practice reconstruction or rehabilitation. While a turf cover is permissible for small-scale infiltration practices, the surface must never be covered by an impermeable material, such as asphalt or concrete.

#### **Maintenance Inspections**

Effective long-term operation of infiltration practices requires a dedicated and routine maintenance inspection schedule with clear guidelines and schedules, as shown in Table 4.20. Where possible, facility maintenance should be integrated into routine landscaping maintenance tasks.

Table 4.20. Typical maintenance activities for infiltration practices.

Schedule	Maintenance Activity
Quarterly	<ul style="list-style-type: none"> <li>Ensure that the CDA, inlets, and facility surface are clear of debris.</li> <li>Ensure that the CDA is stabilized. Perform spot-reseeding if where needed.</li> <li>Remove sediment and oil/grease from inlets, pretreatment devices, flow diversion structures, and overflow structures.</li> <li>Repair undercut and eroded areas at inflow and outflow structures.</li> </ul>
Semi-annual inspection	<ul style="list-style-type: none"> <li>Check observation wells 3 days after a storm event in excess of 0.5 inch in depth. Standing water observed in the well after 3 days is a clear indication of clogging.</li> <li>Inspect pretreatment devices and diversion structures for sediment build-up and structural damage.</li> </ul>
Annually	<ul style="list-style-type: none"> <li>Clean out accumulated sediment from the pretreatment cell.</li> </ul>
As needed	<ul style="list-style-type: none"> <li>Replace pea gravel/topsoil and top surface geotextile fabric (when clogged).</li> <li>Mow vegetated filter strips as necessary and remove the clippings.</li> </ul>

It is highly recommended that a qualified professional conduct annual site inspections for infiltration practices to ensure the practice performance and longevity of infiltration practices.

Beaufort County Public Works Departments's maintenance inspection checklist for infiltration systems and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### 4.5.8 Infiltration Stormwater Compliance Calculations

Infiltration practices are credited with 100% retention for the storage volume (Sv) provided by the practice as well as 100% TSS, TN, and bacteria removal (Table 4.21).

Table 4.21. Retention and pollutant removal for infiltration practices.

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

The practice must be sized using the guidance detailed in Section 4.3.4 Infiltration Design Criteria.

Infiltration practices also contribute to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume (Sv) from the total runoff volume for the 2-year through the 100-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate



peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

#### 4.6 Green Roofs

Green Roofs				
<b>Definition:</b> Practices that capture and store rainfall in an engineered growing media installed over a waterproof membrane that is designed to support plant growth on the roof of a building or other structure.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		100%	100%	100%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
High	Low	High		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	100% of Sv		
Semi-annually	As needed			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Reduces runoff volume and pollutant loads</li><li>▪ Energy savings: keep buildings cool, prolongs roof life</li><li>▪ Possible amenity space for public or users</li><li>▪ Sound absorption</li><li>▪ Life cycle costs comparable to traditional roof</li></ul>		<ul style="list-style-type: none"><li>▪ For retrofits, strengthening structure may be required</li><li>▪ If roof leaks occur, may be harder to trace</li><li>▪ Design and installation require specialized knowledge</li><li>▪ Typically applied on flat roofs (1%–2% pitch)</li><li>▪ Installation costs higher than for traditional roof</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Vegetation that thrives in rooftop climate.</li><li>▪ Engineered planting medium (not soil).</li><li>▪ Containment (Modular systems - plant containers; Non-modular systems - barriers at roof perimeter/drainage structures).</li><li>▪ Drainage layer, sometimes with built-in water reservoirs.</li><li>▪ Water proofing layer or roof membrane with root repellant.</li></ul>		<ul style="list-style-type: none"><li>▪ Good waterproofing material and installation are essential.</li><li>▪ Materials used must be lightweight.</li><li>▪ Building structure must be able to support saturated weight.</li><li>▪ Roofs with moderate to flat slopes are most appropriate. Maximum roof slope of 30%.</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Watering and fertilization until well-established</li><li>▪ Occasional weeding</li></ul>		<ul style="list-style-type: none"><li>▪ Inspection for proper drainage and plant health</li><li>▪ Ordinary life cycle roof replacement</li></ul>		

<sup>1</sup>Credited pollutant load removal

Green roofs are practices that capture and store rainfall in an engineered growing media that is designed to support plant growth (see Figure 4.20). A portion of the captured rainfall evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on development sites. Green roofs typically contain a layered system of roofing, which is designed to support plant growth and retain water for plant uptake while preventing ponding on the roof surface. The roofs are designed so that water drains vertically through the media and then horizontally along a waterproofing layer towards the outlet. Extensive green roofs are designed to have minimal maintenance requirements. Plant species are selected so that the roof does not need supplemental irrigation or fertilization after vegetation is initially established.

Green roofs are typically not designed to provide stormwater detention of larger storms (e.g., 2 - 25-year) although some intensive green roof systems may be designed to meet these criteria. Green roof designs should generally be combined with a separate facility to provide large storm controls.



Figure 4.20. Green roof (photo: Center for Watershed Protection, Inc.)

### **Definition**

Practices that capture and store rainfall in an engineered growing media installed over a waterproof membrane that is designed to support plant growth on the roof of a building or other structure. A portion of the captured rainfall evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on development sites. Green roofs typically contain a layered system of roofing, which is designed to support plant growth and retain water for plant uptake while preventing ponding on the roof surface. The roofs are designed so that water drains vertically through the media and then horizontally along a waterproofing layer towards the outlet. Plant species are selected so that the roof does not need supplemental irrigation and requires minimal, infrequent fertilization after vegetation is initially established.

Design variants include extensive and intensive green roofs.

- G-1 Extensive green roofs have a much shallower growing media layer that typically ranges from 3 to 8 inches thick and are designed to have minimal maintenance requirements.
- G-2 Intensive green roofs have a growing media layer that typically ranges from 8 to 48 inches thick.

Green roofs are typically not designed to provide stormwater detention of larger storms (e.g., 2 - 25-year) although some intensive green roof systems may be designed to meet these criteria. Most green roof designs shall generally be combined with a separate facility to provide large storm controls.

This specification is intended for situations where the primary design objective of the green roof is stormwater management and, unless specified otherwise, addresses the design of extensive roof systems. While rooftop practices such as urban agriculture may provide some retention, their primary design objective is not stormwater management and is not addressed in this specification.

#### **4.6.1 Green Roof Feasibility Criteria**

Green roofs are ideal for use on commercial, institutional, municipal, and multi-family residential buildings. They are particularly well-suited for use on ultra-urban development and redevelopment sites. Key constraints with green roofs include the following:

##### **Structural Capacity of the Roof**

When designing a green roof, designers must not only consider the stormwater storage capacity of the green roof but also its structural capacity to support the weight of the additional water. A conventional rooftop should typically be designed to support an additional 15 to 30 pounds per square foot (psf) for an extensive green roof. As a result, a structural engineer, architect, or other qualified professional should be involved with all green roof designs to ensure that the building has enough structural capacity to support a green roof. See Section 4.6.4 Green Roof Design Criteria for more information on structural design considerations.

##### **Hurricane-Prone Areas**

**As South Carolina is subject to hurricanes, some may be concerned about the durability of green roofs in high winds. Having good vegetative cover and root growth in the growing media is the most effective way to reduce wind erosion of the media during high winds. New green roofs where the plants have not yet deeply rooted are the most susceptible to plant damage and media blow-off in a hurricane. Therefore, it is best to install a green roof three or more months prior to hurricane season, to allow enough time for the plants to be established.**

##### **Roof Pitch**

Green roof storage volume is maximized on relatively flat roofs (a pitch of 1% to 2%). Some pitch is needed to promote positive drainage and prevent ponding and/or saturation of the growing media. Green roofs can be installed on rooftops with slopes up to 30% if baffles, grids, or strips are used to prevent slippage of the media. These baffles must be designed to ensure the roof provides adequate storage for the design storm. Slopes greater than 30% would be considered a green wall, which is not specifically identified as a stormwater BMP. Green walls can be used to receive cistern discharge (calculations are necessary to determine demand).

### **Roof Access**

Adequate, permanent access to the roof must be available to deliver construction materials and perform routine maintenance. A temporary ladder is not sufficient for access to the roof. Roof access can be achieved either by an interior stairway through a penthouse or by an alternating tread device with a roof hatch or trap door not less than 16 square feet in area and with a minimum dimension of 24 inches (NVRC, 2007). Designers should also consider how they will get construction materials up to the roof (e.g., by elevator or crane) and how the roof structure can accommodate material stockpiles and equipment loads. If material and equipment storage is required, rooftop storage areas must be identified and clearly marked based on structural load capacity of the roof.

### **Roof Type**

Green roofs can be applied to most roof surfaces. Certain roof materials, such as exposed treated wood and uncoated galvanized metal, may not be appropriate for green rooftops due to pollutant leaching through the media (Clark et al., 2008).

### **Setbacks**

Green roofs should not be located near rooftop electrical and HVAC systems. A 2-foot-wide vegetation-free zone is recommended along the perimeter of the roof with a 1-foot vegetation-free zone around all roof penetrations, to act as a firebreak. The 2-foot setback may be relaxed for small or low green roof applications where parapets have been properly designed.

### **Contributing Drainage Area**

It is recommended that the contributing drainage area (CDA) to a green roof be limited to the green roof itself. In cases where there will be additional CDA, the designer must provide sufficient design detail showing distribution of this additional runoff throughout the green roof area to prevent erosion or overloading of the roof growing media with the use of level spreaders, splash pads, perforated piping, or other flow dissipation techniques. The absolute maximum CDA to a green roof shall be no more than 100% larger than the area of the green roof (e.g., a 1,000-square-foot green roof can have no more than 1,000 square feet of additional impervious cover draining to it).

### **Local Building Codes**

The green roof design must comply with the local building codes with respect to roof drains and emergency overflow devices. Additionally, a structural engineer should certify that the design complies with structural building codes. For green roofs installed on historic buildings or in historic districts, consult local building codes and architectural review criteria to determine if any special requirements exist for green roof design or maintenance.

Additionally, a State of South Carolina registered structural engineer must certify that the design complies with State building structural codes. This is true for new construction as well as retrofit projects.

### **Economic Considerations**

Green roofs tend to be one of the most expensive BMPs on a per cubic foot captured basis. However, a green roof allows stormwater management to be achieved in otherwise unused space, a major benefit in space-constrained locations. Further, green roofs provide many other non-stormwater services with economic benefits, including increased insulation and roof life expectancy

#### **4.6.2 Green Roof Conveyance Criteria**

The green roof drainage layer (refer to Section 4.6.4 Green Roof Design Criteria) must convey flow from under the growing media directly to an outlet or overflow system such as a traditional rooftop downspout drainage system. The green roof drainage layer must be adequate to convey the volume of stormwater equal to the flow capacity of the overflow or downspout system without backing water up onto the rooftop or into the green roof media. Roof drains immediately adjacent to the growing media should be boxed and protected by flashing extending at least 3 inches above the growing media to prevent clogging. However, an adequate number of roof drains that are not immediately adjacent to the growing media must be provided so as to allow the roof to drain without 3 inches of ponding above the growing media.

#### **4.6.3 Green Roof Pretreatment Criteria**

Pretreatment is not necessary for green roofs.

#### **4.6.4 Green Roof Design Criteria Structural**

##### **Capacity of the Roof**

Green roofs can be limited by the additional weight of the fully saturated soil and plants, in terms of the physical capacity of the roof to bear structural loads. The designer shall consult with a licensed structural engineer to ensure that the building will be able to support the additional live and dead structural load and to determine the maximum depth of the green roof system and any needed structural reinforcement. Typically, the green roof manufacturer can provide specific background specifications and information on their product for planning and design.

In most cases, fully saturated extensive green roofs have loads of about 15 to 30 pounds per square foot, which is fairly similar to traditional new rooftops (12 to 15 pounds per square foot) that have a waterproofing layer anchored with stone ballast.

##### **Functional Elements of a Green Roof System**

A green roof is composed of up to nine different systems or layers that combine to protect the roof and maintain a vigorous cover (see Figure 4.21).

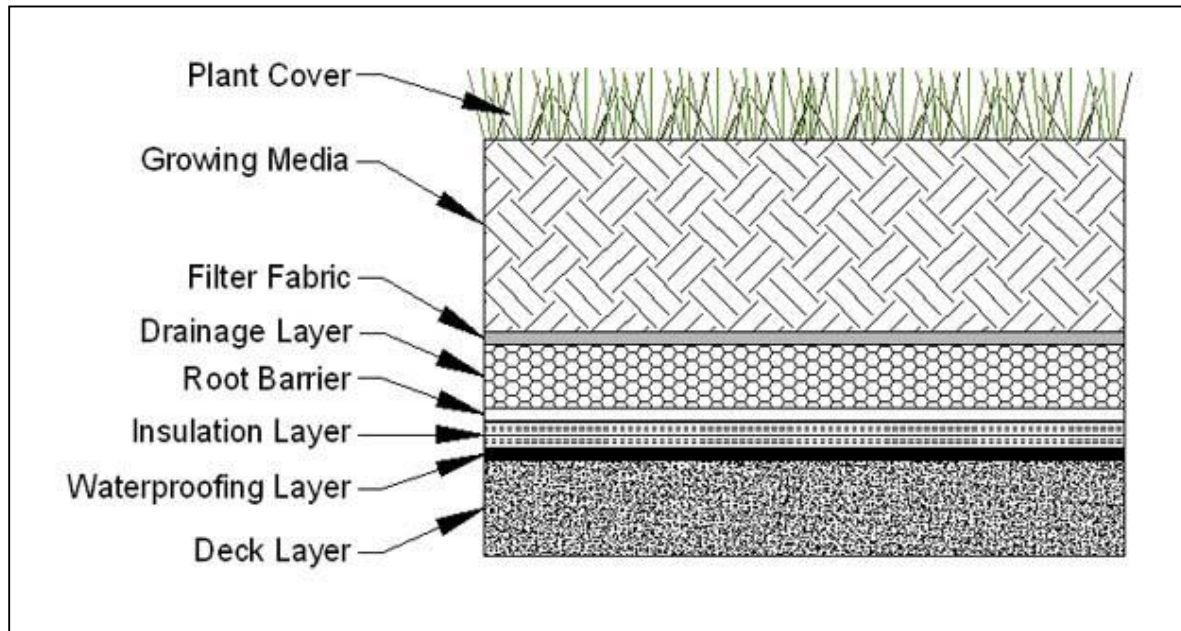


Figure 4.21. Green roof layers (note: the relative placement of various layers may vary depending on the type and design of the green roof system).

The design layers include the following:

1. **Deck Layer.** The roof deck layer is the foundation of a green roof. It may be composed of concrete, wood, metal, plastic, gypsum, or a composite material. The type of deck material determines the strength, load bearing capacity, longevity, and potential need for insulation in the green roof system.
2. **Leak Detection System (optional).** Leak detection systems are often installed above the deck layer to identify leaks, minimize leak damage through timely detection, and locate leak locations. Electric Field Vector Mapping (EFVM®) or other leak detection techniques are strongly recommended as part of the green roof installation process. In the case of EFVM, the deck material must be conductive. If it is not, an additional conductive medium may need to be added on top of the deck. Other leak detection systems may require additional materials between the deck layer and the waterproofing layer.
3. **Waterproofing Layer.** All green roof systems must include an effective and reliable waterproofing layer to prevent water damage through the deck layer. A wide range of waterproofing materials can be used, including hot applied rubberized asphalt, built up bitumen, modified bitumen, thermoplastic membranes, polyvinyl chloride (PVC), thermoplastic olefin membrane (TPO), and elastomeric membranes (EPDM) (see Weiler and Scholz-Barth, 2009, and Snodgrass and Snodgrass, 2006). The waterproofing layer must be 100% waterproof and have an expected life span as long as any other element of the green roof system. The waterproofing material may be loose laid or bonded (recommended). If loose laid, overlapping and additional construction techniques should be used to avoid water migration.
4. **Insulation Layer.** Many green rooftops contain an insulation layer, usually located above, but sometimes below, the waterproofing layer. The insulation increases the energy efficiency of the building and/or protects the roof deck (particularly for metal roofs). According to Snodgrass and Snodgrass (2006), the trend is to install insulation on the outside of the building, in part to avoid

mildew problems. The designer should consider the use of open or closed cell insulation depending on whether the insulation layer is above or below the waterproofing layer (and thus exposed to wetness), with closed cell insulation recommended for use above the waterproofing layer.

5. **Root Barrier.** Another layer of a green roof system, which can be either above or below the insulation layer depending on the system, is a root barrier that protects the waterproofing membrane from root penetration. Chemical root barriers or physical root barriers that have been impregnated with pesticides, metals, or other chemicals that could leach into stormwater runoff must be avoided in systems where the root barrier layer will come in contact with water or allow water to pass through the barrier.
6. **Drainage Layer and Drainage System.** A drainage layer is placed between the root barrier and the growing media to quickly remove excess water from the vegetation root zone. The selection and thickness of the drainage layer type is an important design decision that is governed by the desired stormwater storage capacity, the required conveyance capacity, and the structural capacity of the rooftop. The effective depth of the drainage layer is generally 0.25–1.5 inches thick for extensive green roof system and increases for intensive designs. The drainage layer should consist of synthetic or inorganic materials (e.g., 1–2-inch layer of clean, washed granular material (ASTM D448 size No. 8 stone or lightweight granular mix), high density polyethylene (HDPE)) that are capable of retaining water and providing efficient drainage (ASTM, 2017). A wide range of prefabricated water cups or plastic modules can be used, as well as a traditional system of protected roof drains, conductors, and roof leaders. ASTM E2396 and E2398 can be used to evaluate alternative material specifications (ASTM E2396, 2015 and ASTM E2398, 2015).
7. **Root-Permeable Filter Fabric.** A semi-permeable needled polypropylene filter fabric is normally placed between the drainage layer and the growing media to prevent the media from migrating into the drainage layer and clogging it. The filter fabric must not impede the downward migration of water into the drainage layer.
8. **Growing Media.** The next layer in an extensive green roof is the growing media, which is typically 3–8 inches deep. The recommended growing media for extensive green roofs is typically composed of approximately 70%–80% lightweight inorganic materials, such as expanded slates, shales or clays; pumice; scoria; or other similar materials. The media must contain no more than 30% organic matter, normally well-aged compost (see Appendix C Soil Compost Amendment Requirements). The percentage of organic matter should be limited, since it can leach nutrients into the runoff from the roof and clog the permeable filter fabric. It is advisable to mix the media in a batch facility prior to delivery to the roof. Manufacturer's specifications should be followed for all proprietary roof systems.

The composition of growing media for intensive green roofs may be different (although the organic material limit still applies), and it is often much greater in depth (e.g., 8–48 inches). If trees are included in the green roof planting plan, the growing media must be sufficient to provide enough soil volume for the root structure of mature trees.

9. **Plant Cover.** The top layer of an extensive green roof typically consists of plants that are slow-growing, shallow-rooted, perennial, and succulent. These plants are chosen for their ability to withstand harsh conditions at the roof surface. Guidance on selecting the appropriate green roof plants can often be provided by green roof manufacturers and can also be found in Snodgrass and Snodgrass (2006). A mix of base ground covers (usually *Sedum* species) and accent plants can be used to enhance the visual amenity value of a green roof. See Section 4.6.4 Green Roof Design Criteria for additional plant information. The design must provide for temporary, manual, and/or



permanent irrigation or watering systems, depending on the green roof system and types of plants. For most applications, some type of watering system should be accessible for initial establishment or drought periods. The use of water efficient designs and/or use of non-potable sources are strongly encouraged.

### **Material Specifications**

Standard specifications for North American green roofs continue to evolve, and no universal material specifications exist that cover the wide range of roof types and system components currently available. The ASTM has recently issued several overarching green roof standards, which are described and referenced in Table 4.22 below.

Designers and reviewers should also fully understand manufacturer specifications for each system component, particularly if they choose to install proprietary “complete” green roof systems or modules.

Table 4.22. Extensive Green Roof Material Specifications

Material	Specification
Roof	Structural capacity must conform to ASTM E2397, <i>Standard Practice for Determination of Dead Loads and Live Loads Associated with Vegetative (Green) Roof Systems</i> . In addition, use standard test methods ASTM E2398, <i>Standard Test Method for Water Capture and Media Retention of Geocomposite Drain Layers for Vegetated (Green) Roof Systems</i> and ASTM E2399, <i>Standard Test Method for Maximum Media Density for Dead Load Analysis of Vegetative (Green) Roof Systems</i> .
Leak Detection System	Optional system to detect and locate leaks in the waterproof membrane.
Waterproof Membrane	See Chapter 6 of Weiler and Scholz-Barth (2009) for waterproofing options that are designed to convey water horizontally across the roof surface to drains or gutter. This layer may sometimes act as a root barrier.
Root Barrier	Impermeable liner that impedes root penetration of the membrane.
Drainage Layer	Depth of the drainage layer is generally 0.25–1.5 inches thick for extensive designs. The drainage layer should consist of synthetic or inorganic materials (e.g., gravel, HDPE, etc.) that are capable of retaining water and providing efficient drainage. A wide range of prefabricated water cups or plastic modules can be used, as well as a traditional system of protected roof drains, conductors, and roof leaders. Designers should consult the material specifications as outlined in ASTM E2396 and E2398. Roof drains and emergency overflow must be designed in accordance with the local construction codes.

Material	Specification
Filter Fabric	<p>Generally, needle-punched, non-woven, polypropylene geotextile, with the following qualities:</p> <ul style="list-style-type: none"> <li>▪ Strong enough and adequate puncture resistance to withstand stresses of installing other layers of the green roof. Density as per ASTM D3776 <math>\geq 8</math> oz/yd<sup>2</sup>. Puncture resistance as per ASTM D4833 <math>\geq 130</math> lb. These values can be reduced with submission of a Product Data Sheet and other documentation that demonstrates applicability for the intended use.</li> <li>▪ Adequate tensile strength and tear resistance for long-term performance.</li> <li>▪ Allows a good flow of water to the drainage layer. Apparent Opening Size, as per ASTM D4751, of <math>\geq 0.06\text{mm} \leq 0.2\text{mm}</math>, with other values based on Product Data Sheet and other documentation as noted above.</li> <li>▪ Allows at least fine roots to penetrate.</li> <li>▪ Adequate resistance to soil borne chemicals or microbial growth both during construction and after completion since the fabric will be in contact with moisture and possibly fertilizer compounds.</li> </ul>
Growth Media	<p>70%–80% lightweight inorganic materials and a maximum of 30% organic matter (e.g., well-aged compost). Material makeup of the growing media must be provided. Media must provide sufficient nutrient and water holding capacity to support the proposed plant materials. Determine acceptable saturated water permeability using ASTM E2396. An acceptable emerging industry practice combines the drainage layer with the growing media layer.</p>
Plant Materials	<p><i>Sedum</i>, herbaceous plants, and perennial grasses that are shallow-rooted, low maintenance, and tolerant of full and direct sunlight, drought, wind, and frost. See ASTM E2400, <i>Standard Guide for Selection, Installation, and Maintenance of Plants for Green Roof Systems</i>.</p>

### **Solar Panels and Other Structures**

Occasionally, structures such as solar panels or HVAC systems must be installed above a green roof. These structures can be incorporated into a green roof design with no adverse effects to the retention credit assigned to the green roof if specific design requirements for runoff disbursement, maintenance access, and sun/wind exposure are incorporated, including the following:

- Structures above the green roof must be no more than 6.5 feet wide.
- Structures must have a minimum 3-foot separation between them.
- The lower edge of the structure must be at least 1 foot above the top of the green roof, and the upper edge must be at least 2.5 feet above the top of the green roof. This allows for at least a 15-degree tilt. For flatter installations, the lower edge would need to be raised to ensure that the 2.5-foot minimum for the upper edge is met.

These design requirements are illustrated in Figure 4.22.

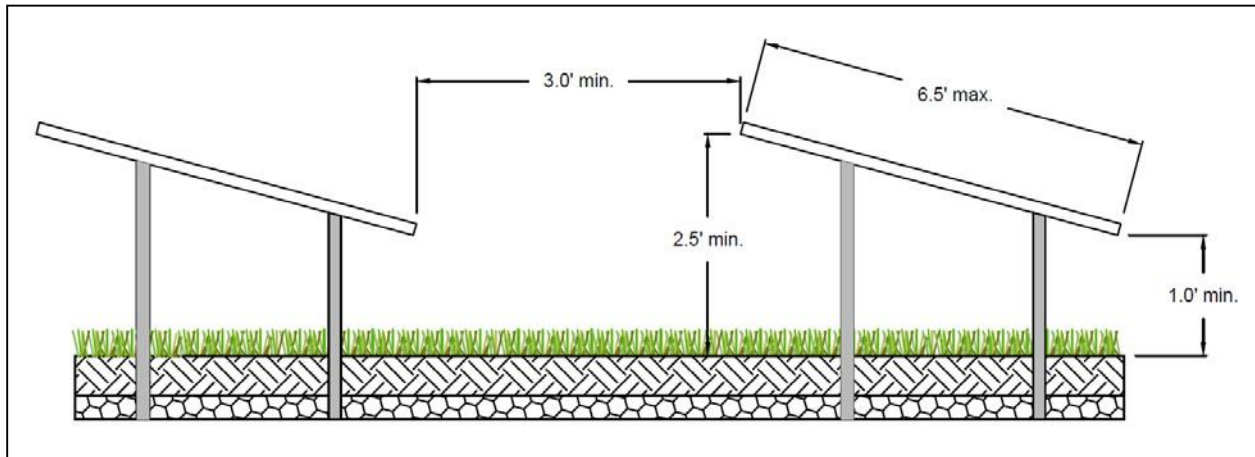


Figure 4.22. Design requirements for structures constructed above green roofs.

### **Green Roof Sizing**

Green roof areas can be designed to capture the entire Stormwater Retention Volume (SWR<sub>v</sub>). In some cases, they could be designed to capture larger design storm volumes as well. The required size of a green roof will depend on several factors, including maximum water retention of the growing media and the underlying drainage and storage layer materials, if present (e.g., prefabricated water cups or plastic modules). As maximum water retention can vary significantly between green roof products, verification of this value must be included with the Stormwater Management Plan (SWMP). Verification shall be provided by an ASTM-certified lab using the methods described by ASTM tests E2396, E2397, E2398, or E2399, as appropriate. In the absence of laboratory test results, the baseline default values must be used. Equation 4.12 below shall be used to determine the storage volume retained by a green roof.

Equation 4.12. Storage Volume for Green Roofs

$$S_v = \frac{SA \times [(d \times MWR_1) + (DL \times MWR_2)]}{12} \times IF$$

Where:

- $S_v$  = green roof storage volume (ft<sup>3</sup>)
- $SA$  = green roof area (ft<sup>2</sup>)
- $d$  = media depth (in.) (minimum 3 in.)
- $MWR_1$  = verified media maximum water retention (use 0.10 as a baseline default in the absence of verification data)
- $DL$  = drainage layer depth (in.) (if the drainage layer is combined with the media layer, then this value is 0)
- $MWR_2$  = verified drainage layer maximum water retention (use 0.0 as a baseline default in the absence of verification data)
- $IF$  = irrigation factor (0.5 for irrigated green roofs, 1.0 for unirrigated green roofs)

The appropriate  $S_v$  can then be compared to the required SWR<sub>v</sub> for the entire rooftop area (including all conventional roof areas) to determine the portion of the design storm captured.

Green roofs can have dramatic rate attenuation effects on larger storm events and may be used, in part, to manage a portion of the 2- to 25-year events. Designers can model various approaches by factoring in storage within the drainage layer. Routing calculations can also be used to provide a more accurate solution of the peak discharge and required storage volume.

#### 4.6.5 Green Roof Landscaping Criteria

Plant selection, landscaping, and maintenance are critical to the performance and function of green roofs. Therefore, a landscaping plan shall be provided for green roofs.

A planting plan must be prepared for a green roof by a landscape architect, botanist, or other professional experienced with green roofs and submitted with the SWMP.

Plant selection for green roofs is an integral design consideration, which is governed by local climate and design objectives. The primary ground cover for most green roof installations is a hardy, low-growing succulent, such as *Sedum*, *Delosperma*, *Talinum*, *Semperivum*, or *Hieracium* that is matched to the local climate conditions and can tolerate the difficult growing conditions found on building rooftops (Snodgrass and Snodgrass, 2006).

A list of some common green roof plant species that work well in the can South Lowcountry region be found in Table 4.23 below.

Table 4.23. Ground Covers Appropriate for Green Roofs in the State of South Carolina

Plant	Light	Moisture Requirement	Notes
<i>Delosperma cooperii</i>	Full Sun	Dry	Pink flowers; grows rapidly
<i>Delosperma</i> 'Kelaidis'	Full Sun	Dry	Salmon flowers; grows rapidly
<i>Delosperma nubigenum</i> 'Basutoland'	Full Sun	Moist-Dry	Yellow flowers; very hardy
<i>Sedum album</i>	Full Sun	Dry	White flowers; hardy
<i>Sedum lanceolatum</i>	Full Sun	Dry	Yellow flowers; native to U.S.
<i>Sedum oreganum</i>	Part Shade	Moist	Yellow flowers; native to U.S.
<i>Sedum stoloniferum</i>	Sun	Moist	Pink flowers; drought tolerant
<i>Sedum telephiodes</i>	Sun	Dry	Blue green foliage; native to region
<i>Sedum ternatum</i>	Part Shade	Dry-Moist	White flowers; grows in shade
<i>Talinum calycinum</i>	Sun	Dry	Pink flowers; self-sows

*Note: Designers should choose species based on shade tolerance, ability to sow or not, foliage height, and spreading rate. See Snodgrass and Snodgrass (2006) for a definitive list of green roof plants, including accent plants.*

- Plant choices can be much more diverse for deeper intensive green roof systems. Herbs, forbs, grasses, shrubs, and even trees can be used, but designers should understand they may have higher watering, weeding, and landscape maintenance requirements.
- The species and layout of the planting plan must reflect the location of the building, in terms of its height, exposure to wind, heat stress, orientation to the sun, and impacts from surrounding buildings. Wind scour and solar burning have been observed on green roof installations that failed to adequately account for neighboring building heights and surrounding window reflectivity. In addition, plants must be selected that are fire resistant and able to withstand heat, cold, and high winds.
- Designers should also match species to the expected rooting depth of the growing media, which can also provide enough lateral growth to stabilize the growing media surface. The planting plan should usually include several accent plants to provide diversity and seasonal color. For a comprehensive resource on green roof plant selection, consult Snodgrass and Snodgrass (2006).
- It is also important to note that most green roof plant species will not be native to the Chesapeake Bay watershed (which contrasts with native plant recommendations for other stormwater practices, such as bioretention and constructed wetlands).
- Given the limited number of green roof plant nurseries in the region, it may be necessary for designers to order plants 6 to 12 months prior to the expected planting date. It is also advisable to have plant materials contract grown.
- Plants can be established using cuttings, plugs, mats, and, more rarely, containers. Several vendors also sell mats, rolls, or proprietary green roof planting modules. For the pros and cons of each method, see Snodgrass and Snodgrass (2006). To achieve 50% coverage after 1 year and 80% coverage after 2 years, the recommended minimum spacing for succulent plantings is 2 plugs per square foot and 10 pounds per 100 square feet.
- When planting cuttings, plugs, and mats, the planting window extends from the spring to early fall; although, it is important to allow plants to root thoroughly before the first killing frost. Green roof manufacturers and plant suppliers may provide guidance on planting windows as well as winter care. Proper planting and care may also be required for plant warranty eligibility.
- When appropriate species are selected, most green roofs will not require supplemental irrigation, except for temporary irrigation during drought or initial establishment. The use of water-efficient designs and/or use of non-potable sources is strongly encouraged. Permanent irrigation of extensive roof designs is prohibited. For intensive roofs, permanent irrigation may be included. However, permanent irrigation can adversely impact the rainfall retention capacity of the green roof. For this reason, soil moisture monitors are a required part of the irrigation system for all irrigated green roofs, and the calculated storage volume for green roofs with permanent irrigation must be reduced by 50%.
- The goal for green roof systems designed for stormwater management is to establish a full and vigorous cover of low-maintenance vegetation that is self-sustaining (not requiring fertilizer inputs) and requires minimal mowing, trimming, and weeding.

The green roof design should include non-vegetated walkways (e.g., paver blocks) to allow for easy access to the roof for weeding and making spot repairs (see Section 4.6.4 Green Roof Design Criteria).

#### 4.6.6 Green Roof Construction Sequence Green

##### Roof Installation

Given the diversity of extensive vegetated roof designs, there is no typical step-by-step construction sequence for proper installation. The following general construction considerations are noted:

- Construct the roof deck with the appropriate slope and material.
- Install the waterproofing method, according to manufacturer's specifications.
- Conduct electric field vector mapping (EVFM®) or flood testing to ensure the system is watertight. Where possible, EVFM® is strongly recommended over the flood test, but not all impermeable membranes and deck systems are compatible with this method. Problems have been noted with the use of EFVM on black ethylene propylene diene terpolymer (EPDM) and with aluminized protective coatings commonly used in conjunction with modified bituminous membranes. If EVFM® or other leak detection systems are not possible, a flood test should be performed instead. The flood test is done by placing at least 2 inches of water over the membrane for 48 hours to confirm the integrity of the waterproofing system.
- Add additional system components (e.g., insulation, root barrier, drainage layer and interior drainage system, and filter fabric) per the manufacturer's specifications, taking care not to damage the waterproofing. Any damage occurring must be reported immediately. Drain collars and protective flashing should be installed to ensure free flow of excess stormwater.
- The growing media should be mixed prior to delivery to the site. Media must be spread evenly over the filter fabric surface as required by the manufacturer. If a delay between the installation of the growing media and the plants is required, adequate efforts must be taken to secure the growing media from erosion and the seeding of weeds. The growing media must be covered and anchored in place until planting. Sheets of exterior grade plywood can also be laid over the growing media to accommodate foot or wheelbarrow traffic. Foot traffic and equipment traffic should be limited over the growing media to reduce compaction beyond manufacturer's recommendations.
- The growing media should be moistened prior to planting, and then planted with the ground cover and other plant materials, per the planting plan or in accordance with ASTM E2400 (2015). Plants should be watered immediately after installation and routinely during establishment.
- It generally takes 2 to 3 growing seasons to fully establish the vegetated roof. The growing medium should contain enough organic matter to support plants for the first growing season, so initial fertilization is not required. Extensive green roofs may require supplemental irrigation during the first few months of establishment. Hand weeding is also critical in the first 2 years (see Table 10.1 of Weiler & Scholz-Barth (2009) for a photo guide of common rooftop weeds).
- Most construction contracts should contain a care and replacement warranty that specifies at least 50% coverage after 1 year and 80% coverage after 2 years for plugs and cuttings, and 90% coverage after 1 year for *Sedum* carpet/tile.

##### Construction Supervision

Supervision during construction is recommended to ensure that the vegetated roof is built in accordance with these specifications. Inspection checklists should be used that include sign-offs by qualified individuals at critical stages of construction and confirm that the contractor's interpretation of the plan is consistent with the intent of the designer and/or manufacturer.

An experienced installer should be retained to construct the vegetated roof system. The vegetated roof should be constructed in sections for easier inspection and maintenance access to the membrane and roof drains. Careful construction supervision/inspection is needed throughout the installation of a vegetated roof, as follows:

- During placement of the waterproofing layer, to ensure that it is properly installed and watertight.
- During placement of the drainage layer and drainage system.
- During placement of the growing media, to confirm that it meets the specifications and is applied to the correct depth (certification for vendor or source should be provided).
- Upon installation of plants, to ensure they conform to the planting plan (certification from vendor or source should be provided).
- Before issuing use and occupancy approvals.
- At the end of the first or second growing season to ensure desired surface cover specified in the Care and Replacement Warranty has been achieved.

Construction phase inspection checklist for green roof practices can be found in Appendix E Construction Inspection Checklists.

#### **4.6.7 Green Roof Maintenance Criteria**

##### **Maintenance Inspections**

A green roof should be inspected by a qualified professional twice a year during the growing season to assess vegetative cover and to look for leaks, drainage problems, and any rooftop structural concerns (see Table 4.24). In addition, the green roof should be hand weeded to remove invasive or volunteer plants, and plants and/or media should be added to repair bare areas (refer to ASTM E2400; ASTM, 2015).

If a roof leak is suspected, it is advisable to perform an electric leak survey (e.g., EVFM<sup>®</sup>), if applicable, to pinpoint the exact location, make localized repairs, and then reestablish system components and ground cover.

The use of herbicides, insecticides, and fungicides should be avoided, since their presence could hasten degradation of some waterproofing membranes. Check with the membrane manufacturer for approval and warranty information. Also, power washing and other exterior maintenance operations should be avoided so that cleaning agents and other chemicals do not harm the green roof plant communities.

Fertilization is generally not recommended due to the potential for leaching of nutrients from the green roof. Supplemental fertilization may be required following the first growing season, but only if plants show signs of nutrient deficiencies and a media test indicates a specific deficiency. Addressing this issue with the holder of the vegetation warranty is recommended. If fertilizer is to be applied, it must be a slow-release type, rather than liquid or gaseous form.

Maintenance inspection checklist for green roofs and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Table 4.24. Typical Maintenance Activities Associated with Green Roofs

Schedule (following construction)	Activity
As needed or As required by manufacturer	<ul style="list-style-type: none"> <li>Water to promote plant growth and survival.</li> <li>Inspect the green roof and replace any dead or dying vegetation.</li> </ul>
Semi-annually	<ul style="list-style-type: none"> <li>Inspect the waterproof membrane for leaks and cracks.</li> <li>Weed to remove invasive plants and tree seedlings (do not dig or use pointed tools where there is potential to harm the root barrier or waterproof membrane).</li> <li>Inspect roof drains, scuppers, and gutters to ensure they are not overgrown and have not accumulated organic matter deposits. Remove any accumulated organic matter or debris.</li> <li>Inspect the green roof for dead, dying, or invasive vegetation. Plant replacement vegetation as needed.</li> </ul>

**Waste Material**

Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

**4.6.8 Green Roof Stormwater Compliance Calculations**

Green roofs are credited with 100% retention for the storage volume (Sv) provided by the practice as well as 100% TSS, TN, and bacteria removal (see Table 4.25).

Table 4.25. Retention and pollutant removal of green roofs.

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

The practice must be designed using the guidance detailed in Section 4.6.4 Green Roof Design Criteria.

Green roofs also contribute to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume (Sv) from the total runoff volume for the design storms. The resulting reduced runoff volumes can then be used to calculate a reduced Natural Resource Conservation Service (NRCS) curve number (CN) for the site or site drainage area (SDA). The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.



#### 4.7 Rainwater Harvesting

Rainwater Harvesting				
<b>Definition:</b> Rainwater harvesting systems store rainfall and release it for future use. Rainwater that falls on a rooftop or other impervious surface is collected and conveyed into an above- or below-ground tank (also referred to as a cistern) or settling pond, where it is stored for non-potable uses.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		Varies*	Varies*	Varies*
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
Low to Moderate	Moderate	Varies*		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	100% of Available Storage Volume		
Quarterly	Every 3 years			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Reduces runoff rates and volume</li><li>▪ Can provide for/supplement irrigation needs</li></ul>		<ul style="list-style-type: none"><li>▪ Stored water must be used on regular basis to maintain capacity</li><li>▪ Stagnant water can breed mosquitos</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Pretreatment</li><li>▪ Conveyance</li><li>▪ First flush diverter</li><li>▪ Cistern (storage tank)</li><li>▪ Overflow</li><li>▪ Low water cutoff</li></ul>		<ul style="list-style-type: none"><li>▪ Plumbing codes (for indoor tanks)</li><li>▪ Size based on CDA, local rainfall patterns, and projected harvest rainwater demand</li><li>▪ Location and elevation of cistern</li><li>▪ Tank manufacturer’s specifications</li><li>▪ Irrigation system and application rates</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Inspect/clean pretreatment devices and first flush diverts</li><li>▪ Clear gutter/downspouts</li></ul>		<ul style="list-style-type: none"><li>▪ Inspect and clean storage tank</li><li>▪ Maintenance log required</li></ul>		

<sup>1</sup>Credited pollutant load removal

\*Varies according to rainwater harvesting storage capacity and demand

Rainwater harvesting systems store rainfall for future, non-potable water uses and on-site stormwater disposal/infiltration. By providing a reliable and renewable source of water to end users, rainwater harvesting systems can also have environmental and economic benefits beyond stormwater management (e.g. increased water conservation, water supply during drought and mandatory municipal water supply restrictions, decreased demand on municipal or groundwater supply, decreased water costs for the end-user, potential for increased groundwater recharge, supply of water post storm/hurricane in case of failed municipal infrastructure etc.).

### **Definition**

Rainwater harvesting systems store rainfall and release it for future use. Rainwater that falls on a rooftop or other impervious surface is collected and conveyed into an above- or below-ground tank (also referred to as a cistern) or settling pond where it is stored for non-potable uses or for on-site disposal or infiltration as stormwater. Cisterns can be sized for commercial as well as residential purposes (see Figure 4.23). Residential cisterns are commonly called rain barrels.



Figure 4.23. Example cistern application (photo: Marty Morganello).

The design includes the following:

#### R-1 Rainwater harvesting for non-potable uses

Non-potable uses of harvested rainwater may include the following:

- Landscape irrigation,
- Exterior washing (e.g., car washes, building facades, sidewalks, street sweepers, and fire trucks),
- Flushing of toilets and urinals,
- Fire suppression (e.g., sprinkler systems),
- Supply for cooling towers, evaporative coolers, fluid coolers, and chillers,
- Supplemental water for closed loop systems and steam boilers,
- Replenishment of water features and water fountains,
- Distribution to a green wall or living wall system, and
- Laundry.

Rainwater stored in a settling pond may only be used for landscape irrigation. Pond design criteria in Section 4.10 and landscaping criteria of Section 4.5.5 shall be followed.

The seven primary components of an enclosed rainwater harvesting system are discussed in detail in Section 4.5.4 Rainwater Harvesting Design Criteria. Some are depicted in Figure 4.25 . The components include the following:

- CDA surface,
- Collection and conveyance system (e.g., gutter and downspouts; number 1 in Figure 4.24)
- Pretreatment, including prescreening and first flush diverters (number 2 in Figure 4.24)
- Cistern (no number, but depicted in Figure 4.24)
- Water quality treatment (as required by Appendix J Rainwater Harvesting Treatment and Management Requirements)
- Distribution system
- Overflow, filter path, or secondary stormwater retention practice (number 8 in Figure 4.24)

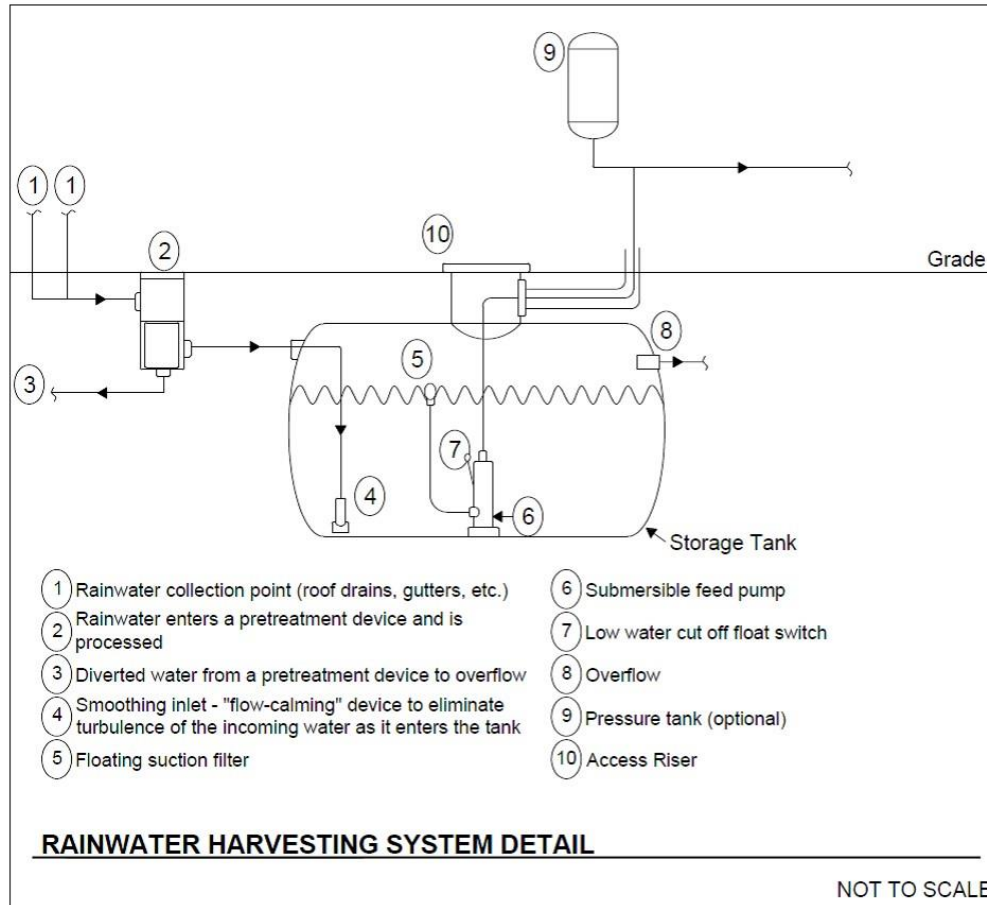


Figure 4.24. Example of a rainwater harvesting system detail.

#### 4.7.1 Rainwater Harvesting Feasibility Criteria

Several site-specific features influence how rainwater harvesting systems are designed and/or utilized. The following are key considerations for rainwater harvesting feasibility. They are not comprehensive or conclusive; rather, they are recommendations to consider during the planning process to incorporate rainwater harvesting systems into the site design.

##### **Plumbing Code**

Designers and plan reviewers should consult with local construction codes to determine the allowable indoor uses and required treatment for harvested rainwater. This specification does not address indoor plumbing or disinfection issues. Designers and plan reviewers should refer to the 2012 Uniform Plumbing Code - Chapter 17 Non-potable Rainwater Catchment Systems, or local plumbing codes, as applicable.

##### **Mechanical, Electrical, Plumbing**

For systems that call for indoor use of harvested rainwater, the seal of a mechanical, electrical, and plumbing engineer is required.

##### **Water Use**

When rainwater harvesting will be used, the requirements in Appendix J Rainwater Harvesting Treatment and Management Requirements must be followed. This will outline the design assumptions and provide water quality end use standards.

### **Available Space**

Adequate space is needed to house the cistern and any overflow. Space limitations are rarely a concern with rainwater harvesting systems if they are considered during the initial building design and site layout of a residential or commercial development. Cisterns can be placed underground, indoors, adjacent to buildings, and on rooftops that are structurally designed to support the added weight. Designers can work with architects and landscape architects to creatively site the cisterns. Underground utilities or other obstructions should always be identified prior to final determination of the cistern location.

### **Site Topography**

Site topography and cistern location should be considered as they relate to every inlet and outlet invert elevation in the rainwater harvesting system.

The final invert of the cistern outlet pipe at the discharge point must match the invert of the receiving mechanism (e.g., natural channel, storm drain system) and be sufficiently sloped to adequately convey this overflow. The elevation drops associated with the various components of a rainwater harvesting system and the resulting invert elevations should be considered early in the design, to ensure that the rainwater harvesting system is feasible for the particular site.

Site topography and cistern location will also affect pumping requirements. Locating cisterns in low areas will make it easier to get water into the cisterns; however, it will increase the amount of pumping needed to distribute the harvested rainwater back into the building or to irrigated areas situated on higher ground. Conversely, placing cisterns at higher elevations may require larger diameter pipes with smaller slopes but will generally reduce the amount of pumping needed for distribution. It is often best to locate a cistern close to the building or SDA, to limit the amount of pipe needed.

### **Available Hydraulic Head**

The required hydraulic head depends on the intended use of the water. For residential landscaping uses, the cistern may be sited up-gradient of the landscaping areas or on a raised stand. Pumps are commonly used to convey stored rainwater to the end use to provide the required head. When the water is being routed from the cistern to the inside of a building for non-potable use, often a pump is used to feed a much smaller pressure tank inside the building, which then serves the internal water demands. Cisterns can also use gravity to accomplish indoor residential uses (e.g., laundry) that do not require high water pressure.

### **Water Table**

Underground storage tanks are most appropriate in areas where the tank can be buried above the water table. The tank should be located in a manner that does not subject it to flooding. In areas where the tank is to be buried partially below the water table, special design features must be employed, such as sufficiently securing the tank (to keep it from floating) and conducting buoyancy calculations when the tank is empty. The tank may need to be secured appropriately with fasteners or weighted to avoid uplift buoyancy. The combined weight of the tank and hold-down ballast must meet or exceed the buoyancy force of the cistern. The cistern must also be installed according to the cistern manufacturer's specifications.

### **Soils**

Cisterns should only be placed on native soils or on fill in accordance with the manufacturer's guidelines. The bearing capacity of the soil upon which the cistern will be placed must be considered, as full cisterns can be very heavy. This is particularly important for above-ground cisterns, as significant settling could

cause the cistern to lean or in some cases to potentially topple. A sufficient aggregate, or concrete foundation, may be appropriate depending on the soils and cistern characteristics. Where the installation requires a foundation, the foundation must be designed to support the cistern's weight when the cistern is full, consistent with the bearing capacity of the soil and good engineering practice. The pH of the soil should also be considered in relation to its interaction with the cistern material.

### **Proximity of Underground Utilities**

All underground utilities must be taken into consideration during the design of underground rainwater harvesting systems, treating all of the rainwater harvesting system components and storm drains as typical stormwater facilities and pipes. The underground utilities must be marked and avoided during the installation of underground cisterns and piping associated with the system.

### **Contributing Drainage Area**

The CDA to the cistern is the area draining to the cistern. Rooftop surfaces are what typically make up the CDA, but paved areas can be used with appropriate treatment (oil/water separators and/or debris excluders).

### **Contributing Drainage Area Material**

The quality of the harvested rainwater will vary according to the roof material or CDA over which it flows. Water harvested from certain types of rooftops and CDAs, such as asphalt sealcoats, tar and gravel, painted roofs, galvanized metal roofs, sheet metal, or any material that may contain asbestos may leach trace metals and other toxic compounds. In general, harvesting rainwater from such surfaces should be avoided. If harvesting from a sealed or painted roof surface is desired, it is recommended that the sealant or paint be certified for such purposes to the NSF International NSF Protocol P151 standard.

### **Water Quality of Rainwater**

Designers should also note that the pH of rainfall in the State tends to be acidic (ranging from 4.5 to 5.0), which may result in leaching of metals from roof surfaces, cistern lining, or water laterals, to interior connections. Once rainfall leaves rooftop surfaces, pH levels tend to be slightly higher, ranging from 5.5 to 6.0. Limestone or other materials may be added in the cistern to buffer acidity, if desired.

### **Pollutant Hotspot Land Uses**

Harvesting rainwater can be an effective method to prevent contamination of rooftop runoff that would result from its mixing with ground-level runoff from a stormwater hotspot operation.

### **Setbacks from Buildings**

Cistern overflow devices must be designed to avoid causing ponding or soil saturation within 10 feet of building foundations. While most systems are generally sited underground and more than 10 feet laterally from the building foundation wall, some cisterns are incorporated into the basement of a building or underground parking areas. In any case, cisterns must be designed to be watertight to prevent water damage when placed near building foundations.

### **Vehicle Loading**

Whenever possible, underground rainwater harvesting systems should be placed in areas without vehicle traffic or other heavy loading, such as deep earth fill. If site constraints dictate otherwise, systems must be designed to support the loads to which they will be subjected.

### **Feasibility**

Rainwater harvesting systems are very well suited to the warm environment of South Carolina and may help to relieve some of the pressure on drinking water aquifers, if applied on a wide scale. In areas with a high-water table, above ground installations will often be more appropriate.

### **Economic Considerations**

Rainwater harvesting systems can provide cost savings by replacing or augmenting municipal water supply needs.

#### **4.7.2 Rainwater Harvesting Conveyance Criteria Collection and Conveyance**

The collection and conveyance systems consist of the gutters, downspouts, and pipes that channel rainfall into cisterns. Gutters and downspouts should be designed as they would for a building without a rainwater harvesting system.

Pipes, which connect downspouts to the cistern, should be at a minimum slope of 1.5% and sized/ designed to convey the intended design storm, as specified above. In some cases, a steeper slope and larger sizes may be recommended and/or necessary to convey the required runoff, depending on the design objective and design storm intensity. Gutters and downspouts should be kept clean and free of debris and rust.

### **Overflow**

An overflow mechanism must be included in the rainwater harvesting system design in order to handle an individual storm event or multiple storms in succession that exceed the capacity of the cistern. The overflow pipe(s) must have a capacity greater than or equal to the inflow pipe(s) and have a diameter and slope sufficient to drain the cistern while maintaining an adequate freeboard height. The overflow pipe(s) must be screened to prevent access to the cistern by small mammals and birds and must include a backflow preventer if it connects directly to the combined sewer or storm sewer. All overflow from the system must be directed to an acceptable flow path that will not cause erosion during a 2-year storm event.

#### **4.7.3 Rainwater Harvesting Pretreatment Criteria**

Prefiltration is required to keep sediment, leaves, contaminants, and other debris from the system. Leaf screens and gutter guards meet the minimal requirement for prefiltration of small systems, although direct water filtration is preferred. The purpose of prefiltration is to significantly cut down on maintenance by preventing organic buildup in the cistern, thereby decreasing microbial food sources.

Various pretreatment devices are described below. In addition to the initial first flush diversion, filters have an associated efficiency curve that estimates the percentage of rooftop runoff that will be conveyed through the filter to the cistern. If filters are not sized properly, a large portion of the rooftop runoff may be diverted and not conveyed to the cistern at all. A design intensity of 1 inch per hour (for design storm = SWRV) must be used for the purposes of sizing pre-cistern conveyance and filter components. This design intensity captures a significant portion of the total rainfall during a large majority of rainfall events (NOAA, 2004). If the system will be used for channel and flood protection, the 2- to 25-year storm intensities must be used for the design of the conveyance and pretreatment portion of the system. The Appendix K Rainwater Harvesting Storage Volume Calculator, discussed in Section 4.7.4-Rainwater Harvesting Design Criteria, allows for input of variable filter efficiency rates for the

design storm. To meet the requirements to manage the 2- to 25-year storms, a minimum filter efficiency of 90% must be met.

- **First Flush Diverters.** First flush diverters (see Figure 4.25) direct the initial pulse of rainfall away from the cistern. While leaf screens effectively remove larger debris such as leaves, twigs, and blooms from harvested rainwater, first flush diverters can be used to remove smaller contaminants such as dust, pollen, and bird and rodent feces.
- **Leaf Screens.** Leaf screens are mesh screens installed over either the gutter or downspout to separate leaves and other large debris from rooftop runoff. Leaf screens must be regularly cleaned to be effective; if not maintained, they can become clogged and prevent rainwater from flowing into the cisterns. Built-up debris can also harbor bacterial growth within gutters or downspouts (Texas Water Development Board, 2005).
- **Roof Washers.** Roof washers are placed just ahead of cisterns and are used to filter small debris from harvested rainwater (see Figure 4.26). Roof washers consist of a cistern, usually between 25 and 50 gallons in size, with leaf strainers and a filter with openings as small as 30 microns. The filter functions to remove very small particulate matter from harvested rainwater. All roof washers must be cleaned on a regular basis.
- **Hydrodynamic Separator.** For large-scale applications, hydrodynamic separators and other devices can be used to filter rainwater from larger CDAs.

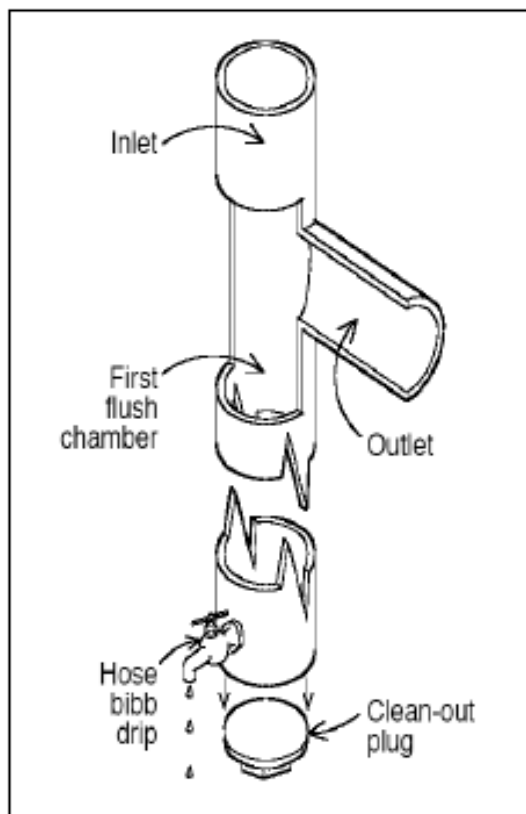


Figure 4.25. Diagram of a first flush diverter (photo: Texas Water Development Board, 2005).



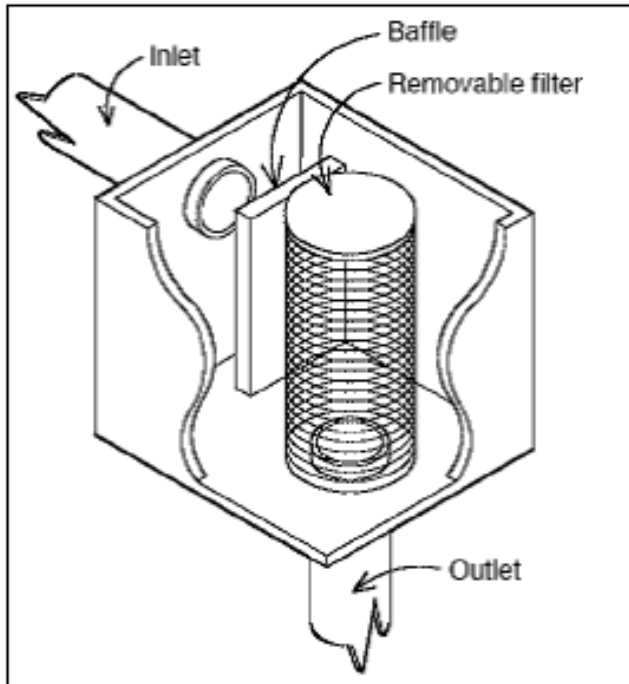


Figure 4.26. Diagram of a roof washer (photo: Texas Water Development Board, 2005).

#### 4.7.4 Rainwater Harvesting Design Criteria

System Components: Seven primary components of a rainwater harvesting system require special considerations:

- ❑ CDA or CDA surface
- ❑ Collection and conveyance system (i.e., gutter and downspouts)
- ❑ Cisterns (Storage Tank)
- ❑ Pretreatment, including prescreening and first flush diverters
- ❑ Water quality treatment (as described in Appendix J Rainwater Harvesting Treatment and Management Requirements)
- ❑ Distribution systems
- ❑ Overflow, filter path, or secondary stormwater retention practice

The system components are discussed below:

##### **CDA Surface**

When considering CDA surfaces, smooth, non-porous materials will drain more efficiently. Slow drainage of the CDA leads to poor rinsing and a prolonged first flush, which can decrease water quality.

Rainwater can also be harvested from other impervious surfaces, such as parking lots and driveways; however, this practice requires more extensive pretreatment and treatment prior to use.

### **Collection and Conveyance System**

See Section 1544.7.2 Rainwater Harvesting Conveyance Criteria.

### **Pretreatment**

See Section 4.7.3 Rainwater Harvesting Pretreatment Criteria.

### **Cisterns (Storage Tank)**

Also known as the storage tank, the cistern is the most important and typically the most expensive component of a rainwater harvesting system. Cistern capacities generally range from 250 to 30,000 gallons, but they can be as large as 100,000 gallons or more for larger projects. Multiple cisterns can be placed adjacent to each other and connected with pipes to balance water levels and to tailor the storage volume needed. Typical rainwater harvesting system capacities for residential use range from 1,500 to 5,000 gallons. Cistern volumes are calculated to meet the water demand and stormwater storage volume retention objectives, as described further below in this specification.

While many of the graphics and photos in this specification depict cisterns with a cylindrical shape, the cisterns can be made of many materials and configured in various shapes, depending on the type used and the site conditions where the cisterns will be installed. For example, configurations can be rectangular, L-shaped, or step vertically to match the topography of a site. The following factors should be considered when designing a rainwater harvesting system and selecting a cistern:

- Aboveground cisterns should be ultraviolet and impact resistant.
- Underground cisterns must be designed to support the overlying sediment and any other anticipated loads (e.g., vehicles, pedestrian traffic).
- Underground rainwater harvesting systems must have a standard size manhole or equivalent opening to allow access for cleaning, inspection, and maintenance purposes. The access opening must be installed in such a way as to prevent surface- or groundwater from entering through the top of any fittings, and it must be secured/locked to prevent unwanted entry. Confined space safety precautions/requirements should be observed during cleaning, inspection, and maintenance.
- All rainwater harvesting systems must be sealed using a water-safe, non-toxic substance.
- Rainwater harvesting systems may be ordered from a manufacturer or can be constructed on site from a variety of materials. Table 4. 26 compares the advantages and disadvantages of different cistern materials.
- Cisterns must be opaque or otherwise protected from direct sunlight to inhibit growth of algae, and they must be screened to discourage mosquito breeding.
- Dead storage below the outlet to the distribution system and an air gap at the top of the cistern must be included in the total cistern volume. For gravity-fed systems, a minimum of 6 inches of dead storage must be provided. For systems using a pump, the dead storage depth will be based on the pump specifications.
- Any hookup to a municipal backup water supply must have a backflow prevention device to keep municipal water separate from stored rainwater; this may include incorporating an air gap to separate the two supplies.

Table 4. 26. Advantages and Disadvantages of Typical Cistern Materials

Cistern Material	Advantages	Disadvantages
Fiberglass	Commercially available, alterable and moveable; durable with little maintenance; light weight; integral fittings (no leaks); broad application	Must be installed on smooth, solid, level footing; pressure proof for below-ground installation; expensive in smaller sizes
Polyethylene	Commercially available, alterable, moveable, affordable; available in wide range of sizes; can install above or below ground; little maintenance; broad application	Can be UV-degradable; must be painted or tinted for above-ground installations; pressure-proof for below-ground installation
Modular Storage	Can modify to topography; can alter footprint and create various shapes to fit site; relatively inexpensive	Longevity may be less than other materials; higher risk of puncturing of watertight membrane during construction
Plastic Barrels	Commercially available; inexpensive	Low storage capacity (20–50 gallons); limited application
Galvanized Steel	Commercially available, alterable, and moveable; available in a range of sizes; film develops inside to prevent corrosion	Possible external corrosion and rust; must be lined for potable use; can only install above ground; soil pH may limit underground applications
Steel Drums	Commercially available, alterable, and moveable	Small storage capacity; prone to corrosion, and rust can lead to leaching of metals; verify prior to reuse for toxics; water pH and soil pH may also limit applications
FerroConcrete	Durable and immovable; suitable for above or below ground installations; neutralizes acid rain	Potential to crack and leak; expensive
Cast-in-Place Concrete	Durable, immovable, and versatile; suitable for above or below ground installations; neutralizes acid rain	Potential to crack and leak; permanent; will need to provide adequate platform and design for placement in clay soils
Stone or Concrete Block	Durable and immovable; keeps water cool in summer months	Difficult to maintain; expensive to build

Source: Cabell Brand Center, 2007; Cabell Brand Center, 2009

#### ? Water Quality Treatment

Depending upon the collection surface, method of dispersal, and proposed use for the harvested rainwater, a water quality treatment device may be required. Treatment requirements are described in Appendix J Rainwater Harvesting Treatment and Management Requirements.

#### ? Distribution Systems

Most distribution systems require a pump to convey harvested rainwater from the cistern to its final destination, whether inside the building, an automated irrigation system, or gradually discharged to a secondary stormwater treatment practice. The rainwater harvesting system should be equipped with an appropriately sized pump that produces sufficient pressure for all end-uses.

The typical pump and pressure tank arrangement consists of a multi-stage, centrifugal pump, which draws water out of the cistern and sends it into the pressure tank, where it is stored for distribution. Some systems will not require this two-tank arrangement (e.g., low-pressure and gravel systems). When water is drawn out of the pressure tank, the pump activates to supply additional water to the distribution system. The backflow preventer is required to separate harvested rainwater from the main potable water distribution lines.

A drain plug or cleanout sump must be installed to allow the system to be completely emptied, if needed. Above-ground outdoor pipes must be insulated or heat-wrapped to prevent freezing and ensure uninterrupted operation during winter if winter use is planned.

#### **❓ Overflow**

See Section 4.7.2 Rainwater Harvesting Conveyance Criteria.

### **Rainwater Harvesting Material Specifications**

The basic material specifications for rainwater harvesting systems are presented in Table 4.27. Designers should consult with experienced rainwater harvesting system and irrigation installers on the choice of recommended manufacturers of prefabricated cisterns and other system components.

Table 4.27. Design Specifications for Rainwater Harvesting Systems

Item	Specification
Gutters and Downspouts	<p>Materials commonly used for gutters and downspouts include polyvinylchloride (PVC) pipe, vinyl, aluminum, and galvanized steel. Lead must not be used as gutter and downspout solder, since rainwater can dissolve the lead and contaminate the water supply.</p> <ul style="list-style-type: none"> <li>▪ The length of gutters and downspouts is determined by the size and layout of the catchment and the location of the cisterns.</li> <li>▪ Include needed bends and tees.</li> </ul>
Pretreatment	<p>At least one of the following (all rainwater to pass through pretreatment):</p> <ul style="list-style-type: none"> <li>▪ First flush diverter</li> <li>▪ Hydrodynamic separator</li> <li>▪ Roof washer</li> <li>▪ Leaf and mosquito screen (1 mm mesh size)</li> </ul>
Cisterns	<ul style="list-style-type: none"> <li>▪ Materials used to construct cisterns must be structurally sound.</li> <li>▪ Cisterns should be constructed in areas of the site where soils can support the load associated with stored water.</li> <li>▪ Cisterns must be watertight and sealed using a water-safe, non-toxic substance.</li> <li>▪ Cisterns must be opaque or otherwise shielded to prevent the growth of algae.</li> <li>▪ The size of the rainwater harvesting system(s) is determined through design calculations.</li> </ul>

Note: This table does not address indoor systems or pumps.

### **Design Objectives and System Configuration**

Rainwater harvesting systems can have many design variations that meet user demand and stormwater objectives. This specification provides a design framework to achieve the SWRv objectives that are required to comply with the regulations, and it adheres to the following concepts:

- ⑦ Give preference to use of rainwater as a resource to meet on-site demand or in conjunction with other stormwater retention practices.
- ⑦ Reduce peak flow by achieving volume reduction and temporary storage of runoff.

Based on these concepts, this specification focuses on system design configurations that harvest rainwater for internal building uses, seasonal irrigation, and other activities, such as cooling tower use and vehicle washing. While harvested rainwater will be in year-round demand for many internal building uses, some other uses will have varied demand depending on the time of year (e.g., cooling towers and seasonal irrigation). Thus, a lower retention volume is assigned to a type of use that has reduced demand.

### **Design Objectives & Cistern Design Set-Ups**

Prefabricated rainwater harvesting cisterns typically range in size from 250 to over 30,000 gallons. Three basic cistern designs meet the various rainwater harvesting system configurations in this section.

**Cistern Design 1.** The first cistern set-up (Figure 4.27) maximizes the available storage volume to meet the desired level of stormwater retention. This layout also maximizes the storage that can be used to meet a demand. An emergency overflow exists near the top of the cistern as the only gravity release outlet device (not including the pump, manway, or inlets). It should be noted that it is possible to address 2- to 25-year storm volumes with this cistern configuration, but the primary purpose is to address the smaller SWRv design storm.

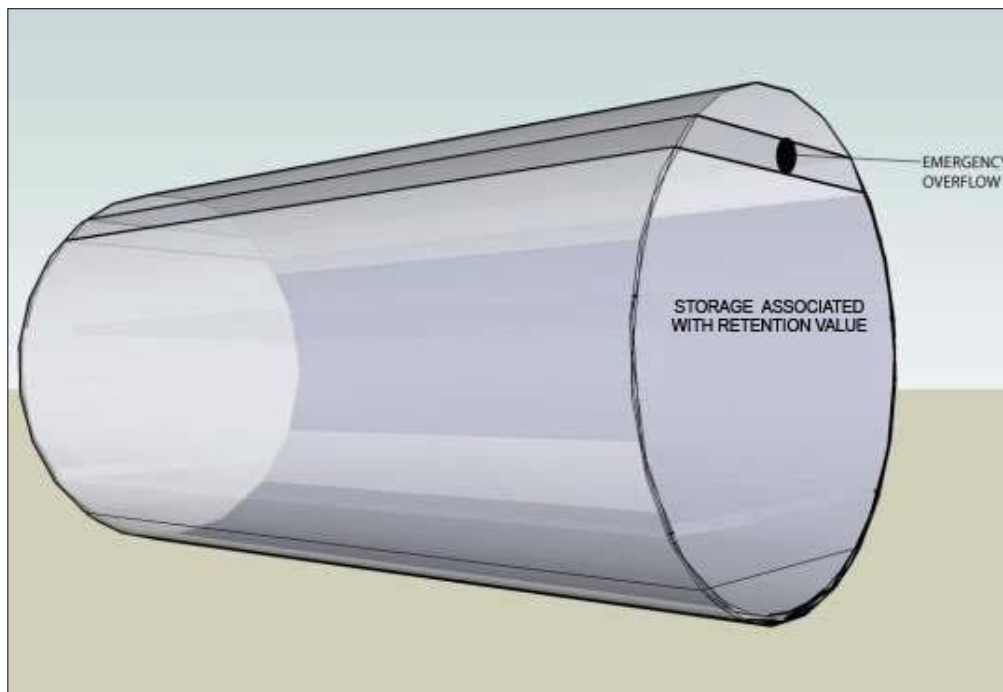


Figure 4.27. Cistern Design 1: Storage associated with the design storm volume only.

**Cistern Design 2.** The second cistern set-up (Figure 4.28) uses cistern storage to meet the SWRv retention objectives and also uses additional detention volume to meet some or all of the 2- to 25-year storm volume requirements. An orifice outlet is provided at the top of the design storage for the SWRv level, and an emergency overflow is located at the top of the detention volume level.

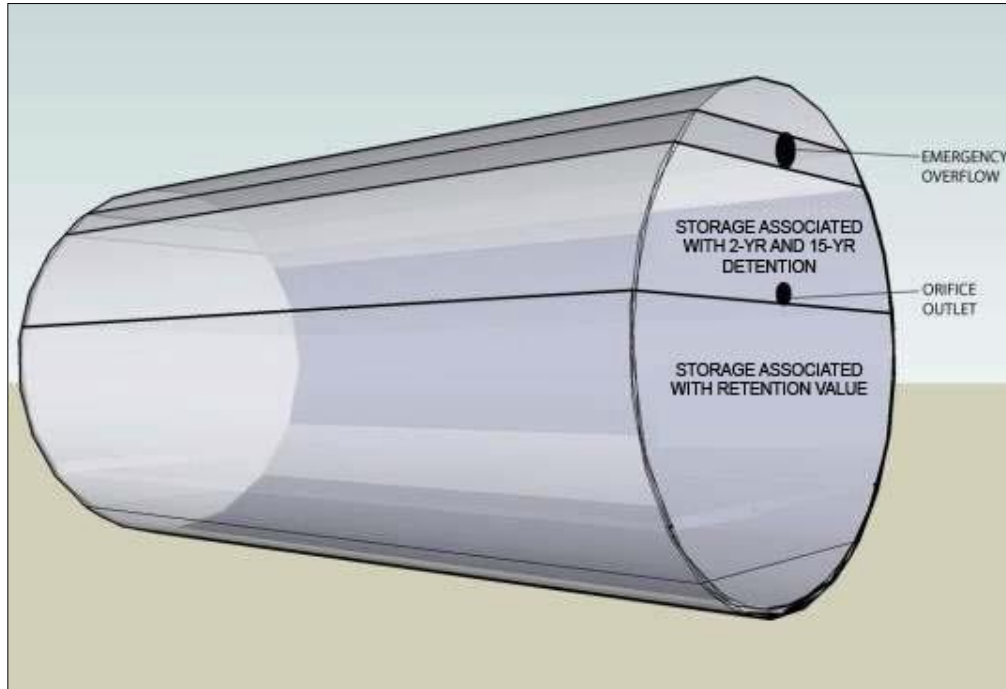


Figure 4.28. Cistern Design 2: Storage associated with design storm, channel protection, and flood volume.

**Cistern Design 3.** The third cistern set-up (Figure 4.29) creates a constant drawdown within the system. The small orifice at the bottom of the cistern needs to be routed to an appropriately designed secondary practice (i.e., bioretention, stormwater infiltration) that will allow the rainwater to be treated and allow for groundwater recharge over time. The release must not be discharged to a receiving channel or storm drain without treatment, and maximum specified drawdown rates from this constant drawdown should be adhered to, since the primary function of the system is not intended to be detention.

While a small orifice is shown at the bottom of the cistern in Figure 4.29, the orifice could be replaced with a pump that would serve the same purpose, conveying a limited amount of water to a secondary practice on a routine basis.

For this design, the secondary practice must be considered a component of the rainwater harvesting system with regard to the storage volume calculated in the General Retention Compliance Calculator in Appendix H. In other words, the storage volume associated with the secondary practice must not be included as a separate BMP because the secondary practice is an integral part of a rainwater harvesting system with a constant drawdown.

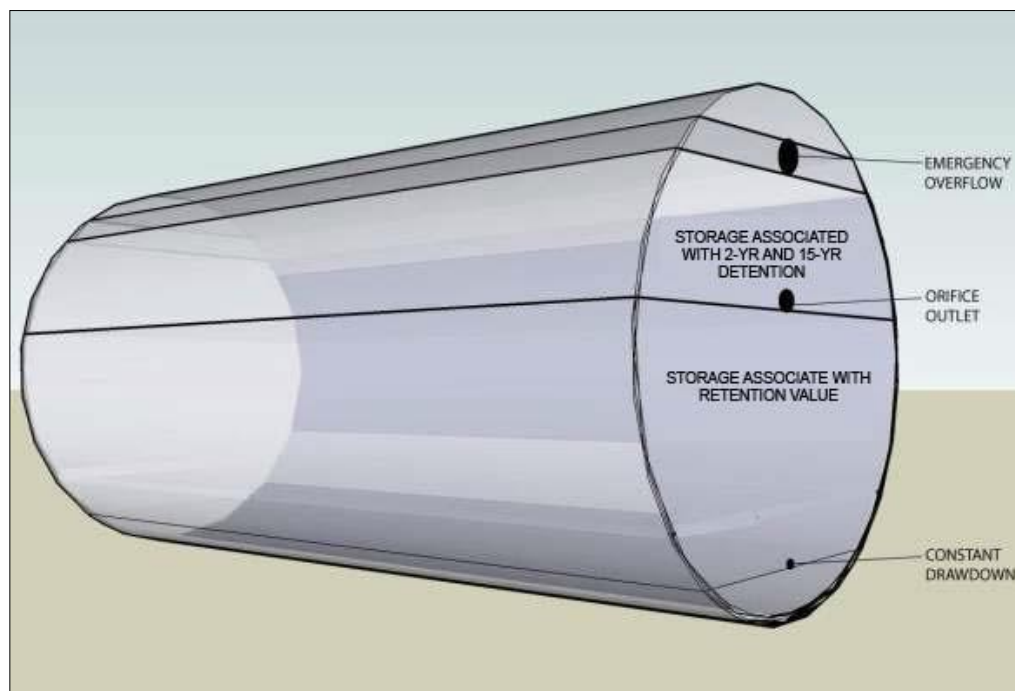


Figure 4.29. Cistern Design 3: Constant drawdown version where storage is associated with design storm, channel protection, and flood volume.

### **Sizing of Rainwater Harvesting Systems**

The rainwater harvesting cistern sizing criteria presented in this section were developed using a spreadsheet model that used best estimates of indoor and outdoor water demand, long-term rainfall data, and CDA capture area data (Forasté 2011). The Rainwater Harvesting Storage Volume Calculator in Appendix J1 is used for cistern sizing guidance and to quantify the available storage volume achieved. This storage volume value is required for input into the General Retention Compliance Calculator and is part of the submission of a SWMP using rainwater harvesting systems for compliance. A secondary objective of the spreadsheet is to increase the beneficial uses of the stored stormwater, treating it as a valuable natural resource.

### **Rainwater Harvesting Storage Volume Calculator**

The design specification provided in this section is follows the Rainwater Harvesting Storage Volume Calculator Appendix J1. The spreadsheet uses daily rainfall data from January 1, 2007 to December 31, 2019 to model performance parameters of the cistern under varying CDAs, demands on the system and cistern size.

The size of ponds used for irrigation, their irrigation area and characteristics of soil and land use can be entered in the calculator to determine stormwater volume retained. The runoff that reaches the cistern each day is added to the water level that existed in the cistern the previous day, with all of the total demands subtracted on a daily basis. If any overflow is realized, the volume is quantified and recorded. If the cistern runs dry (reaches the cut-off volume level), then the volume in the cistern is fixed at the low level. A summary of the water balance for the system is provided below.

### **Incremental Design Volumes within Cistern**

Rainwater cistern sizing is determined by accounting for varying precipitation levels, captured CDA runoff, first flush diversion (through filters) and filter efficiency, low water cut-off volume, dynamic water levels at the beginning of various storms, storage needed for the design storm (permanent storage), storage needed for 2- to 25-year volume (temporary detention storage), seasonal and year-round demand use and objectives, overflow volume, and freeboard volumes above high water levels during very large storms. See Figure 4. 30 for a graphical representation of these various incremental design volumes.

The design specification described in this section does not provide guidance for sizing larger storms, but rather provides guidance on sizing for the 85<sup>th</sup> and 95<sup>th</sup> percentile design storms.



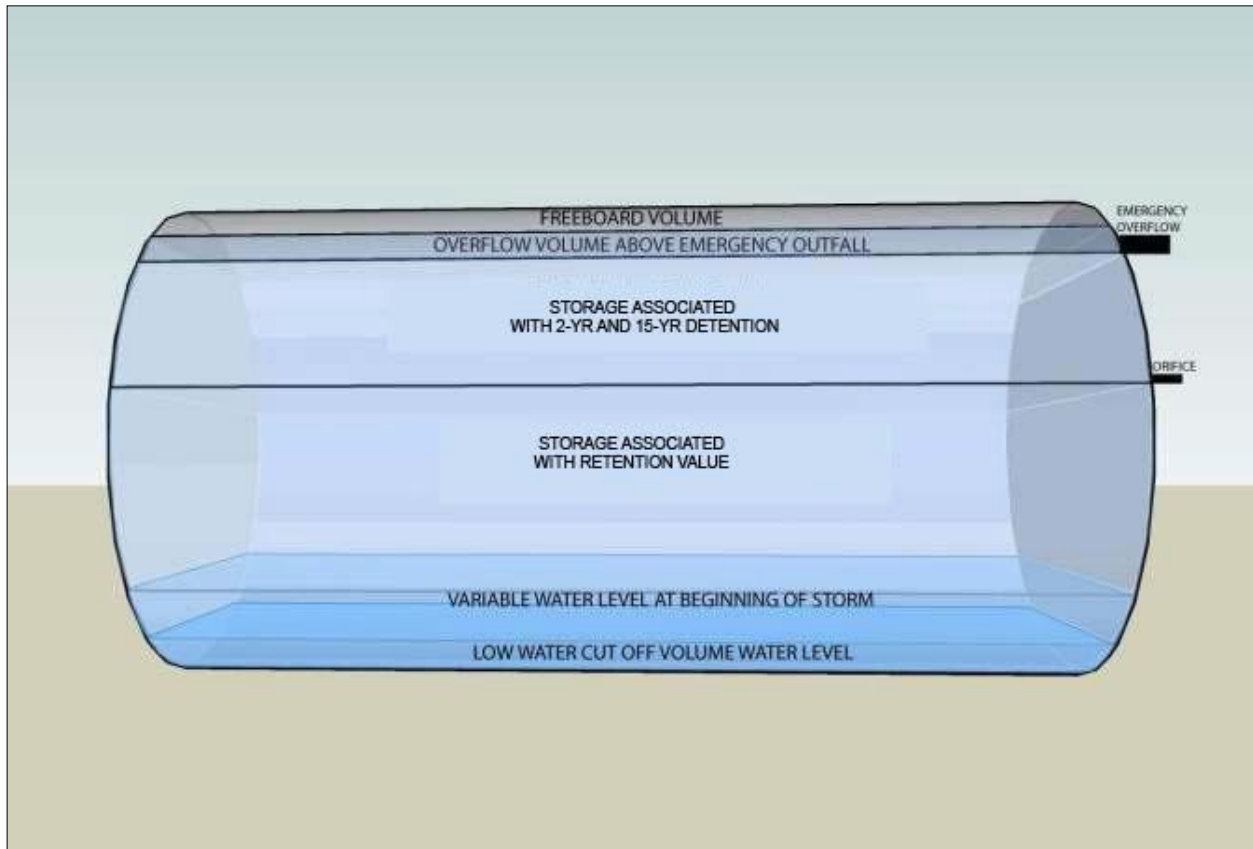


Figure 4.30. Incremental design volumes associated with cistern sizing.

The “Average Available Storage Volume” is the average storage within the cistern that is modeled and available to retain rainfall. While the SWRV will remain the same for a specific CDA, the “Average Available Storage Volume” is dependent on demand and cistern volume. It is the available space in the cistern between the average level at the beginning of a storm and the orifice outflow.

### Water Contribution

#### **❓ Precipitation**

The volume of water contributing to the rainwater harvesting system is a function of the rainfall and CDA, as defined by the designer.

#### **❓ Municipal Backup (optional)**

In some cases, the designer may choose to install a municipal backup water supply to supplement cistern levels. Note that municipal backups may also be connected post-cistern (i.e., a connection is made to the non-potable water line that is used for pumping water from the cistern for reuse), thereby not contributing any additional volume to the cistern. Municipal backup designs that supply water directly to the cistern are not accounted for in the Rainwater Harvesting Storage Volume Calculator.

## **Water Losses**

### **? Contributing Drainage Area Runoff Coefficient**

The CDA is assumed to convey 95% of the rainfall that lands on its surface (i.e.,  $RRRR = 0.95$ ).

### **? First Flush Diversion**

The first 0.02 to 0.06 inches of rainfall that is directed to filters is diverted from the system in order to prevent clogging it with debris. This value is assumed to be contained within the filter efficiency rate.

### **? Filter Efficiency**

It is assumed that, after the first flush diversion and loss of water due to filter inefficiencies, the remainder of the design storm will be captured successfully. For the 85<sup>th</sup> or 95<sup>th</sup> percentile storms, a minimum of 95% of the runoff should be conveyed into the cistern. The minimum values are included as the filter efficiencies in the Rainwater Harvesting Storage Volume Calculator, although they can be altered (increased) if appropriate. The Rainwater Harvesting Storage Volume Calculator applies these filter efficiencies, or interpolated values, to the daily rainfall record to determine the volume of runoff that reaches the cistern. For the purposes of selecting an appropriately sized filter, a rainfall intensity of 1 inch per hour shall be used when the design storm is the SWRV. The appropriate rainfall intensity values for the 2- to 25-year storms shall be used when designing for larger storm events.

### **? Drawdown (Storage Volume)**

This is the stored water within the cistern that is reused or directed to a secondary stormwater practice. It is the volume of runoff that is reduced from the CDA. This is the water loss that translates into the achievable storage volume retention.

## **Overflow**

For the purposes of addressing the SWRV (not for addressing larger storm volumes), orifice outlets for both detention and emergency overflows are treated the same. This is the volume of water that may be lost during large storm events or successive precipitation events.

## **Storage Volume Results**

The Rainwater Harvesting Storage Volume Calculator determines the average daily volume of water in the cistern for a range of cistern sizes. From this value, the available storage volume for the 85th and 95th percentile storm can be calculated; it is simply the difference between the cistern size and the average daily volume. The available storage volume for the selected cistern size should be used as an input to the General Retention Compliance Calculator. Similarly, the pond used for irrigation stormwater volume is entered in the General Retention Compliance Calculator in the rainwater harvesting row rather than the stormwater pond row to produce runoff reduction and pollutant removal credit with the other BMPs for the stormwater plan.

### **? Available Storage Volume (Sv)**

The volume available for storage of the 85th and 95th percentile storm is calculated for multiple sizes of cisterns. A trade-off curve plots these results, which allows for a comparison of the retention achieved versus cistern size. While larger cisterns yield more retention, they are more expensive. The curve helps the user to choose the appropriate cistern size, based on the design objectives and site needs.

## 2 Overflow Volume

The volume of the overflows resulting from the 85<sup>th</sup> or 95<sup>th</sup> percentile precipitation event is also reported in this sheet. The overflow volume is also plotted to illustrate the effects of cistern size on overflow volume. An example chart is shown in Figure 4.31. The effect of diminishing returns is clear. Beyond a cistern size of 9,000 gallons, the overflow volume drops to zero. So, while the available storage continues to increase, the 85<sup>th</sup> or 95<sup>th</sup> percentile storm is entirely retained, and no additional retention will be possible.

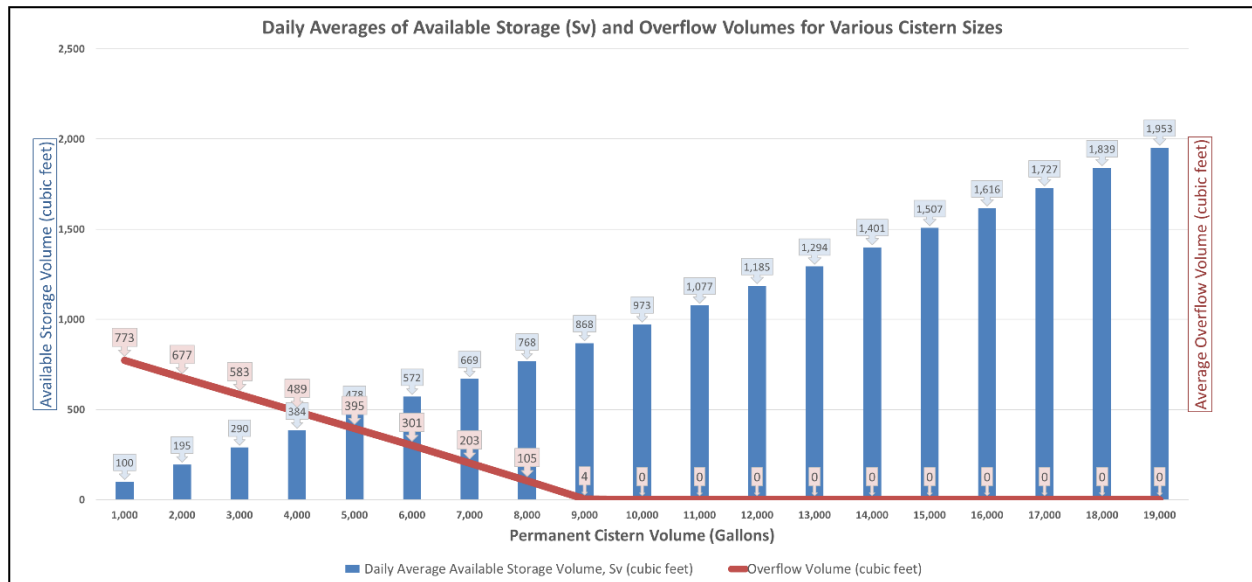


Figure 4.31. Example of graph showing Average Available Storage Volume and Overflow Volume for an example cistern design.

## Results from the Rainwater Harvesting Storage Volume Calculator to be Transferred to the Compliance Calculator

There are two results from the Rainwater Harvesting Storage Volume Calculator that are to be transferred to the Compliance Calculator as follows:

### 2 Contributing Drainage Area

Enter the CDA that was used in the Rainwater Harvesting Storage Volume Calculator into the appropriate columns in the “Rainwater Harvesting” row of the Compliance Calculator BMP sheet.

### 2 Available Storage Volume

Once a cistern has been selected, enter the Available Storage Volume (ft<sup>3</sup>) associated with that cistern into the Compliance Calculator column called “Storage Volume Provided by BMP” in the “Rainwater Harvesting” row of the BMP sheet.

## Completing the Sizing Design of the Cistern

The total size of the cistern is the sum of the following four volume components:

### 2 Low Water Cutoff Volume (Included)

A dead storage area must be included so the pump will not run the cistern dry. This volume is included in the Rainwater Harvesting Storage Volume Calculator’s modeled volume.

❓ **Cistern Storage Associated with Design Volume (Included)**

This is the cistern design volume from the Rainwater Harvesting Storage Volume Calculator.

❓ **Adding Channel Protection and Flood Volumes (Optional)**

Additional detention volume may be added above and beyond the cistern storage associated with the design storm volumes for the 2- to 25-year events. Typical routing software programs may be used to design for this additional volume.

❓ **Adding Overflow and Freeboard Volumes (Required)**

An additional volume above the emergency overflow must be provided in order for the cistern to allow very large storms to pass. Above this overflow water level, there will be an associated freeboard volume that should account for at least 5% of the overall cistern size. Sufficient freeboard must be verified for large storms, and these volumes must be included in the overall size of the cistern.

#### **4.7.5 Rainwater Harvesting Landscaping Criteria**

If the harvested water is to be used for irrigation, the design plan elements must include the proposed delineation of planting areas to be irrigated, the planting plan, and quantification of the expected water demand. The default water demand for irrigation is 1.0 inches per week over the area to be irrigated during the months of May through October only. Justification must be provided if larger volumes are to be used.

#### **4.7.6 Rainwater Harvesting Construction Sequence Installation**

It is advisable to have a single contractor to install the rainwater harvesting system, outdoor irrigation system, and secondary retention practices. The contractor should be familiar with rainwater harvesting system sizing, installation, and placement. A licensed plumber is required to install the rainwater harvesting system components to the plumbing system.

A standard construction sequence for proper rainwater harvesting system installation is provided below. This can be modified to reflect different rainwater harvesting system applications or expected site conditions.

1. Choose the cistern location on the site.
2. Route all downspouts or pipes to prescreening devices and first flush diverters.
3. Properly install the cistern.
4. Install the pump (if needed) and piping to end uses (indoor, outdoor irrigation, or cistern dewatering release).
5. Route all pipes to the cistern.
6. Stormwater must not be diverted to the rainwater harvesting system until the overflow filter path has been stabilized with vegetation.

#### **Construction Supervision**

The following items should be inspected by a qualified professional in the mechanical, electrical, or plumbing fields prior to final sign-off and acceptance of a rainwater harvesting system:

- Rooftop area matches plans

- Diversion system is properly sized and installed
- Pretreatment system is installed
- Mosquito screens are installed on all openings
- Overflow device is directed as shown on plans
- Rainwater harvesting system foundation is constructed as shown on plans
- Catchment area and overflow area are stabilized
- Secondary stormwater treatment practice(s) is installed as shown on plans
- System commissioning

Construction phase inspection checklist for rainwater harvesting practices and the Stormwater Facility Leak Test form can be found in Appendix E Construction Inspection Checklists.

#### **4.7.7 Rainwater Harvesting Maintenance Criteria Maintenance**

##### **Inspections**

Periodic inspections and maintenance shall be conducted for each system by a qualified professional.

Maintenance inspection checklists for rainwater harvesting systems and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

##### **Maintenance Schedule**

Maintenance requirements for rainwater harvesting systems vary according to use. Systems that are used to provide supplemental irrigation water have relatively low maintenance requirements, while systems designed for indoor uses have much higher maintenance requirements. Table 4.28 describes routine maintenance tasks necessary to keep rainwater harvesting systems in working condition. It is recommended that maintenance tasks be performed by an “Inspector Specialist,” certified by the American Rainwater Catchment Association. Maintenance tasks must be documented and substantially comply with the maintenance responsibilities outlined in the maintenance agreement.

Table 4.28. Typical Maintenance Tasks for Rainwater Harvesting Systems

Responsible Person	Frequency	Activity
Owner	Four times a year	Inspect and clean prescreening devices and first flush diverters
	Twice a year	Keep gutters and downspouts free of leaves and other debris
	Once a year	<ul style="list-style-type: none"> <li>▪ Inspect and clean storage cistern lids, paying special attention to vents and screens on inflow and outflow spigots. Check mosquito screens and patch holes or gaps immediately</li> <li>▪ Inspect condition of overflow pipes, overflow filter path, and/or secondary stormwater treatment practices</li> </ul>
	Every third year	Clear overhanging vegetation and trees over roof surface
Qualified	According to Manufacturer	Inspect water quality devices

Responsible Person	Frequency	Activity
Third-Party Inspector	As indicated in Appendix J Rainwater Harvesting Treatment and Management Requirements	Field verification and data logs must be available at all times and annual reports should be sent to the Public Works Department.
	Every third year	<ul style="list-style-type: none"> <li>▪ Inspect cistern for sediment buildup</li> <li>▪ Check integrity of backflow preventer</li> <li>▪ Inspect structural integrity of cistern, pump, pipe and electrical system</li> <li>▪ Replace damaged or defective system components</li> </ul>

### **Mosquitoes**

In some situations, poorly designed rainwater harvesting systems can create habitat suitable for mosquito breeding. Designers must provide screens on above- and below-ground cisterns to prevent mosquitoes and other insects from entering the cisterns. If screening is not sufficient in deterring mosquitoes, dunks or pellets containing larvicide can be added to cisterns when water is intended for landscaping use.

### **Waste Material**

Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

### **4.7.8 Rainwater Harvesting Stormwater Compliance Calculations**

Rainwater harvesting practices are credited with 100% retention for the average available storage volume (Sv) available in the cistern as well as 100% TSS, TN, and bacteria removal (see Table 4.29). This average available storage volume is determined by using the Rainwater Harvesting Storage Volume Calculator, as described in Section 4.5.4 Rainwater Harvesting Design Criteria.

Table 4.29. Rainwater Harvesting Retention and Pollutant Removal

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

Rainwater harvesting practices also contribute to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume from the total runoff volume for the 2-year through the 100-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.



#### 4.8 Impervious Surface Disconnection

Impervious Surface Disconnection				
<b>Definition:</b> This strategy involves managing runoff close to its source by directing it from rooftops and other impervious surfaces to pervious areas.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		80%	40%	40%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
Low	Low	Low		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	40%		
At least annually	As needed			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Low cost construction and maintenance</li><li>▪ Reduces runoff volume</li><li>▪ Helps restore pre-development hydrologic conditions</li></ul>		<ul style="list-style-type: none"><li>▪ Only applicable to small drainage areas</li><li>▪ Difficult to apply to treatment trains</li><li>▪ Requires pervious receiving area</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Conveyance</li><li>▪ Receiving area</li><li>▪ Vegetation</li><li>▪ Receiving soils</li></ul>		<ul style="list-style-type: none"><li>▪ Maximum CDA of 1,000 ft<sup>2</sup> per disconnection</li><li>▪ Disconnection area should be at least 35 feet long and 10 feet wide.</li><li>▪ Slope of receiving area should be &lt; 2% (with turf reinforcement, &lt;5%)</li><li>▪ Building setback for areas with &lt; 1% slope</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Typical lawn/landscaping maintenance</li></ul>		<ul style="list-style-type: none"><li>▪ Ensure receiving area remains uncompacted and pervious</li></ul>		

<sup>1</sup>Credited pollutant load removal



In this practice, runoff from a rooftop or other small impervious surface is directed to a pervious surface or small practice to provide infiltration, filtering, or reuse (Figure 4.32)



Figure 4.32. Rooftop disconnection (photo: Center for Watershed Protection, Inc.)

#### **Definition**

This strategy involves managing runoff close to its source by directing it from rooftops and other impervious surfaces to pervious areas. Disconnection practices can be used to reduce the volume of runoff that enters the combined or separate sewer systems. Applicable practices include the following:

- D-1 Disconnection to pervious areas with the compacted cover designation
- D-2 Disconnection to conservation areas

**Disconnection practices reduce a portion of the SWRv. In order to fully meet retention requirements, , disconnection practices must be combined with additional practices.**

#### **4.8.1 Impervious Surface Disconnection Feasibility Criteria**

Impervious surface disconnections are ideal for use on commercial, institutional, municipal, multi-family residential, and single-family residential buildings. Key constraints with impervious surface disconnections include available space, soil permeability, and soil compaction. These and other feasibility criteria are described below and summarized in Table 4. 30.

- **Contributing Drainage Area.** For rooftop impervious areas, the maximum impervious area treated cannot exceed 1,000 square feet per disconnection. For impervious areas other than rooftop, the longest contributing impervious area flow path cannot exceed 75 feet.
- **Sizing.** The available disconnection area must be at least 10 feet wide and 35 feet long. For sheet flow from impervious areas, the disconnection area must be as wide as the area draining to it.
- **Site Topography.** Disconnection is best applied when the grade of the receiving pervious area is less than 2%, or less than 5% with turf reinforcement. The slope of the receiving areas must be graded away from any building foundations. Turf reinforcement may include erosion control matting or other appropriate reinforcing materials that are confirmed by the designer to be erosion resistant for the specific characteristics and flow rates anticipated at each individual application, and acceptable to the plan-approving authority.

- **Soils.** Impervious surface disconnection can be used on any post-construction hydrologic soil group (HSG). The disconnection area must be kept well-vegetated with minimal bare spots—at least 95% soil cover.
- **Building Setbacks.** If the grade of the receiving area is less than 1%, downspouts must be extended 5 feet away from building.

**Discharge Across Property Lines.** Disconnection areas must be designed such that runoff is not directed across property lines toward other sites.

**Economic Considerations.** Disconnection is one of the least expensive BMPs available.

**Table 4.30. Feasibility Criteria for Disconnection**

Design Factor	Disconnection Design
Contributing Drainage Area	1,000 square feet per rooftop disconnection. For impervious areas other than rooftop, the longest contributing impervious area flow path cannot exceed 75 feet.
Sizing	The available disconnection area must be at least 10 feet wide and 35 feet long. For sheet flow from impervious areas, the disconnection area must be as wide as the area draining to it.
Site Topography	Grade of the receiving pervious area is less than 2%, or less than 5% with turf reinforcement. The slope of the receiving areas must be graded away from any building foundations.
Soils	Impervious surface disconnection can be used on any post-construction HSG. The disconnection area must be kept well-vegetated with minimal bare spots.
Building Setbacks	5 feet away from building if the grade of the receiving area is less than 1%.

#### 4.8.2 Impervious Surface Disconnection Conveyance Criteria

Receiving areas in disconnection practices (D-1, D-2, and D-3) require a design that safely conveys the 2- to 25-year storm events over the receiving area without causing erosion. In some applications, erosion control matting or other appropriate reinforcing materials may be needed to control flow rates anticipated for these larger design storms.

#### 4.8.3 Impervious Surface Disconnection Pretreatment Criteria

Pretreatment is not needed for impervious surface disconnection.

#### 4.8.4 Impervious Surface Disconnection Design Criteria

If the feasibility criteria presented in Section 4.6.1 are met for a disconnection area, the storage volume is equal to the SWRV for the impervious area draining to it. The disconnection area itself should be considered Compacted Cover or Open Space rather than BMP area and should not be considered as part of the contributing drainage area to the impervious surface disconnection.

The following additional design criteria apply to Disconnection to Conservation Areas:

- **(D-2) Disconnection to a Conservation Area.** Disconnection area cannot include regulated wetlands and buffer areas.

- Inflow must be conveyed via sheet flow or via a level spreader.
- If inflow is conveyed via a level spreader, the maximum flow path is 150 feet, and the level spreader must be designed with an appropriate width as specified below.

**Level Spreaders.** A level spreader can be used to disperse or “spread” concentrated flow thinly over a vegetated or forested area to promote greater runoff infiltration in the receiving area. A level spreader consists of a permanent linear structure constructed at a 0% grade that transects the slope. The influent concentrated runoff must be spread over an area wide enough area so that erosion of the receiving area does not result. Detailed information on the design and function of level spreaders can be found in Hathaway and Hunt (2006) and NCDWQ (2010).

The minimum required width of the level spreader is

- 13 linear feet per each 1 cubic foot/second of inflow if the receiving conservation area has a minimum 90% ground cover
- 40 linear feet per 1 cubic foot/second of inflow if the receiving conservation area is forested

#### 4.8.5 Impervious Surface Disconnection Landscaping Criteria

All receiving disconnection areas must be stabilized to prevent erosion or transport of sediment to receiving practices or drainage systems according to the Erosion and Sediment Control seeding and vegetation requirements. Designers must ensure that the maximum flow velocities do not exceed the acceptable values for the selected grass species and the specific site slope.

#### 4.8.6 Impervious Surface Disconnection Construction Sequence

**Construction Sequence for Disconnection to Pervious Areas.** For disconnection to a pervious area, the pervious area can be within the limits of disturbance (LOD) during construction. The following procedures should be followed during construction:

- Before site work begins, the receiving pervious disconnection area boundaries should be clearly marked.
- Construction traffic in the disconnection area should be limited to avoid compaction. The material stockpile area shall not be located in the disconnection area.
- Construction runoff should be directed away from the proposed disconnection area, using perimeter silt fence, or, preferably, a diversion dike.
- If existing topsoil is stripped during grading, it shall be stockpiled for later use.
- The disconnection area may require light grading to achieve desired elevations and slopes. This should be done with tracked vehicles to prevent compaction.
- Topsoil and or compost amendments should be incorporated evenly across the disconnection area, stabilized with seed, and protected by biodegradable erosion control matting or blankets.
- Stormwater must not be diverted into any topsoil or compost amended areas until the area is stabilized (establishment of 95% or greater groundcover).

**Construction Sequence for Disconnection to Conservation Areas.** For disconnection to a conservation area, the conservation area must be fully protected during the construction stage of development and kept outside the LOD on the soil erosion and sediment control plan.

- No staging, parking, clearing, grading, or heavy equipment access is allowed in the conservation area except temporary disturbances associated with incidental utility construction, restoration operations, or management of nuisance vegetation. Incidental utility construction includes protecting existing utilities, removing abandoned utilities, rearranging service lines, temporarily rearranging utilities, and adjusting utility appurtenances.
- Any conservation areas shall be protected by super silt fence, chain link fence, orange safety fence, or other measures to prevent sediment discharge consistent with soil erosion and sediment control standards and specifications.
- The LOD must be clearly shown on all construction drawings and identified and protected in the field by acceptable signage, silt fence or other protective barrier.
- If a level spreader is to be used in the design, construction of the level spreader shall not commence until the CDA has been stabilized and perimeter soil erosion and sediment control measures have been removed and cleaned out. Stormwater must not be diverted into the disconnection area until the level spreader is installed and stabilized.

**Construction Supervision.** Construction supervision is recommended to ensure compliance with design standards. A qualified professional should evaluate the performance of the disconnection after the first significant rainfall event to look for evidence of gullies, outflanking, undercutting, or sparse vegetative cover. Spot repairs should be made as needed.

Construction phase inspection checklist for impervious cover disconnection can be found in Appendix E Construction Inspection Checklists.

#### 4.8.7 Impervious Surface Disconnection Maintenance Criteria

Maintenance of disconnected downspouts usually involves regular lawn or landscaping maintenance in the filter path from the roof to the street. In some cases, runoff from a disconnection may be directed to a more natural, undisturbed setting (i.e., where lot grading and clearing is “fingerprinted” and the proposed filter path is protected). Typical maintenance activities include erosion control of the receiving area and ensuring the receiving area remains uncompacted and pervious.

Maintenance inspection checklists for disconnection can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

**4.8.8 Impervious Surface Disconnection Stormwater Compliance Calculations** Disconnection practices are credited with 40% retention for the SWRV as well as 80% TSS, 40% TN, and 40% bacteria removal (see Table 4.31).

Table 4.31. Disconnection Retention and Pollutant Removal

Retention	= 40%
TSS Removal	= 80%

TN Removal	= 40%
Bacteria Removal	= 40%

Impervious surface disconnection also contributes to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume from the total runoff volume for the 2- to 25-year, and 100-year storms. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

#### 4.9 Open Channel Systems

Open Channel Systems						
<b>Definition:</b> Vegetated open channels that are designed to capture and treat or convey the design storm volume (SWRv).						
Site Applicability		BMP Performance Summary				
Land Uses	Required Footprint	WQ Improvement: Moderate to High				
<ul style="list-style-type: none"><li>▪ Suburban</li><li>▪ Rural</li></ul>	Moderate	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>		
		50-80%	25-70%	30-80%		
		Runoff Reduction				
Construction Costs	Maintenance Burden	Volume				
Low	Low	Low				
Maintenance Frequency:		SWRv				
Routine	Non-Routine	O-1a	O-1b	O-2	O-3	O-4
Quarterly	Every 10-15 years	10%	20%	60%	0%	0%
Advantages/Benefits		Disadvantages/Limitation				
<ul style="list-style-type: none"><li>▪ Less expensive than curb and gutter</li><li>▪ Relatively low maintenance requirements</li><li>▪ Provides pretreatment if used as part of runoff conveyance system</li><li>▪ Provides partial infiltration of runoff in some soils</li><li>▪ Good for small drainage areas</li></ul>		<ul style="list-style-type: none"><li>▪ Must be carefully designed to achieve low flow rates in the channel (&lt; 1.0 ft/s)</li><li>▪ May re-suspend sediment</li><li>▪ May not be acceptable for some areas because of standing water in channel</li></ul>				
Components		Design considerations				
<ul style="list-style-type: none"><li>▪ Channel geometry</li><li>▪ Dense vegetation</li><li>▪ Check dams, as needed)</li></ul>		<ul style="list-style-type: none"><li>▪ Maximum drainage area of 2.5 acres</li><li>▪ Slopes (&lt;4% unless using O-4)</li><li>▪ Runoff velocities must be non-erosive</li><li>▪ Vegetation must withstand both relatively high velocity flows and wet/dry periods.</li></ul>				
Maintenance Activities						
<ul style="list-style-type: none"><li>▪ Mow grass to 3 or 4 inches high</li><li>▪ Inspect for, and correct, formation of rills and gullies</li></ul>		<ul style="list-style-type: none"><li>▪ Clean out sediment accumulation in channel</li><li>▪ Ensure that vegetation remains well established</li></ul>				

<sup>1</sup>Credited pollutant load removal

Often found along roadsides, parking lots, and property boundaries, open channels can provide stormwater conveyance, capture and/or treatment (Figure 4.33). One of the most visible stormwater BMPs, they are often part of stormwater conveyance systems.



**Figure 4.33. Open channel (photo: Center for Watershed Protection, Inc.)**

**Definition.** Vegetated open channels that are designed to capture and treat or convey the design storm volume (SWRv). Design variants include the following:

- O-1 Grass channels
- O-2 Dry swales/bioswales
- O-3 Wet swales
- O-4 Regenerative stormwater conveyance (RSC)

Open channel systems shall not be designed to provide stormwater detention except under extremely unusual conditions. Open channel systems must generally be combined with a separate facility to meet detention requirements.

**Grass channels (O-1)** can provide a modest amount of runoff filtering and volume attenuation within the stormwater conveyance system resulting in the delivery of less runoff and pollutants than a traditional system of curb and gutter, storm drain inlets, and pipes (see Figure 4.34). The performance of grass channels will vary depending on the underlying soil permeability. Grass channels, however, are not capable of providing the same stormwater functions as dry swales as they lack the storage volume associated with the engineered filter media. Their retention performance can be boosted when compost amendments are added to the bottom of the swale (see Appendix C Soil Compost Amendment Requirements). Grass channels are a preferable alternative to both curb and gutter and storm drains as a stormwater conveyance system, where development density, topography, and soils permit.

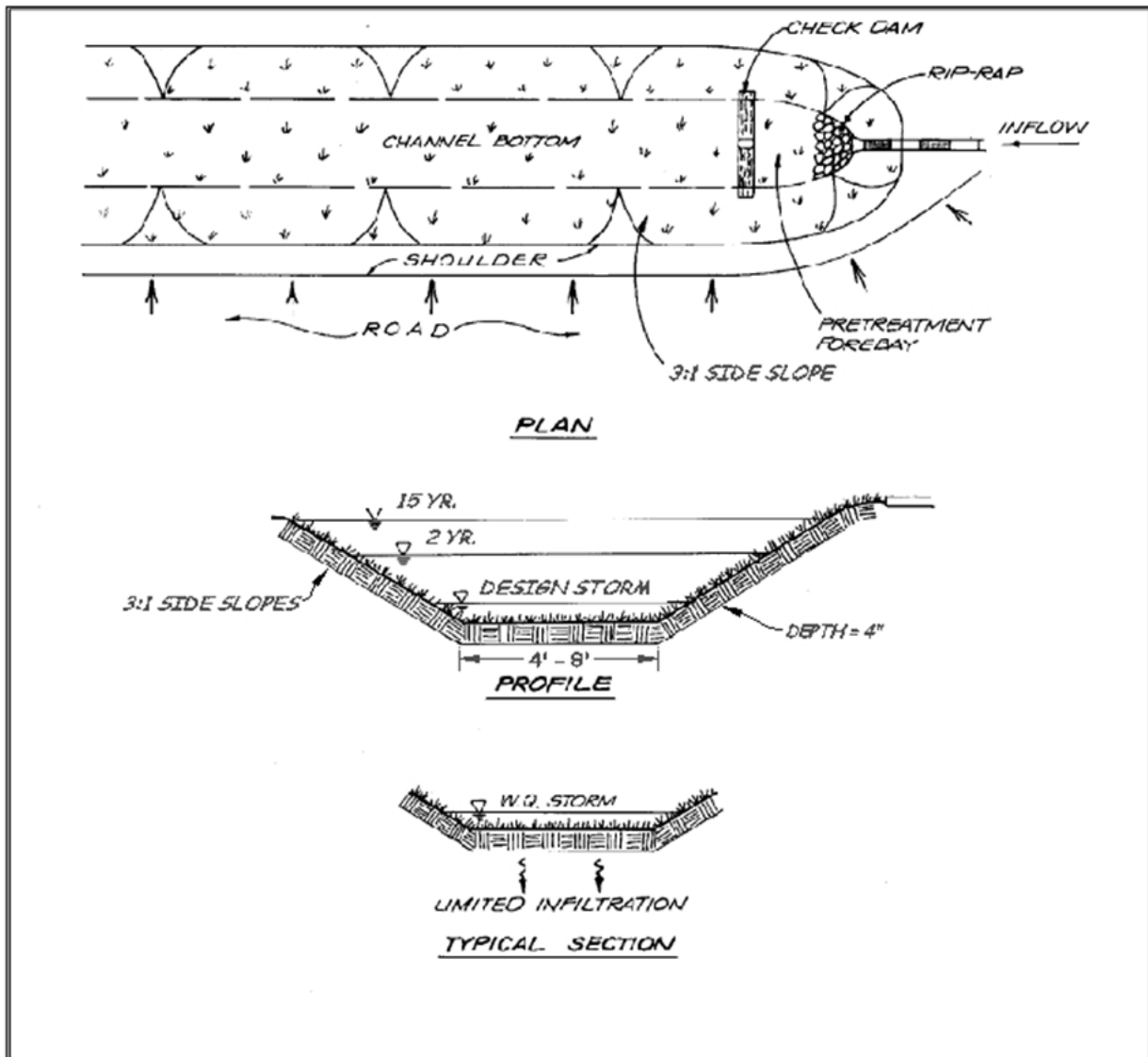


Figure 4.34. Grass channel typical plan, profile, and section views (O-1).

**Dry swales (O-2)**, also known as bioswales, are essentially bioretention cells that are shallower, configured as linear channels, and covered with turf or other surface material (other than mulch and ornamental plants). The dry swale is a soil filter system that temporarily stores and then filters the desired design storm volume. Dry swales rely on a premixed filter media below the channel that is identical to that used for bioretention. In most cases, the runoff treated by the filter media flows into an underdrain, which conveys treated runoff back to the conveyance system further downstream. The underdrain system consists of a perforated pipe within a gravel layer on the bottom of the swale, beneath the filter media. However, if soils are permeable, runoff infiltrates into underlying soils and the dry swale can be designed without an underdrain as if it were an enhanced bioretention. In either case, check dams should be constructed to encourage ponding (see Site Topography). Dry swales may appear as simple grass channels with the same shape and turf cover, while others may have more elaborate landscaping. Swales can be planted with turf grass, tall meadow grasses, decorative herbaceous cover, or trees.



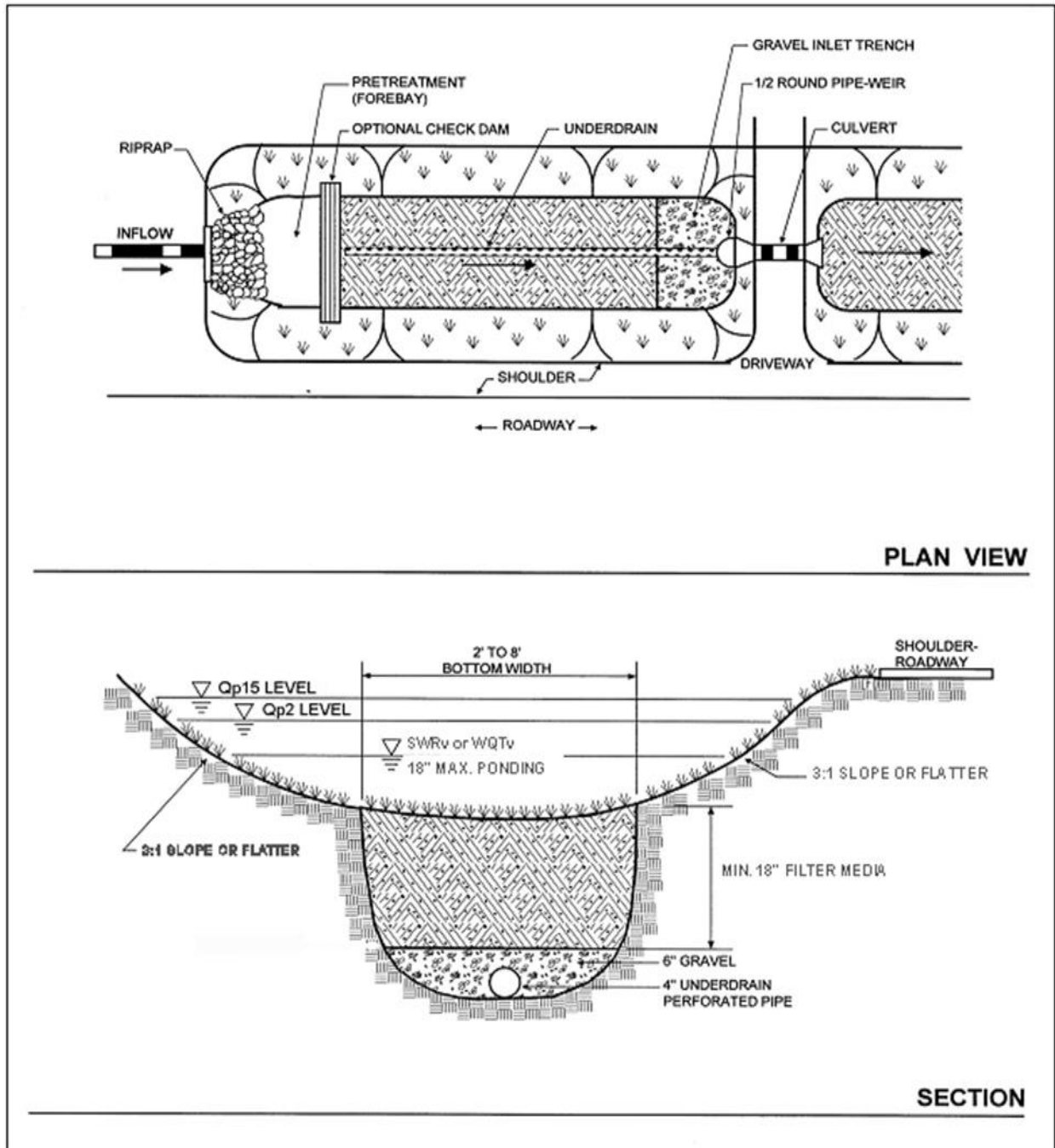
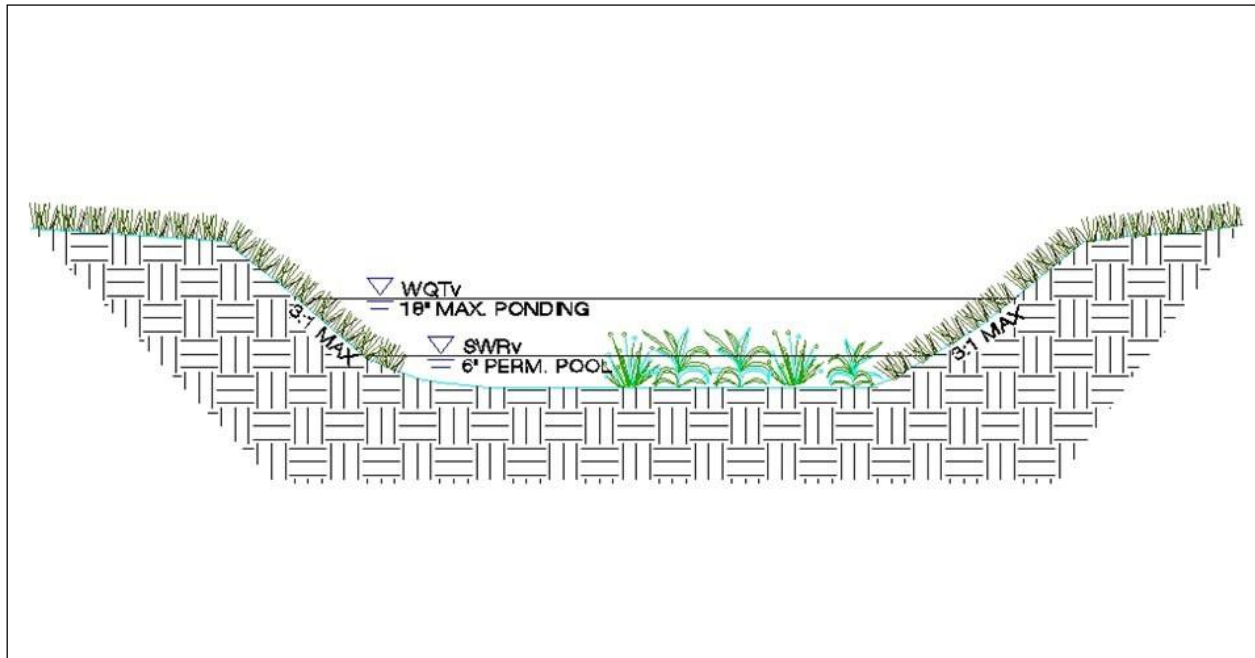


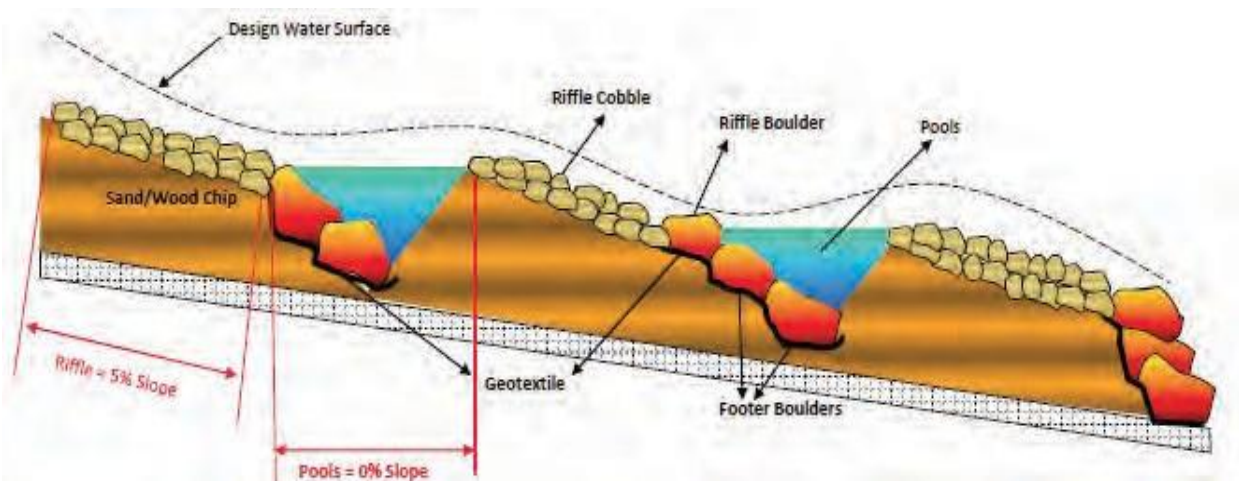
Figure 4.35. Example of a dry swale/bioswale (O-2).

**Wet swales (O-3)** can provide a modest amount of runoff filtering within the conveyance (see Figure 4.36). These linear wetland cells often intercept shallow groundwater to maintain a wetland plant community. The saturated soil and wetland vegetation provide an ideal environment for gravitational settling, biological uptake, and microbial activity. On-line or off-line cells are formed within the channel to create saturated soil or shallow standing water conditions (typically less than 6 inches deep).



**Figure 4.36. Example of a wet swale (O-3).**

**Regenerative Stormwater Conveyance (O-4).** RSC is a unique conveyance practice that can be used in locations where other conveyance practices are infeasible, or as a restoration practice for eroded or degraded outfalls and drainage channels (Figure 4.37). RSC utilizes a series of shallow aquatic pools, riffle weir grade controls, native vegetation and underlying sand and woodchip beds to treat, detain, and convey storm flow. It can be used in places where grades make traditional stormwater practices difficult to implement. Because of the regional topography and waters of the state limitations, RSC Systems will have limited application in the Southern Lowcountry. RSC Systems combine features and treatment benefits of Swales, Infiltration, Filtering and Wetland practices. In addition, they are designed to convey flows associated with larger storm events in a non-erosive manner, which results in a reduction of channel erosion impacts commonly encountered at conventional stormwater outfalls and headwater stream channels.



**Figure 4.37. Example of Regenerative Stormwater Conveyance (O-4).**

#### 4.9.1 Open Channel Feasibility Criteria

Open channel systems are primarily applicable for land uses, such as roads, highways, and residential development. Some key feasibility issues for open channels include the following:

**Contributing Drainage Area.** The maximum CDA to an open channel should be 2.5 acres, preferably less. When open channels treat and convey runoff from CDAs greater than 2.5 acres, the velocity and flow depth through the channel often becomes too great to treat runoff or prevent erosion in the channel. The design criteria for maximum channel velocity and depth are applied along the entire length (see Section 4.9.4 Open Channel Design Criteria). Dry Swales should be approximately 3%–10% of the size of the CDA, depending on the amount of impervious cover. Wet swale footprints usually cover about 5%–15% of their CDA.

**Available Space.** Open channel footprints can fit into relatively narrow corridors between utilities, roads, parking areas, or other site constraints. Grass channels can be incorporated into linear development applications (e.g., roadways) by utilizing the footprint typically required for an open section drainage feature. The footprint required will likely be greater than that of a typical conveyance channel. However, the benefit of the retention may reduce the footprint requirements for stormwater management elsewhere on the development site.

**Site Topography.** Grass channels and wet swales should be used on sites with longitudinal slopes of less than 4%. Check dams can be used to reduce the effective slope of the channel and lengthen the contact time to enhance filtering and/or infiltration. Longitudinal slopes of less than 2% are ideal and may eliminate the need for check dams. However, channels designed with longitudinal slopes of less than 1% should be monitored carefully during construction to ensure a continuous grade so as to avoid flat areas with pockets of standing water.

For dry swales, check dams will be necessary regardless of the longitudinal slope to create the necessary ponding volume.

**Land Uses.** Open channels can be used in residential, commercial, or institutional development settings.

When open channels are used for both conveyance and water quality treatment, they should be applied only in linear configurations parallel to the contributing impervious cover, such as roads and small parking areas. The linear nature of open channels makes them well-suited to treat highway or low- and medium-density residential road runoff, if there is adequate right-of-way width and distance between driveways. Typical applications of open channels include the following, as long as CDA limitations and design criteria can be met:

- Within a roadway or bicycle path right-of-way;
- Along the margins of small parking lots;
- Oriented from the roof (downspout discharge) to the street;
- Disconnecting small impervious areas; and
- Used to treat the managed turf areas of parkland, sports fields, golf courses, and other turf-intensive land uses, or to treat CDAs with both impervious and managed turf cover (such as residential streets and yards).

Open channels are not recommended when residential density exceeds more than four (4) dwelling units per acre, due to a lack of available land and the frequency of driveway crossings along the channel.

Open channels can also provide pretreatment for other stormwater treatment practices.

**Available Hydraulic Head.** A minimum amount of hydraulic head is needed to implement open channels in order to ensure positive drainage and conveyance through the channel. The hydraulic head for wet swales and grass channels is measured as the elevation difference between the channel inflow and outflow point. The hydraulic head for dry swales is measured as the elevation difference between the inflow point and the storm drain invert (unless an infiltration-based design will be used). Dry swales typically require 3 to 5 feet of hydraulic head since they have both a filter bed and underdrain.

**Hydraulic Capacity.** Open channels are typically designed as on-line practices that must be designed with enough capacity to (1) convey runoff from the 25-year design storm at non-erosive velocities, and (2) contain the 25-year flow within the banks of the swale. This means that the swale's surface dimensions are more often determined by the need to pass the 25-year storm events, which can be a constraint in the siting of open channels within existing rights-of-way (e.g., constrained by sidewalks).

**Depth to Water Table.** The bottom of dry swales and grass channels must be at least 0.5 feet above the seasonally high groundwater table, to ensure that groundwater does not intersect the filter bed, since

this could lead to groundwater contamination or practice failure. It is permissible for wet swales to intersect the water table.

**Soils.** Soil conditions do not constrain the use of open channels, although they do dictate some design considerations:

- Dry swales in soils with low infiltration rates may need an underdrain. Designers must verify site-specific soil permeability at the proposed location using the methods for on-site soil investigation presented in Appendix B Geotechnical Information Requirements for Underground BMPs to eliminate the requirements for a dry swale underdrain.
- Grass channels situated on low-permeability soils may incorporate compost amendments to improve performance (see Appendix C Soil Compost Amendment Requirements).
- Wet swales work best on the more impermeable HSG C or D soils.
- At infill soil locations, geotechnical investigations are required to determine if the use of an impermeable liner and underdrain are necessary for open channel designs.

**Utilities.** Typically, utilities can cross linear channels if they are specially protected (e.g., double-casing). Interference with underground utilities should be avoided, if possible. When large site development is undertaken, the expectation of achieving avoidance will be high. Conflicts may be commonplace on smaller sites and in the PROW. Where conflicts cannot be avoided, these guidelines shall be followed:

- Consult with each utility company on recommended offsets that will allow utility maintenance work with minimal disturbance to the BMP.
- Whenever possible, coordinate with utility companies to allow them to replace or relocate their aging infrastructure while BMPs are being implemented.
- BMP and utility conflicts will be a common occurrence in PROW projects. However, the standard solution to utility conflict should be the acceptance of conflict provided sufficient soil coverage over the utility can be assured.
- Additionally, when accepting utility conflict into the BMP design, it is understood that the BMP will be temporarily impacted during utility maintenance but restored to its original condition.

**Avoidance of Irrigation or Baseflow.** Open channels should be located so as to avoid inputs of springs, irrigation systems, chlorinated wash-water, or other dry weather flows.

**Setbacks.** To avoid the risk of seepage, stormwater cannot flow from the open channel reservoir layer or via baseflow to the traditional pavement base layer, existing structure foundations, or future foundations which may be built on adjacent properties. Open channels should be set back at least 10 feet down-gradient from building foundations and property lines, 50 feet from septic system fields and 150 feet from public or private drinking water wells. The 10-foot building setback may be relaxed if an impermeable building liner is installed.

**Pollutant Hotspot Land Use.** In areas where higher pollutant loading is likely (i.e. oils and greases from fueling stations or vehicle storage areas, sediment from un-stabilized pervious areas, or other pollutants from industrial processes), appropriate pretreatment, such as an oil-water separator or filtering device must be provided. These pretreatment facilities should be monitored and maintained frequently to avoid negative impacts to the channel and subsequent water bodies.

Runoff from hotspot land uses must not be treated with infiltrating dry swales due to the potential interaction with the water table and the risk that hydrocarbons, trace metals, and other toxic pollutants could migrate into the groundwater. An impermeable liner must be used for filtration of hotspot runoff for dry swales.

Grass channels can typically be used to convey runoff from stormwater hotspots, but they do not qualify as a hotspot treatment mechanism. Wet swales are not recommended to treat stormwater hotspots, due to the potential interaction with the water table and the risk that hydrocarbons, trace metals, and other toxic pollutants could migrate into the groundwater.

On sites with existing contaminated soils, infiltration is not allowed; dry and wet swales on these hotspots must include an impermeable liner.

**Feasibility.** Open channels are ideally suited to the Southern Lowcountry environment, since open channel drainage is often the norm due to the flat topography. Depending on underlying soil and other characteristics, however, a specific open channel option may be the most appropriate. For example, the wet swale design option is most suited to areas with elevated groundwater tables, while dry swales and grassed channels are best suited for sandy soils of the coastal plain.

**Economic Considerations.** While most open channel designs provide relatively small water quality credits when compared with other stormwater practices, they nevertheless provide greater quality benefits than traditional conveyance designs, such as curb and gutter.

#### 4.9.2 Open Channel Conveyance Criteria

The bottom width and slope of a grass channel must be designed such that the velocity of flow from the design storm provides a minimum hydraulic residence time (average travel time for a particle of water through a waterbody) of 9 minutes for the peak flows from the SWRV or design storm. Check dams may be used to achieve the needed retention volume, as well as to reduce the flow velocity. Check dams must be spaced based on channel slope and ponding requirements, consistent with the criteria in Section 4.9.4 Open Channel Design Criteria.

Open channels must also convey the 25-year storm at non-erosive velocities (generally less than 6 feet per second) for the soil and vegetative cover provided. The final designed channel shall provide 6 inches minimum freeboard above the designated water surface profile of the channel. The analysis must evaluate the flow profile through the channel at normal depth, as well as the flow depth over top of the check dams.

RSC systems are typically designed to convey larger storm events, up to and including the 100- year storm event.

#### 4.9.3 Open Channel Pretreatment Criteria

Pretreatment is required for open channels to dissipate energy, trap sediments, and slow down the runoff velocity.

The selection of a pretreatment method depends on whether the channel will experience sheet flow or concentrated flow. Several options are as follows:

- **Check Dams (channel flow).** These energy dissipation devices are acceptable as pretreatment on small open channels with CDAs of less than 1 acre. The most common form is the use of wooden or stone check dams. The pretreatment volume stored must be 15% of the design volume.
- **Tree Check Dams (channel flow).** These are street tree mounds that are placed within the bottom of grass channels up to an elevation of 9 to 12 inches above the channel invert. One side has a gravel or river stone bypass to allow runoff to percolate through (Cappiella et al, 2006). The pretreatment volume stored must be 15% of the design volume.
- **Grass Filter Strip (sheet flow).** Grass filter strips extend from the edge of the pavement to the bottom of the open channel at a slope of 5H:1V or flatter. Alternatively, provide a combined 5 feet of grass filter strip at a maximum 5% (20H:1V) cross slope and 3H:1V or flatter side slopes on the open channel.
- **Gravel or Stone Diaphragm (sheet flow).** The gravel diaphragm is located at the edge of the pavement or the edge of the roadway shoulder and extends the length of the channel to pretreat lateral runoff. This requires a 2- to 4-inch elevation drop from a hard-edged surface into a gravel or stone diaphragm. The stone must be sized according to the expected rate of discharge.
- **Gravel or Stone Flow Spreaders (concentrated flow).** The gravel flow spreader is located at curb cuts, downspouts, or other concentrated inflow points, and should have a 2- to 4-inch elevation drop from a hard-edged surface into a gravel or stone diaphragm. The gravel should extend the entire width of the opening and create a level stone weir at the bottom or treatment elevation of the channel.
- **Initial Sediment Forebay (channel flow).** This grassed cell is located at the upper end of the open channel segment with a recommended 2:1 length to width ratio and a storage volume equivalent to at least 15% of the total design storm volume. If the volume of the forebay will be included as part of the dry swale storage volume, the forebay must de-water between storm events. It cannot have a permanent ponded volume.

#### 4.9.4 Open Channel Design Criteria

**Channel Geometry.** Design guidance regarding the geometry and layout of open channels is provided below:

- Open channels should generally be aligned adjacent to and the same length as the CDA identified for treatment.
- Open channels should be designed with a trapezoidal or parabolic cross section. A parabolic shape is preferred for aesthetic, maintenance, and hydraulic reasons.
- The bottom width of the channel should be between 4 to 8 feet wide to ensure that an adequate surface area exists along the bottom of the swale for filtering. If a channel will be wider than 8 feet, the designer must incorporate benches, check dams, level spreaders, or multi-level cross sections to prevent braiding and erosion along the channel bottom.
- Open-channel side slopes should be no steeper than 3H:1V for ease of mowing and routine maintenance. Flatter slopes are encouraged, where adequate space is available, to enhance pretreatment of sheet flows entering the channel.
- RSC has several specific geometry requirements, which are outlined in RSC Sizing below.

**Check dams.** Check dams may be used for pretreatment, to break up slopes, and to increase the hydraulic residence time in the channel. Design requirements for check dams are as follows:

- Check dams should be spaced based on the channel slope, as needed to increase residence time, provide design storm storage volume, or any additional volume attenuation requirements. In typical spacing, the ponded water at a downhill check dam should not touch the toe of the upstream check dam. More frequent spacing may be desirable in dry swales to increase the ponding volume.
- The maximum desired check dam height is 12 inches, for maintenance purposes. However, for some sites, a maximum of 18 inches can be allowed, with additional design elements to ensure the stability of the check dam and the adjacent and underlying soils.
- Armoring may be needed at the downstream toe of the check dam to prevent erosion.
- Check dams must be firmly anchored into the side-slopes to prevent outflanking; check dams must also be anchored into the channel bottom so as to prevent hydrostatic head from pushing out the underlying soils.
- Check dams must be designed with a center weir sized to pass the channel design storm peak flow (25-year storm event for man-made channels).
- For grass channels, each check dam must have a weep hole, or similar drainage feature, so it can dewater after storms. This is not appropriate for dry swales.
- Check dams should be composed of wood, concrete, stone, compacted soil, or other non-erodible material, or should be configured with elevated driveway culverts.
- Individual channel segments formed by check dams or driveways should generally be at least 25 to 40 feet in length.

Check dams for grass channels must be spaced to reduce the effective slope to less than 2%, as indicated in Table 4.32.

**Table 4.32. Typical Check Dam Spacing to Achieve Effective Channel Slope**

Channel Longitudinal Slope (%)	Check Dam Spacing to Achieve Effective Slope <sup>a, b, c</sup>	
	Effective Slope of 2% (ft)	Effective Slope of 0%–1% (ft)
0.5	–	
1.0	–	
1.5	–	67–200
2.0	–	50–100
2.5	200	40–67
3.0	100	33–50
3.5	67	30–40
4.0	50	25–33



4.5 <sup>d</sup>	40	20–30
5.0 <sup>d</sup>	40	20–30

<sup>a</sup> All check dams require a stone energy dissipator at the downstream toe.

<sup>b</sup> Check dams require weep holes at the channel invert. Swales with slopes less than 2% will require multiple weep holes (at least 3) in each check dam.

<sup>c</sup> Assumed check dam height is 12 inches. The spacing dimension is half of the above distances if a 6-inch check dam is used.

<sup>d</sup> Open channels with slopes greater than 4% require special design considerations, such as drop structures to accommodate greater than 12-inch high check dams (and therefore a flatter effective slope), in order to ensure non-erosive flows.

**Ponding Depth.** Check dams must be used in dry swales to create ponding cells along the length of the channel. The maximum ponding depth in a dry swale must not exceed 18 inches. Minimum surface ponding depth is 3 inches (averaged over the surface area of the open channel). In order to increase the ponding depth, it may be necessary or desirable to space check dams more frequently than is shown in Table 4.32.

**Dry Swale Filter Media.** Dry swales require replacement of native soils with a prepared filter media. The filter media provides adequate drainage, supports plant growth, and facilitates pollutant removal within the dry swale. At least 18 inches of filter media must be added above the choker stone layer (and no more than 6 feet) to create an acceptable filter. The recipe for the filter media is identical to that used for bioretention and is provided in Section 4.1 Bioretention. The batch receipt confirming the source of the filter media should be submitted to the Beaufort County Public Works Department inspector. One acceptable design adaptation is to use 100% sand for the first 18 inches of the filter and add a combination of topsoil and compost, as specified in Appendix C Soil Compost Amendment Requirements, for the top 4 inches, where turf cover will be maintained.

**Dry Swale Drawdown.** Dry swales must be designed so that the desired design storm volume is completely filtered within 72 hours, using the equations specified in Section 4.9.6 Open Channel Construction Sequence.

**Dry Swale Underdrain.** Some dry swale designs will not use an underdrain (where soil infiltration rates meet minimum standards). See Section 4.9.1 Open Channel Feasibility Criteria for more details. When underdrains are necessary, they should have a minimum diameter of 4 to 6 inches and be encased in a 12-inch deep gravel bed. Two layers of stone should be used. A choker stone layer, consisting of No. 8 or No. 89 stone at least 3 inches deep, must be installed immediately below the filter media. Below the choker stone layer, the underdrain must be encased (a minimum of 2 inches above and below the underdrain) in a layer of clean, double-washed ASTM D448 No.57 or smaller (No. 68, 8, or 89) stone. The maximum depth of the underdrain stone layer combined with the choking layer is 12 inches, and it cannot extend beyond the surface dimensions of the dry swale filter media.

**Impermeable Liner.** An impermeable liner is not typically required, although it may be utilized in fill applications where deemed necessary by a geotechnical investigation, on sites with contaminated soils, or on the sides of the practice to protect adjacent structures from seepage. Use a PVC geomembrane liner or an equivalent of an appropriate thickness (follow manufacturer's instructions for installation). Field seams must be sealed according to the liner manufacturer's specifications. A minimum 6-inch overlap of material is required at all seams.

**Dry Swale Observation Well.** A dry swale must include well-anchored, 4- to 6-inch diameter PVC pipe observation wells along the length of the swale. For a dry swale with an underdrain, the wells should be tied into any Ts or Ys in the underdrain system and must extend upward above the surface of the ponding. These observation wells may double as clean outs. For an infiltrating dry swale, the observation well should be perforated in the gravel layer only.

**Grass Channel Material Specifications.** The basic material specifications for grass channels are outlined in Table 4.33.

**Table 4.33. Grass Channel Material Specifications**

Component	Specification
Grass	<p>A dense cover of water-tolerant, erosion-resistant grass. The selection of an appropriate species or mixture of species is based on several factors including climate, soil type, topography, and sun or shade tolerance.</p> <p>Grass species should have the following characteristics:</p> <ul style="list-style-type: none"> <li>▪ A deep root system to resist scouring;</li> <li>▪ A high stem density with well-branched top growth;</li> <li>▪ Water-tolerance;</li> <li>▪ Resistance to being flattened by runoff;</li> <li>▪ An ability to recover growth following inundation; and</li> </ul>
Check Dams	<p>Check dams should be constructed of a non-erodible material such as wood, gabions, riprap, or concrete.</p> <p>Wood used for check dams should consist of pressure-treated logs or timbers or water-resistant tree species such as cedar, hemlock, swamp oak, or locust.</p> <p>Computation of check dam material is necessary, based on the surface area and depth used in the design computations.</p>
Diaphragm	Pea gravel used to construct pretreatment diaphragms must consist of washed, open-graded, course aggregate between 3 and 10 mm in diameter.
Erosion Control Fabric	Where flow velocities dictate, biodegradable erosion control netting or mats that are durable enough to last at least two growing seasons must be used.

**Dry Swale Material Specifications.** For additional material specifications pertaining to dry swales, designers should consult Section 4.1.4 Bioretention Design Criteria and Table 4.34.

**Table 4.34. Dry Swale Material Specifications**

Material	Specification	Notes
Filter Media Composition	<p>Filter Media to contain:</p> <ul style="list-style-type: none"> <li>☐ 80%–90% sand</li> <li>☐ 10%–20% soil fines</li> <li>☐ Maximum 10% clay</li> </ul>	To account for settling/compaction, it is recommended that 110% of the plan volume be utilized.

Material	Specification	Notes
	☑ 3%–5% organic matter	
Filter Media Testing	P content = 5 to 15 mg/kg (Mehlich I) or 18 to 40 mg/kg (Mehlich III) CEC > 5 milliequivalents per 100 grams	See Section 4.3.4 Bioretention, for additional filter media information.
Geotextile	Geotextile fabric meeting the following specifications: ☑ AASHTO M-288 Class 2, latest edition ☑ Has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability. ☑ Apply along sides of the filter media only and do not apply along the swale bottom.	
Choking Layer	A 2- to 4-inch layer of choker stone (typically No. 8 or No. 89 washed gravel) laid above the underdrain stone.	
Underdrain Stone Layer	Stone must be double-washed and clean and free of all fines (ASTM D448 No. 57 or smaller stone).	
Underdrains and Cleanouts	4-inch or 6-inch rigid schedule 40 PVC pipe, with 3 or 4 rows of 3/8-inch perforations at 6 inches on center.	Install perforated pipe for the full length of the dry swale cell. Use non-perforated pipe, as needed, to connect with the storm drain system.
Observation Wells	4-inch or 6-inch rigid schedule 40 PVC pipe	For dry swales with underdrains, tie the non-perforated observation well to the underdrain via T or Y connection. This observation well can double as a cleanout. For dry swales without an underdrain, the pipe should only be perforated in the gravel layer. The observation wells should extend to the top of ponding.
Impermeable Liner	Where appropriate, use a PVC geomembrane liner or equivalent.	
Vegetation	Plant species as specified on the landscaping plan.	
Check Dams	Use non-erosive material, such as wood, gabions, riprap, or concrete. Wood used for check dams should consist of pressure-treated logs or timbers, or water-resistant tree species, such as cedar, hemlock, swamp oak, or locust.	
Erosion Control Fabric	Where flow velocities dictate, use woven biodegradable erosion control fabric or mats (EC2) that are durable enough to last at least 2 growing seasons.	

**RSC Material Specifications.** RSC has several design elements that are unique to this practice. The practice includes riffle and pool segments, underlain with a sand/ wood chip bed, and with a top dressing of compost and plant material. Table 4.35 outlines the materials needed for this practice.

**Table 4.35. Regenerative Stormwater Conveyance System Material Specifications**

Material	Specification
Footer Boulders	Should have a natural appearance and be equivalent in size to Class 3 Rip Rap (average diameter 26.4 inches)
Cobble	Should have a natural appearance and a minimum diameter of 6"
Sand/ Woodchip Bed	<p>The sand component of the sand/wood chip bed should meet the AASHTO- M-6 or ASTM-C-33, 0.02 inches to 0.04 inches in size. Sand shall be a silica-based coarse aggregate. Substitutions such as Diabase and Gray- stone (AASHTO) #10 are not acceptable. No calcium carbonate or dolomitic sand substitutions are acceptable. No "rock dust" can be used for sand. Locally-approved pulverized glass may be substituted if the local authority undertakes testing to verify compliance with the particle size specification. No art glass shall be used for a pulverized glass material.</p> <p>For woodchips, use aged, shredded hardwood chips/mulch. The woodchips should be added to the sand mix, approximately 20 percent by volume, to increase the organic content and promote plant growth and sustainability.</p>
Choker Stone	The choker stone layer between the sand bed and the bank run gravel should be clean, washed #8 or #78 stone.
Bank Run Gravel	The bank run gravel layer that is placed beneath and above the sand bed/choker stone layers should be constructed using clean, washed # 5 or # 57 coarse aggregate.
Compost	The compost used as a top dressing over the RSC System should consist of a 100% organic compost, with a pH of between 6.0 and 7.0, a moisture content of between 30 and 55%, and a particle size of 0.25 inches or less. (See Appendix C for compost specifications)
Wood Chips	The wood chips used within the sand bed should consist of double-shredded or double-ground hardwood mulch that is free of dyes, chromated copper arsenate and other preservatives.
Plant Materials	Plants should be native species, appropriate to the planting/wetness zone where they are located.

**Wet Swale Design Issues.** The following criteria apply to the design of wet swales:

- ❑ The average normal pool depth (dry weather) throughout the swale must be 6 inches or less.
- ❑ The maximum temporary ponding depth in any single wet swale cell must not exceed 18 inches at the most downstream point (e.g., at a check dam or driveway culvert).
- ❑ Check dams should be spaced as needed to maintain the effective longitudinal slope.

- ⑦ Individual wet swale segments formed by check dams or driveways should generally be at least 25 to 40 feet in length.
- ⑦ Wet swale side slopes should be no steeper than 4H:1V to enable wetland plant growth. Flatter slopes are encouraged where adequate space is available, to enhance pretreatment of sheet flows entering the channel. Under no circumstances are side slopes to steeper than 3H:1V.

**Grass Channel Enhancement using Compost Soil Amendments.** Soil compost amendments serve to increase the retention capability of a grass channel. The following design criteria apply when compost amendments are used:

- ⑦ The compost-amended strip must extend over the length and width of the channel bottom, and the compost must be incorporated to a depth as outlined in Appendix C Soil Compost Amendment Requirements.
- ⑦ For grass channels on steep slopes, it may be necessary to install a protective biodegradable erosion control mat to protect the compost-amended soils. Care must be taken to consider the erosive characteristics of the amended soils when selecting an appropriate erosion control mat.

**Grass Channel Sizing.** Unlike other BMPs, grass channels are designed based on a peak rate of flow. Designers must demonstrate channel conveyance and treatment capacity in accordance with the following guidelines:

- Hydraulic capacity should be verified using Manning's Equation or an accepted equivalent method, such as erodibility factors and vegetal retardance.
- ⑦ The flow depth for the peak flow generated by the SWRV must be maintained at 4 inches or less.
- Manning's "n" value for grass channels is 0.2 for flow depths up to 4 inches, decreasing to 0.03 at a depth of 12 inches and above, which would apply to the 2- to 25-year storms if an on-line application (Haan et. al, 1994).
- ⑦ Peak flow rates for the 25-year frequency storm must be non-erosive, in accordance with Table 4. 37 (see Section 4.9.5 Open Channel Landscaping Criteria), or subject to a site-specific analysis of the channel lining material and vegetation; and the 25-year peak flow rate must be contained within the channel banks (with a minimum of 6 inches of freeboard).
- ⑦ Calculations for peak flow depth and velocity must reflect any increase in flow along the length of the channel, as appropriate. If a single flow is used, the flow at the outlet must be used.
- ⑦ The hydraulic residence time (e.g., the average travel time for a particle of water through a waterbody) must be a minimum of 9 minutes for the peak flows from the SWRV or design storm (Mar et al., 1982; Barrett et al., 1998; Washington State Department of Ecology, 2005). If flow enters the swale at several locations, a 9-minute minimum hydraulic residence time must be demonstrated for each entry point, using Equation 4.13 through Equation 4. 17.

The bottom width of the grass channel is therefore sized to maintain the appropriate flow geometry as follows:

**Equation 4. 13 Manning's Equation**

$$V = \left( \frac{1.49}{n} \right) \times D^{2/3} \times S^{1/2}$$

Where:

- $V$  = flow velocity (ft/s)
- $n$  = roughness coefficient (0.2, or as appropriate)
- $D$  = flow depth (ft) (Note:  $D$  approximates hydraulic radius for shallow flows)
- $S$  = channel slope (ft/ft)

**Equation 4. 14 Continuity Equation**

$$Q = V \times (W + 3 \times D) \times D$$

where:

- $Q$  = design storm peak flow rate (cfs)
  - $V$  = design storm flow velocity (ft/s)
  - $W$  = channel bottom width (ft)
  - $D$  = flow depth (ft)
- (Note: Channel width ( $W$ ) plus 3 times the depth ( $D$ ) represents the average width of a trapezoidal channel with 3H:1V side slopes. Average width multiplied by depth equals the cross-sectional flow area.)

Combining Equation 4.13 and Equation 4.14, and rewriting them provides a solution for the minimum width (Equation 4.15):

**Equation 4. 15 Minimum Width**

$$W = \frac{D \times Q}{1.49 \times D^{5/3} \times S^{1/2}} - (3 \times D)$$

where:

- $W$  = channel bottom width (ft)
- $n$  = roughness coefficient (0.2, or as appropriate)
- $Q$  = design storm peak flow rate (cfs)
- $D$  = flow depth (ft)
- $S$  = channel slope (ft/ft)

Equation 4.16 provides the corresponding velocity:

**Equation 4. 16 Corresponding Velocity**

$$VV = \frac{QQ}{(WW + 3 \times DD) \times DD}$$

where:

$V$	=	design storm flow velocity (ft/s)
$Q$	=	design storm peak flow rate (cfs)
$W$	=	channel bottom width (ft)
$D$	=	flow depth (ft)

The width, slope, or Manning's "n" value can be adjusted to provide an appropriate channel design for the site conditions. However, if a higher density of grass is used to increase the Manning's "n" value and decrease the resulting channel width, it is important to provide material specifications and construction oversight to ensure that the denser vegetation is actually established. Equation 4.17 can then be used to ensure adequate hydraulic residence time.

**Equation 4. 17 Grass Channel Length for Hydraulic Residence Time of 9 minutes (540 seconds)**

$$LL = 540 \times VV$$

where:

$L$	=	minimum swale length (ft)
$V$	=	flow velocity (ft/s)

The storage volume ( $S_v$ ) provided by the grass channel is equal to the total runoff from the design storm (typically  $SWR_v$ ) used to size the channel (conveyed at a depth of 4 inches or less), as shown in Equation 4.18.

**Equation 4. 18 Grass Channel Storage Volume**

$$SSRR = DDDDDDDDDSSSSDDDDDD$$

where:

$S_v$	=	total storage volume of grass channel (ft <sup>3</sup> )
<i>DesignStorm</i>	=	$SWR_v$ or other design storm volume (ft <sup>3</sup> ) (e.g., portion of the $SWR_v$ )

**Dry Swale Sizing.** Dry swales are typically sized to capture the  $SWR_v$  or larger design storm volumes in the surface ponding area, filter media, and gravel reservoir layers of the dry swale.

Total storage volume of the BMP is calculated using Equation 4.19.

#### Equation 4. 19 Dry Swale Storage Volume

$$SSRR = SSS_{bottom} \times d_{media} \times \eta_{media} + (SSS_{gravel} \times \eta_{gravel}) + (SSS_{average} \times d_{ponding})$$

where:

$S_v$	=	total storage volume of dry swale (ft <sup>3</sup> )
$SA_{bottom}$	=	bottom surface area of dry swale (ft <sup>2</sup> )
$d_{media}$	=	depth of the filter media, including mulch layer (ft)
$\eta_{media}$	=	effective porosity of the filter media (typically 0.25)
$d_{gravel}$	=	depth of the underdrain and underground storage gravel layer, including choker stone (ft)
$\eta_{gravel}$	=	effective porosity of the gravel layer (typically 0.4)
$SA_{average}$	=	average surface area of the dry swale (ft <sup>2</sup> ) typically, where $SA_{top}$ is the top surface area of dry swale,

$$SA_{average} = \frac{SA_{bottom} + SA_{top}}{2}$$

$d_{ponding}$	=	the maximum ponding depth of the dry swale (ft)
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Equation 4.19 can be modified if the storage depths of the filter media, gravel layer, or ponded water vary in the actual design or with the addition of any surface or subsurface storage components (e.g., additional area of surface ponding, subsurface storage chambers, etc.). The maximum depth of ponding in the dry swale must not exceed 18 inches. If storage practices will be provided off-line or in series with the dry swale, the storage practices should be sized using the guidance in Section 0 Storage Practices.

Dry swales can be designed to address, in whole or in part, the detention storage needed to comply with channel protection and/or flood control requirements. The  $S_v$  can be counted as part of the 2- to 25-year runoff volumes to satisfy stormwater quantity control requirements.

Note: To increase the storage volume of a dry swale, the ponding surface area may be increased beyond the filter media surface area. However, the top surface of the BMP (at the top of the ponding elevation) may not be more than twice the size of surface area of the filter media ( $SA_{bottom}$ ).

**Wet Swale Sizing.** Wet swales can be designed to capture and treat the SWRV remaining from any upstream stormwater retention practices. The storage volume is made up of the temporary and permanent storage created within each wet swale cell. This includes the permanent pool volume and up to 12 inches of temporary storage created by check dams or other design features that has 24 hours extended detention.

The storage volume ( $S_v$ ) of the practice is equal to the volume provided by the pond permanent pool plus the 24-hour extended detention (ED) volume provided by the practice (Equation 4.20). The total  $S_v$  cannot exceed the design SWRV.

#### Equation 4. 20 Wet Swale Storage Volume

$$SSRR = PPDDDDd + PPDDDDppDDDDDD + PPDDDD \eta_{RRDD} + 24 h_{DD} EDD \eta_{RRDD}$$



**RSC Sizing.** RSC design is an iterative process in which the channel is sized to convey the 100-year storm event, using Manning's equation for parabolic channels.

Some key RSC sizing considerations include the following:

- One control structure and pool (riffle-pool) combination is needed for each foot of elevation difference along the channel.
- The length of each grade control structure or pool is determined by Equation 4.21

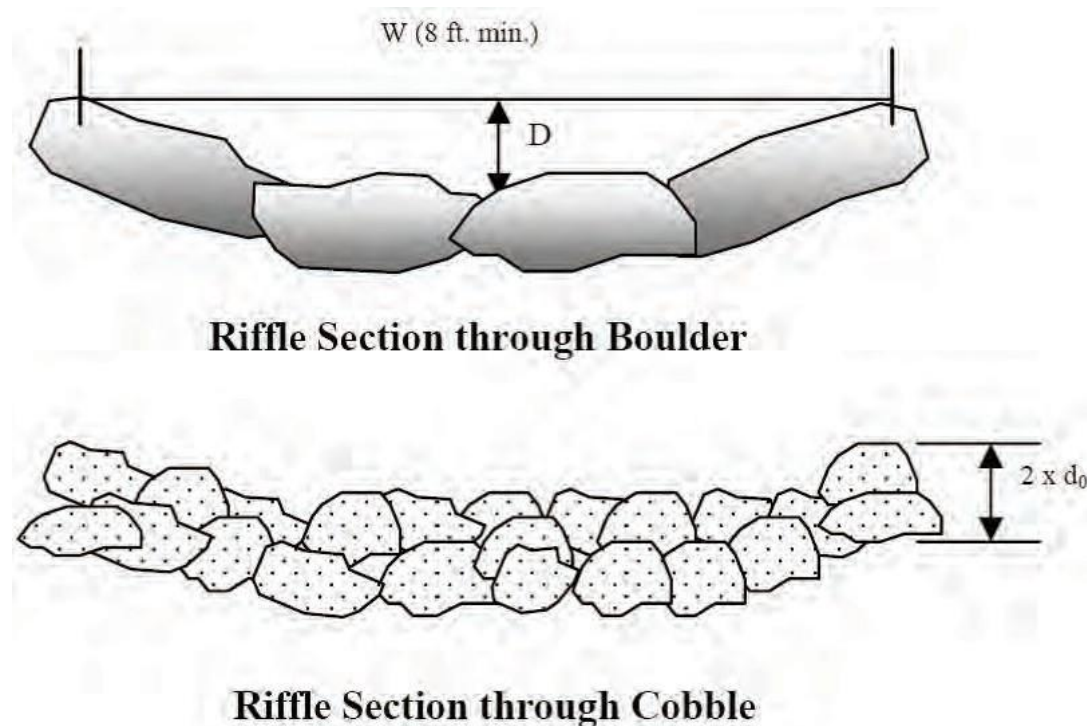
#### Equation 4. 21 Riffle Pool Length

$$L_{\text{riffle}} = \frac{L_{\text{pool}}}{(E_{\text{riffle}} \times 2)}$$

where:

$L_{\text{pool}}$	=	surface length of each pool (ft)
$L_{\text{riffle}}$	=	total length of riffle pool (ft)
Elevation Change	=	difference in elevation between pool and bottom pool (ft)

- In areas with steep slopes (10% or greater) the length of the pool or riffle may be small (<10'). In these locations, cascades may be needed as a part of the system design.
- The minimum width of grade control structures should be 8 ft and the width should be equal to 10 times the channel depth (Figure 4.38).
- The depth of flow in the riffle sections should be less than 4 inches.
- Cobbles in the riffle section should be sized so that the velocity of the 100-year storm is non-erosive (Table 4.36).



**Figure 4.38. Typical Width and Depth of Riffle Sections (Anne Arundel County, 2011).**

**Table 4.36. Maximum Allowable Velocity**

Cobble size (in)		Allowable velocity (ft/s)
4		5.8
5		6.4
6		6.9
7		7.4
8		7.9
9		8.4
10		8.8
11		9.2
12		9.6
15		10.4

- Pools should be between 1.5 and 3 feet deep, and equal to the width of the riffle sections.
- The RSC system is underlain with a sand bed with a 1–5 foot depth and a width between 4 and 14 feet.
- The downstream edge of the riffle should incorporate a series of boulders in a parabolic shape.
- Place a cobble apron below the riffle section to allow for a stable transition between the riffle section and the downstream pools when the pools are dry. The cobble apron should be approximately 5 feet wide and 3 feet long.

The total  $S_v$  in the RSC system (available for water quality treatment) is determined by Equation 4.22.

#### Equation 4.22 RSC Systems Storage Volume

$$SSRR = V_{pool} + V_{sandbed}$$

where:

- $S_v$  = total storage volume of RSC system (ft<sup>3</sup>)  
 $V_{pool}$  = volume in pools (ft<sup>3</sup>)  
 $V_{sandbed}$  = volume in sand bed (ft<sup>3</sup>), use effective porosity of 0.25

#### 4.9.5 Open Channel Landscaping Criteria

All open channels must be stabilized to prevent erosion or transport of sediment to receiving practices or drainage systems. There are several types of grasses appropriate for dry open channels (grass channels and dry swales). These are listed in Table 4.37. Designers should choose plant species that can withstand both wet and dry periods and relatively high velocity flows for planting within the channel. Designers should ensure that the maximum flow velocities do not exceed the values listed in the table for the selected grass species and the specific site slope. For more information on stabilization seeding, see the Charleston County Stabilization Specifications.

**Table 4.37. Recommended Vegetation for Open Channels**

Vegetation Type	Slope (%)	Maximum Velocity (ft/s)	
		Erosion Resistant Soil	Easily Eroded Soil
Bermuda Grass	0–5	8	6
	5–10	7	5
	>10	6	4
Kentucky Bluegrass	0–5	7	5
	5–10	6	4
	>10	5	3
Tall Fescue Grass Mixture	0–5	6	4
	5–10	4	3
Annual and Perennial Rye	0–5	4	3
Sod		4	3

Source: USDA, TP-61, 1954; Roanoke Virginia, Stormwater Design Manual, 2008

Wet swales should be planted with grass and wetland plant species that can withstand both wet and dry periods as well as relatively high velocity flows within the channel. For a list of wetland plant species suitable for use in wet swales, refer to the wetland planting guidance and plant lists provided in Section 0 Stormwater Wetlands.

Landscape design shall specify proper grass species based on site-specific soils and hydric conditions present along the channel.

Open channels should be seeded at such a density to achieve a 90% vegetated cover after the second growing season. Taller and denser grasses are preferable, although the species is less important than good stabilization and dense vegetative cover.

Grass channels should be seeded and not sodded. Seeding establishes deeper roots and sod may have muck soil that is not conducive to infiltration. Grass channels should be protected by a biodegradable erosion control fabric to provide immediate stabilization of the channel bed and banks.

#### 4.9.6 Open Channel Construction Sequence

**Design Notes.** Channel invert and tops of banks are to be shown in plan and profile views. A cross sectional view of each configuration and completed limits of grading must be shown for proposed channels. For proposed channels, the transition at the entrance and outfall is to be clearly shown on plan and profile views.

**Open Channel Installation.** The following is a typical construction sequence to properly install open channels, although steps may be modified to reflect different site conditions or design variations. Grass channels should be installed at a time of year that is best to establish turf cover without irrigation. For more specific information on the installation of wet swales, designers should consult the construction criteria outlined in Section 0 Stormwater Wetlands.

1. **Protection During Site Construction.** Ideally, open channels should remain outside the limits of disturbance during construction to prevent soil compaction by heavy equipment. However, this is seldom practical, given that the channels are a key part of the drainage system at most sites. In these cases, temporary soil erosion and sediment controls such as dikes, silt fences, and other erosion control measures should be integrated into the swale design throughout the construction sequence. Specifically, barriers should be installed at key check dam locations, and erosion control fabric should be used to protect the channel. Dry swales that lack underdrains (and rely on infiltration) must be fully protected by silt fence or construction fencing to prevent compaction by heavy equipment during construction.
2. **Installation.** Installation may only begin after the entire CDA has been stabilized with vegetation. Any accumulation of sediments that does occur within the channel must be removed during the final stages of grading to achieve the design cross section. Soil erosion and sediment controls for construction of the channel must be installed as specified in the soil erosion and sediment control plan. Stormwater flows must not be permitted into the channel until the bottom and side slopes are fully stabilized.
3. **Grading.** Grade the grass channel to the final dimensions shown on the plan. Excavators or backhoes should work from the sides to grade and excavate the open channels to the appropriate design dimensions. Excavating equipment should have scoops with adequate reach so they do not have to sit inside the footprint of the open channel area. If constructing a dry swale, the bottom of the swale should be ripped, rototilled or otherwise scarified to promote greater infiltration.
4. **Placing Stone Layer (for dry swales).** If constructing a dry swale, place an acceptable geotextile fabric on the underground (excavated) sides of the dry swale with a minimum 6-inch overlap. Place the stone needed for storage layer over the filter bed. Add the perforated underdrain pipe. Add the remaining stone jacket, and then pack No. 57 stone (clean, double-washed) to 3 inches above the top of the underdrain, and then add 3 inches of pea gravel as a filter layer. Add the filter media in 12-inch lifts until the desired top elevation of the dry swale is achieved. Water thoroughly and add additional media as needed where settlement has occurred.
5. **Add Amendments (optional, for grass channels).** Add soil amendments as needed. Till the bottom of the grass channel to a depth of 1 foot and incorporate compost amendments according to Appendix C Soil Compost Amendment Requirements.
6. **Install Check Dams.** Install check dams, driveway culverts and internal pretreatment features as shown on the plan. Fill material used to construct check dams should be placed in 8- to 12-inch lifts and compacted to prevent settlement. The top of each check dam must be constructed level at the design elevation.
7. **Hydro-seed.** Hydro-seed the bottom and banks of the open channel, and peg in erosion control fabric or blanket where needed. After initial planting, a biodegradable erosion control fabric should be used, conforming the South Carolina BMP Handbook (SDHEC, 2005).
8. **Plant.** Plant landscaping materials as shown in the landscaping plan, and water them weekly during the first 2 months. The construction contract should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction.
9. **Final Inspection.** A qualified professional should conduct the final construction inspection and develop a punch list for facility acceptance.

**Open Channel Construction Supervision.** Supervision during construction is recommended to ensure that the open channel is built in accordance with these specifications.

Construction phase inspection checklist is available in Appendix E Construction Inspection Checklists.

Some common pitfalls can be avoided by careful construction supervision that focuses on the following key aspects of dry swale installation:

- Make sure the desired coverage of turf or erosion control fabric has been achieved following construction, both on the channel beds and their contributing side-slopes.
- Inspect check dams and pretreatment structures to make sure they are at correct elevations, are properly installed, and are working effectively.
- For dry swale designs:
  - ❑ Check the filter media to confirm that it meets specifications and is installed to the correct depth.
  - ❑ Check elevations, such as the invert of the underdrain, inverts for the inflow and outflow points, and the ponding depth provided between the surface of the filter bed and the overflow structure.
  - ❑ Ensure that caps are placed on the upstream (but not the downstream) ends of the underdrains.
  - ❑ Check that outfall protection/energy dissipation measures at concentrated inflow and outflow points are stable.

The real test of an open channel occurs after its first big storm. The post-storm inspection should focus on whether the desired sheet flow, shallow concentrated flows or fully concentrated flows assumed in the plan actually occur in the field. Minor adjustments are normally needed as part of this post-storm inspection (e.g., spot reseeding, gully repair, added armoring at inlets, or realignment of outfalls and check dams). Also, a qualified professional should check that dry swale practices drain completely within the 72-hour drawdown period.

#### 4.9.7 Open Channel Maintenance Criteria

Maintenance is a crucial and required element that ensures the long-term performance of open channels. Once established, grass channels have minimal maintenance needs outside of the spring cleanup, regular mowing, repair of check dams, and other measures to maintain the hydraulic efficiency of the channel and a dense, healthy grass cover. Dry swale designs may require regular pruning and management of trees and shrubs. The surface of dry swale filter beds can become clogged with fine sediment over time, but this can be alleviated through core aeration or deep tilling of the filter bed. Additional effort may be needed to repair check dams, stabilize inlet points, and remove deposited sediment from pretreatment cells. Table 4.38 provides a schedule of typical maintenance activities required for open channels.

**Table 4.38. Typical Maintenance Activities and Schedule for Open Channels**

Schedule	Maintenance Activity
As needed	<ul style="list-style-type: none"> <li>Mow grass channels and dry swales during the growing season to maintain grass heights in the 4- to 6-inch range.</li> </ul>
Quarterly	<ul style="list-style-type: none"> <li>Ensure that the CDA, inlets, and facility surface are clear of debris.</li> <li>Ensure that the CDA is stabilized. Perform spot-reseeding if where needed.</li> <li>Remove accumulated sediment and oil/grease from inlets, pretreatment devices, flow diversion structures, and overflow structures.</li> <li>Repair undercut and eroded areas at inflow and outflow structures.</li> </ul>
Annual inspection	<ul style="list-style-type: none"> <li>Add reinforcement planting to maintain 90% turf cover. Reseed areas of dead vegetation.</li> <li>Remove any accumulated sand or sediment deposits behind check dams.</li> <li>Inspect upstream and downstream of check dams for evidence of undercutting or erosion. Remove trash or blockages at weepholes.</li> <li>Examine channel bottom for evidence of erosion, braiding, excessive ponding, or dead grass.</li> <li>Check inflow points for clogging and remove any sediment.</li> <li>Inspect side slopes and grass filter strips for evidence of any rill or gully erosion and repair.</li> <li>Look for any bare soil or sediment sources in the CDA and stabilize immediately.</li> </ul>

**Maintenance Inspections.** Annual inspections by a qualified professional are used to trigger maintenance operations, such as sediment removal, spot revegetation, and inlet stabilization. Maintenance inspection checklists for disconnection and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### 4.9.8 Open Channel Stormwater Compliance Calculations

Grass channels are credited with 10% retention for the storage volume (Sv) provided by the practice as well as 50% TSS, 25% TN, and 30% bacteria removal (see Table 4.39).

**Table 4.39. Grass Channel Retention and Pollutant Removal**

Retention	= 10%
TSS Removal	= 50%
TN Removal	= 25%
Bacteria Removal	= 30%

Grass channels with amended soils are credited with 20% retention for the storage volume (Sv) provided by the practice as well as 50% TSS, 35% TN, and 30% bacteria removal (Table 4.40).

Table 4.40. Grass Channel on Amended Soils Retention and Pollutant Removal

Retention	= 20%
TSS Removal	= 50%
TN Removal	= 35%
Bacteria Removal	= 30%

Dry swales are credited with 60% retention for the storage volume (Sv) provided by the practice as well as 85% TSS, 70% TN, and 80% bacteria removal (Table 4.41).

**Table 4.41. Dry Swale Retention and Pollutant Removal**

Retention	= 60%
TSS Removal	= 85%
TN Removal	= 70%
Bacteria Removal	= 80%

Wet Swales are credited with 0% retention, but they do receive 80% TSS, 25% TN, and 60% bacteria removal for the storage volume (Sv) provided by the practice (Table 4.42).

**Table 4.42. Wet Swale Retention and Pollutant Removal**

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 25%
Bacteria Removal	= 60%

RSCs are credited with 0% retention, but they do receive 80% TSS, 40% TN, and 80% bacteria removal for the storage volume (Sv) provided by the practice (Table 4.43).



**Table 4.43. RSC Retention and Pollutant Removal**

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 40%
Bacteria Removal	= 80%

All practices must be sized using the guidance detailed in Section 4.9.4 Open Channel Design Criteria.

Open channels also contribute to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume from the total runoff volume for the 2-year through the 50-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

#### 4.10 Filtering Systems

Filtering Systems				
<b>Definition:</b> Practices that capture and temporarily store the design storm volume and pass it through a filter bed of sand media. Filtered runoff may be collected and returned to the conveyance system or allowed to partially infiltrate into the soil.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		80%	30%	80%
		Runoff Reductions		
Construction Costs	Maintenance Burden	Volume		
High	High	Low		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	0%		
At least annually	Every 5 years			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Applicable to small drainage areas</li><li>▪ Good for highly impervious areas</li><li>▪ Good for water quality retrofits to existing developments</li></ul>		<ul style="list-style-type: none"><li>▪ High maintenance burden</li><li>▪ Not recommended for areas with high sediment content in stormwater or clay/silt runoff areas</li><li>▪ Relatively costly</li><li>▪ Possible odor problems, if not maintained</li><li>▪ Limited volume and rate control</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Conveyance</li><li>▪ Pretreatment</li><li>▪ Sand bed (or Filtration) chamber</li><li>▪ Spillway/outlet system(s)</li><li>▪ Liner, as needed</li></ul>		<ul style="list-style-type: none"><li>▪ Typically requires 2 to 10 feet of head</li><li>▪ Maximum CDA of 2-5 acres</li><li>▪ Must drain within 40 hours</li><li>▪ In karst areas, watertight structure required</li><li>▪ Maintenance access</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Inspect for clogging—rake first inch of sand</li><li>▪ Remove sediment from pretreatment areas</li></ul>		<ul style="list-style-type: none"><li>▪ Replace filter media as needed</li><li>▪ Clean spillway/outlet system(s)</li></ul>		

<sup>1</sup>Credited pollutant load removal

Stormwater filters are a useful practice to treat stormwater runoff from small, highly impervious sites. Stormwater filters capture, temporarily store, and treat stormwater runoff by passing it through an engineered filter media, collecting the filtered water in an underdrain, and then returning it back to the storm drainage system. Stormwater filters are a versatile option because they consume very little surface land and have few site restrictions. They provide moderate pollutant removal performance at small sites where space is limited.

**Definition.** Practices that capture and temporarily store the design storm volume and pass it through a filter bed of sand media. Filtered runoff may be collected and returned to the conveyance system or allowed to partially infiltrate into the soil. Design variants include the following:

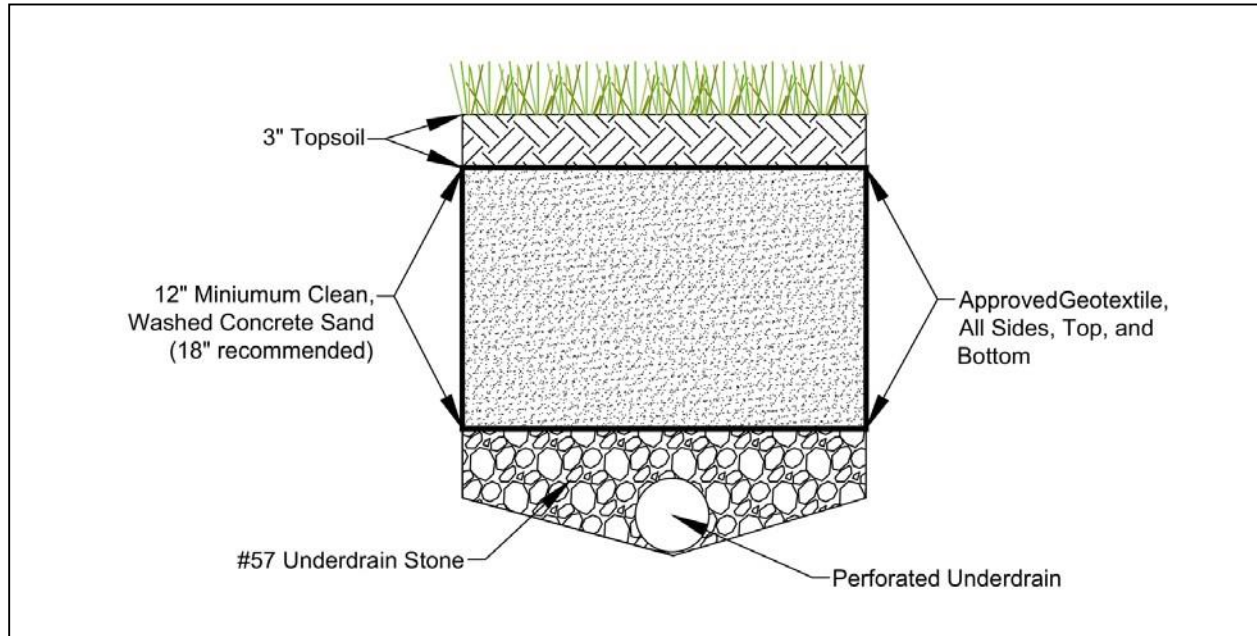
- F-1 Nonstructural sand filter
- F-2 Surface sand filter
- F-3 Three-chamber underground sand filter
- F-4 Perimeter sand filter

Filters have no retention capability, so designers should consider using up-gradient retention practices, which have the effect of decreasing the design storm volume and size of the filtering practices. Filtering practices are also suitable to provide special treatment at designated stormwater hotspots.

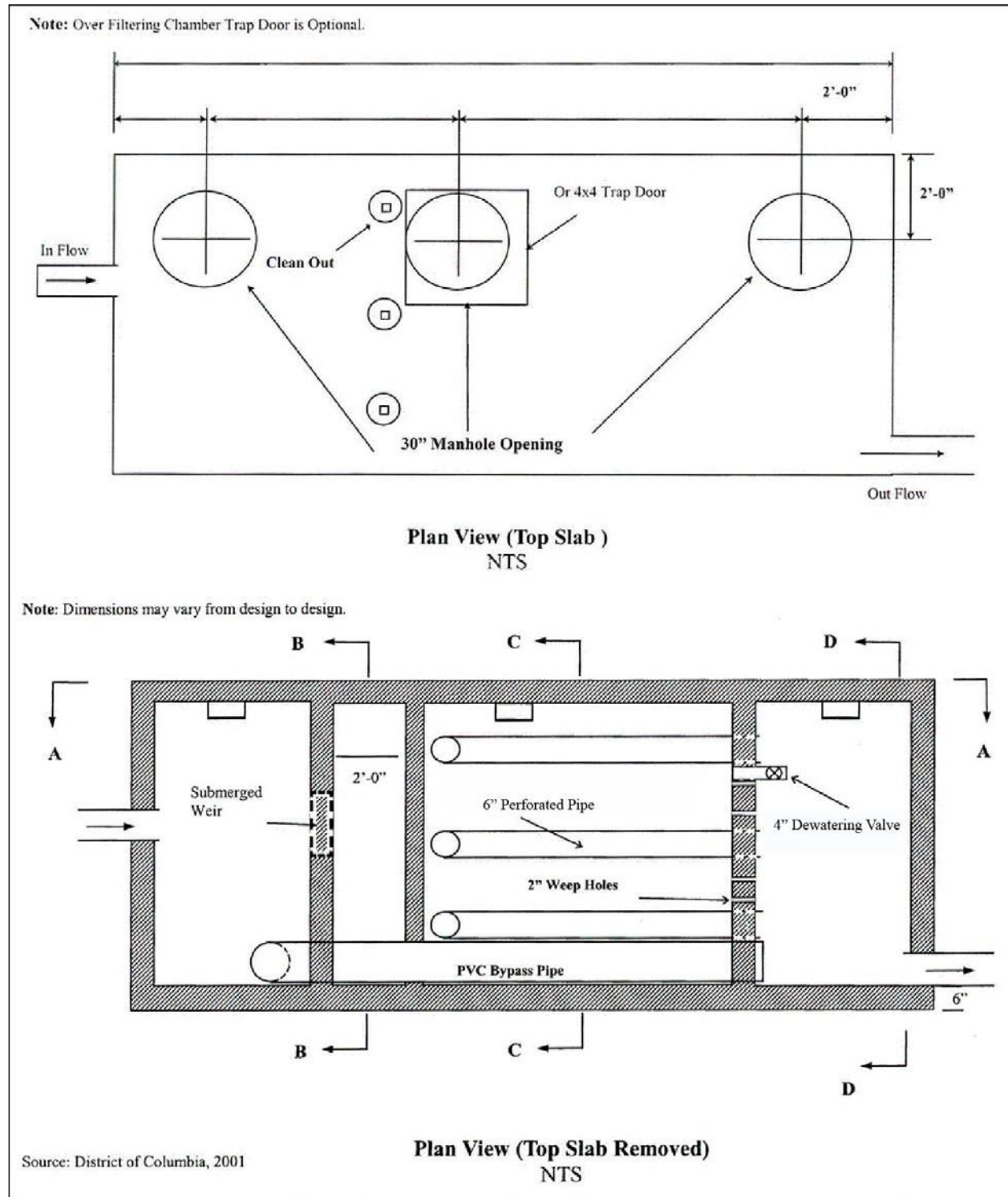
Filtering systems are typically not designed to provide stormwater detention, but they may be in some circumstances. Filtering practices are generally combined with separate facilities to provide this type of control. However, the three-chamber underground sand filter can be modified by expanding the first (or settling) chamber, or by adding an extra chamber between the filter chamber and the clear well chamber to handle the detention volume, which is subsequently discharged at a predetermined rate through an orifice and weir combination.

A nonstructural or surface sand filter is depicted in Figure 4.39, while Figure 4.40 through Figure 4.45 depict three-chamber underground sand filters.

Perimeter sand filters (Figure 4.46) are enclosed stormwater management practices that are typically located just below grade in a trench along the perimeter of parking lot, driveway, or other impervious surface. Perimeter sand filters consist of a pretreatment forebay and a filter bed chamber. Stormwater runoff is conveyed into a perimeter sand filter through grate inlets located directly above the system

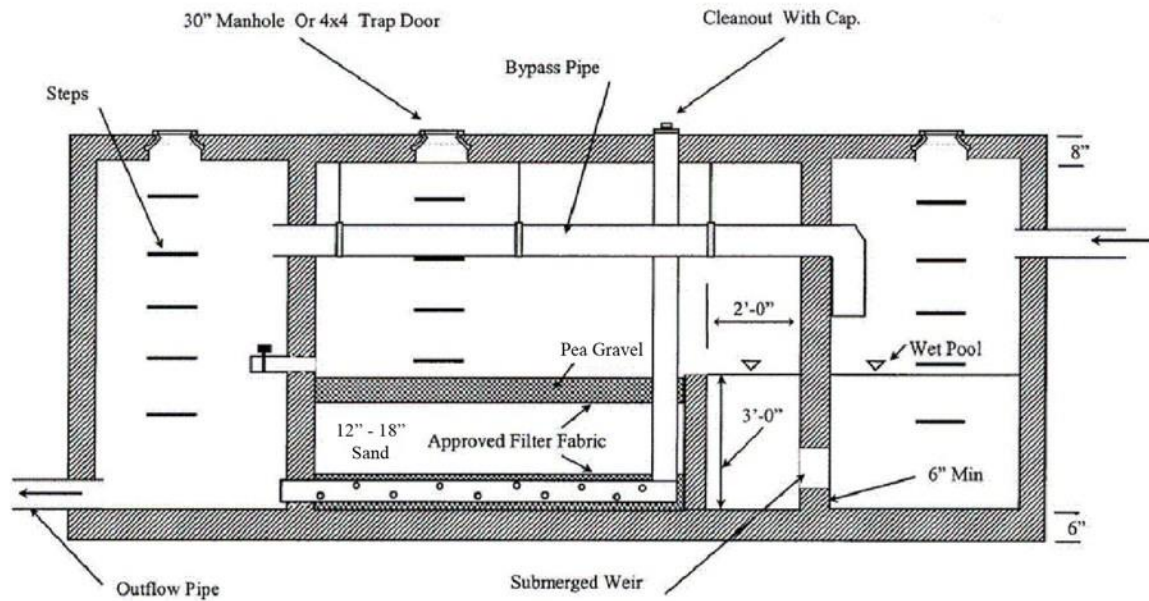


**Figure 4.39. Typical schematic for a nonstructural or surface sand filter (note: material specifications are found in Table 4.44).**

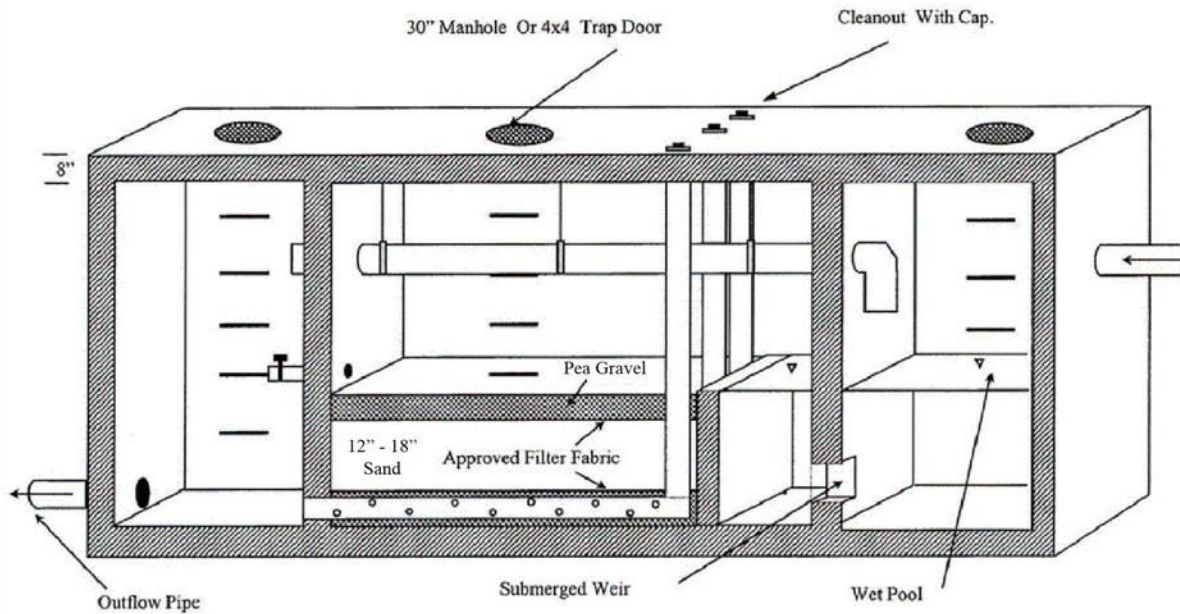


**Figure 4.40. Example of a three-chamber underground sand filter (F-3) for separate sewer options. Part A. Note: material specifications are indicated in Table 4.44.**

Note: Dimensions may vary from design to design.



Section A-A  
NTS

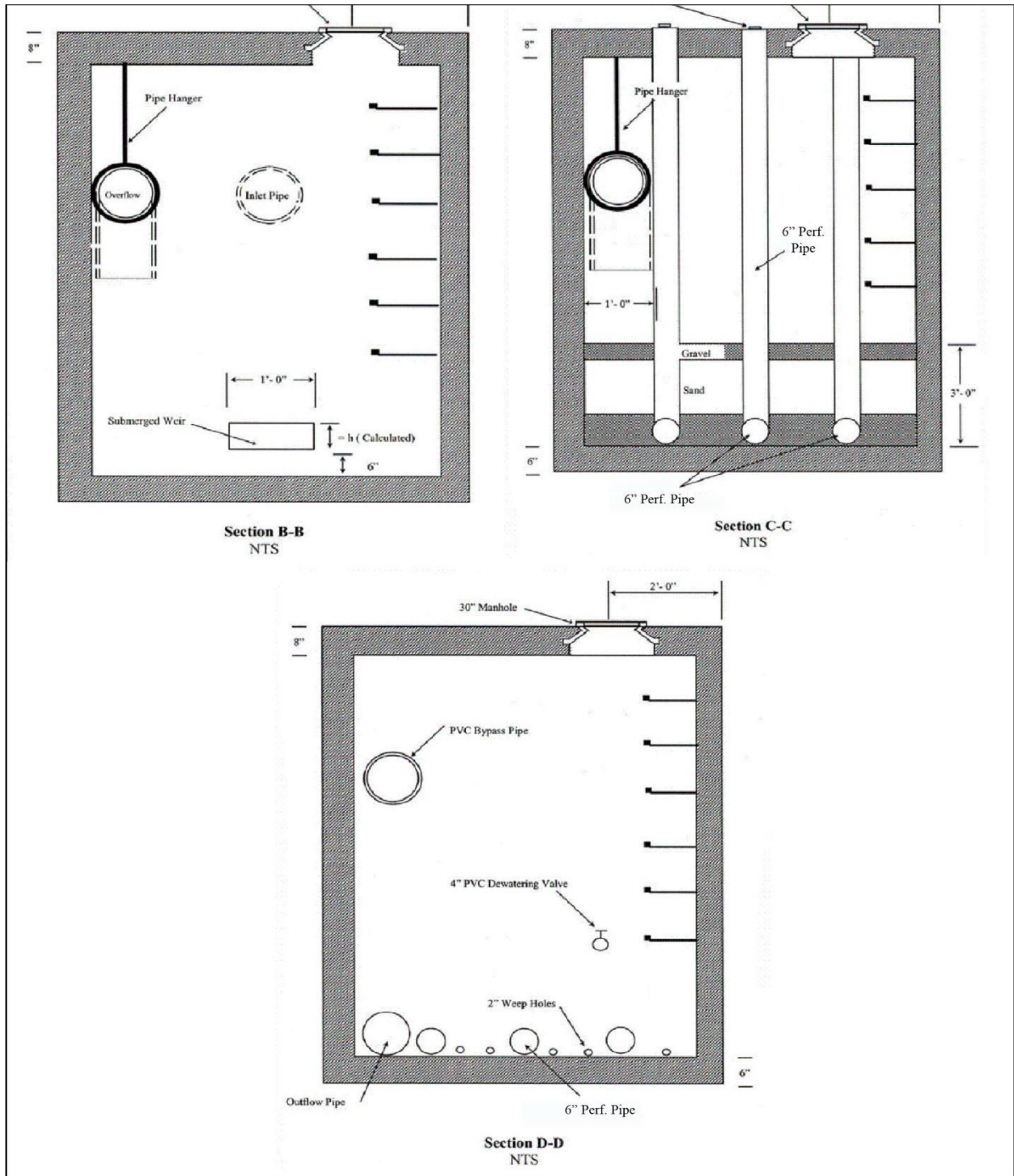


Section A-A (3D)  
NTS

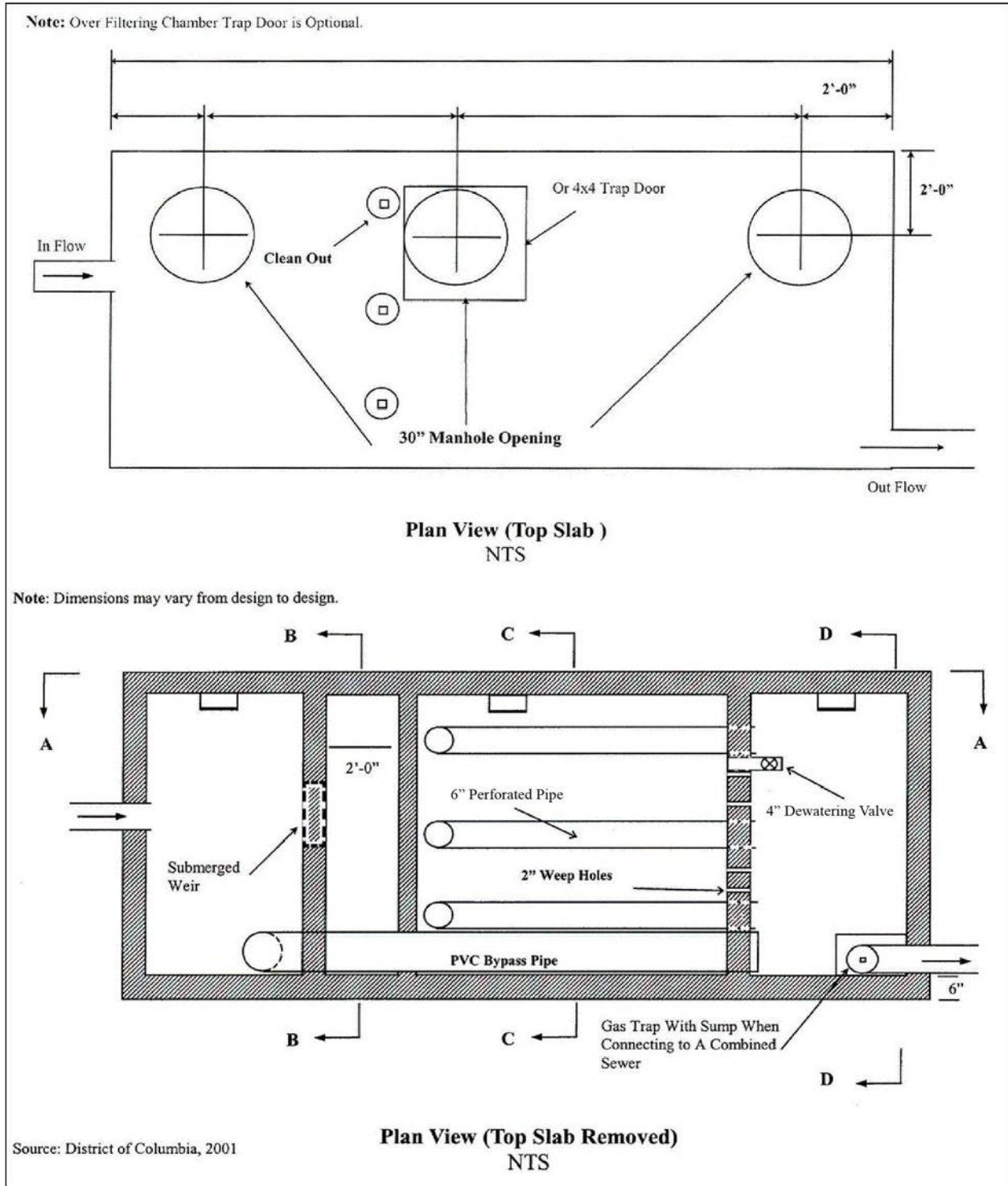
Source: District of Columbia, 2001

Figure 4.41. Example of a three-chamber underground sand filter (F-3) for separate sewer areas. Part B. Note: material specifications are indicated in Table 4.44.



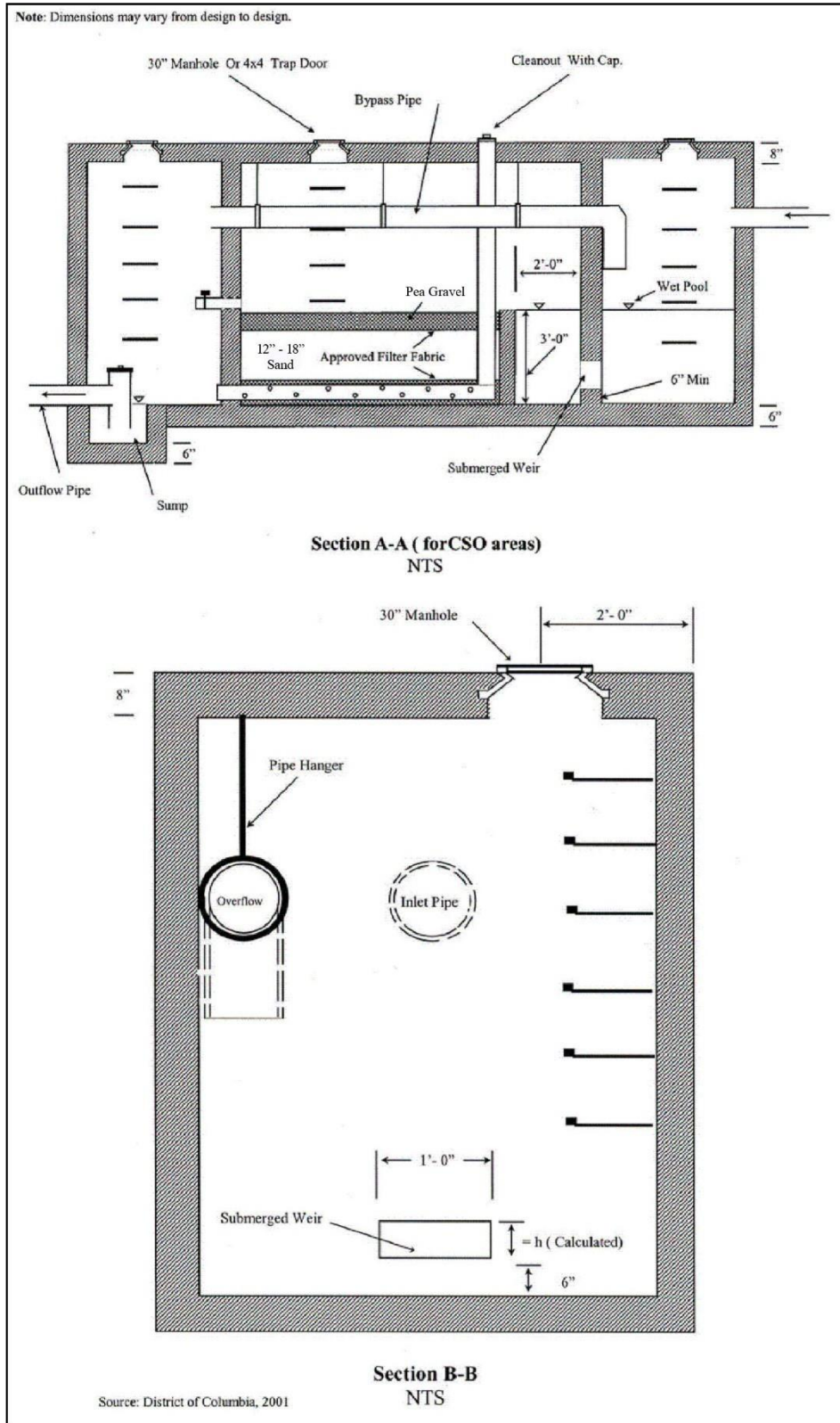


**Figure 4. 42. Example of a three-chamber underground sand filter (F-3) for separate sewer areas. Part C. Note: material specifications are indicated in Table 4.44.**

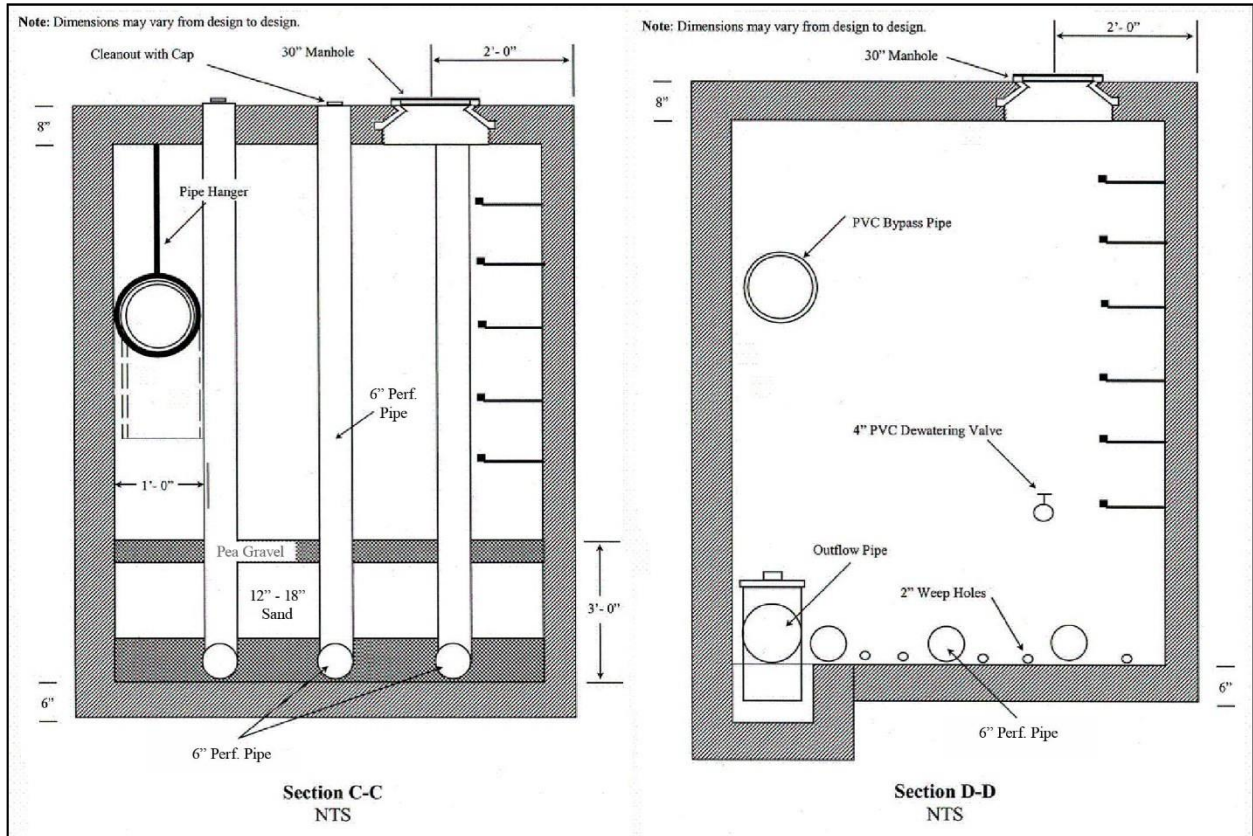


**Figure 4.43. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part A. Note: Material specifications are indicated in Table 4.44.**

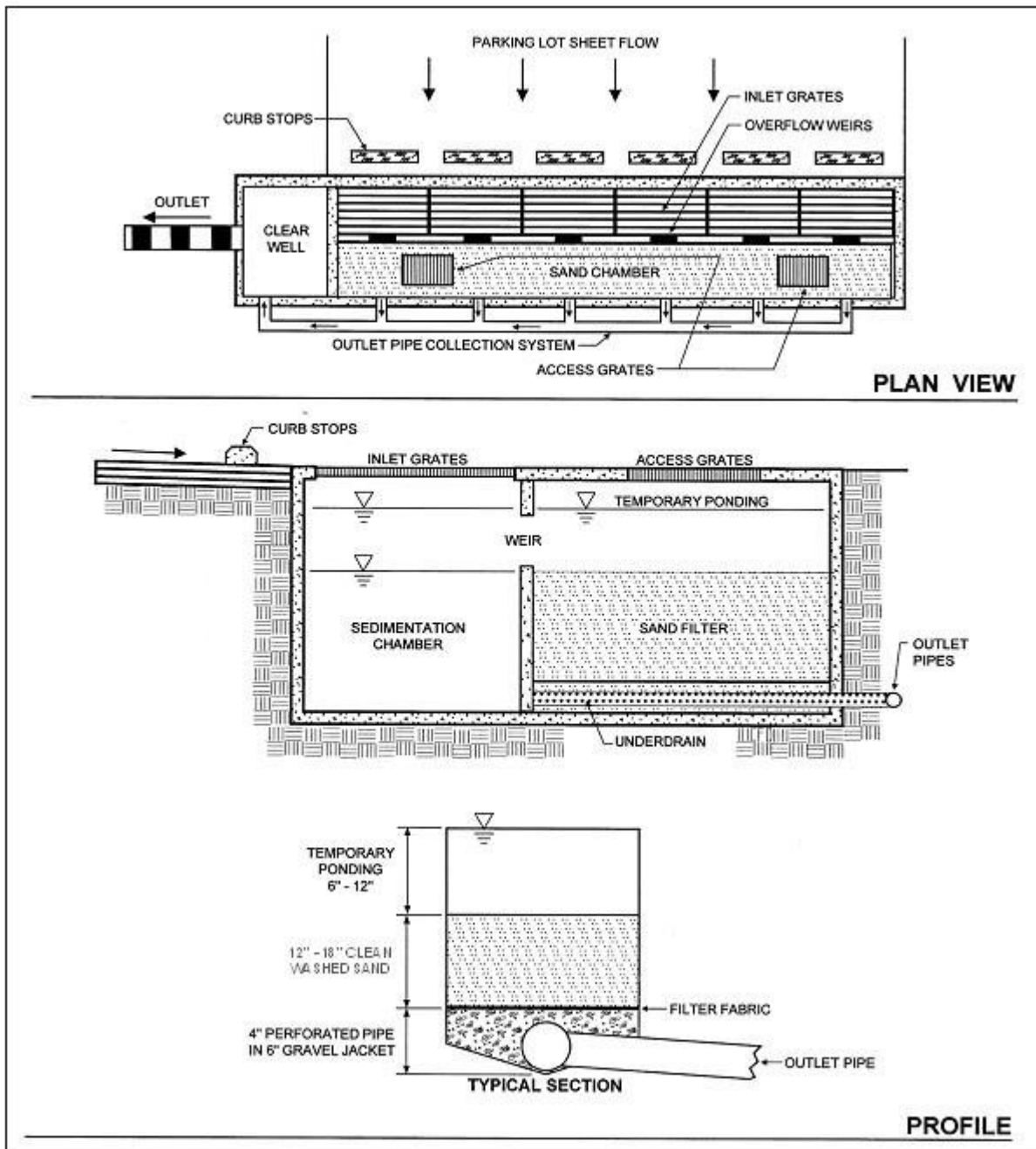




**Figure 4. 44. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part B. Note: Material specifications are indicated in Table 4.44.**



**Figure 4.45. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part C. Note: Material specifications are indicated in Table 4.44.**



**Figure 4.46.** Example of a perimeter sand filter (F-4). Note: material specifications are indicated in Table 4.44.

#### 4.10.1 Filtering System Feasibility Criteria

Stormwater filters can be applied to most types of urban land. They are not always cost-effective, given their high unit cost and small area served, but there are situations where they may clearly be the best option for stormwater treatment (e.g., hotspot runoff treatment, small parking lots, ultra-urban areas, etc.). The following criteria apply to filtering practices:

**Available Hydraulic Head.** The principal design constraint for stormwater filters is available hydraulic head, which is defined as the vertical distance between the top elevation of the filter and the bottom elevation of the existing storm drain system that receives its discharge. The head required for stormwater filters ranges from 2 to 10 feet, depending on the design variant. It is difficult to employ filters in extremely flat terrain, since they require gravity flow through the filter. The only exception is the perimeter sand filter, which can be applied at sites with as little as 2 feet of head.

**Depth to Water Table.** The designer must assure a standard separation distance of at least 0.5 feet between the groundwater table and the bottom invert of the filtering practice.

**Contributing Drainage Area.** Filters are best applied on small sites where the CDA is as close to 100% impervious as possible to reduce the risk that eroded sediment will clog the filter. If the CDA is pervious, then the vegetation must be dense and stable. Turf is acceptable (see Section 4.10.5 Filtering Landscaping Criteria). A maximum CDA of 5 acres is recommended for surface sand filters, and a maximum CDA of 2 acres is recommended for perimeter or underground filters. Filters have been used on larger CDAs in the past, but greater clogging problems have typically resulted.

**Space Required.** The amount of space required for a filter practice depends on the design variant selected. Surface sand filters typically consume about 2%–3% of the CDA, while perimeter sand filters typically consume less than 1%. Underground stormwater filters generally consume no surface area except their manholes.

**Land Use.** As noted above, filters are particularly well suited to treat runoff from stormwater hotspots and smaller parking lots. Other applications include redevelopment of commercial sites or when existing parking lots are renovated or expanded. Filters can work on most commercial, industrial, institutional, or municipal sites and can be located underground if surface area is not available.

**Site Topography.** Filters shall not be located on slopes greater than 6%.

**Utilities.** All utilities shall have a minimum 5-foot, horizontal clearance from the filtering practice.

**Facility Access.** All filtering systems shall be located in areas where they are accessible for inspection and for maintenance (by vacuum trucks).

**Soils.** Soil conditions do not constrain the use of filters. At least one soil boring must be taken at a low point within the footprint of the proposed filtering practice to establish the water table and evaluate soil suitability. A geotechnical investigation is required for all underground stormwater BMPs, including underground filtering systems. Geotechnical testing requirements are outlined in Appendix B Geotechnical Information Requirements for Underground BMPs.

**Setbacks.** Filters should be set back at least 10 feet from the property line, and the bottom of the practice should be separated from groundwater by at least 0.5 feet.

**Economic Considerations.** Perimeter sand filters are expensive relative to other treatment practices, but may be the only option to treat small hotspot drainage areas.

#### 4.10.2 Filtering System Conveyance Criteria

Most filtering practices are designed as off-line systems so that all flows enter the filter storage chamber until it reaches capacity, at which point larger flows are then diverted or bypassed around the filter to an

outlet chamber and are not treated. Runoff from larger storm events must be bypassed using an overflow structure or a flow splitter.

Some underground filters will be designed and constructed as on-line BMPs. In these cases, designers must indicate how the device will safely pass larger storm events (e.g., the 25-year event) to a stabilized water course without resuspending or flushing previously trapped material.

All stormwater filters must be designed to drain or dewater within 40 hours (1.67 days) after a storm event to reduce the potential for nuisance conditions.

#### 4.10.3 Filtering System Pretreatment Criteria

Adequate pretreatment is needed to prevent premature filter clogging and ensure filter longevity. Dry or wet pretreatment shall be provided prior to filter media. Pretreatment devices are subject to the following criteria:

- Sedimentation chambers are typically used for pretreatment to capture coarse sediment particles before they reach the filter bed.
- Sedimentation chambers may be wet or dry but must be sized to accommodate at least 25% of the total design storm volume (inclusive).
- Sediment chambers should be designed as level spreaders such that inflows to the filter bed have near zero velocity and spread runoff evenly across the bed.
- Non-structural and surface sand filters may use alternative pretreatment measures, such as a grass filter strip, forebay, gravel diaphragm, check dam, level spreader, or a combination of these. The grass filter strip must be a minimum length of 15 feet and have a slope of 3% or less. The check dam may be wooden or concrete and must be installed so that it extends only 2 inches above the filter strip and has lateral slots to allow runoff to be evenly distributed across the filter surface. Alternative pretreatment measures must contain a non-erosive flow path that distributes the flow evenly over the filter surface. If a forebay is used, it must be designed to accommodate at least 25% of the total design storm volume (inclusive).

#### 4.10.4 Filtering System Design Criteria

**Detention time.** All filter systems must be designed to drain the design storm volume from the filter chamber within 40 hours (1.67 days) after each rainfall event.

**Structural Requirements.** If a filter will be located underground or experience traffic loads, a licensed structural engineer must certify the structural integrity of the design.

**Geometry.** Filters are gravity flow systems that normally require 2 to 5 feet of driving head to push the water through the filter media through the entire maintenance cycle; therefore, sufficient vertical clearance between the inverts of the inflow and outflow pipes is required.

**Type of Filter Media.** The normal filter media consists of clean, washed AASHTO M-6/ASTM C-33 medium aggregate concrete sand with individual grains 0.02 to 0.04 inches in diameter.

**Depth of Filter Media.** The depth of the filter media plays a role in how quickly stormwater moves through the filter bed and how well it removes pollutants. The recommended filter bed depth is 18 inches. An absolute minimum filter bed depth of 12 inches above underdrains is required; although,

designers should note that specifying the minimum depth of 12 inches will incur a more intensive maintenance schedule and possibly result in costlier maintenance.

**Underdrain and Liner.** Stormwater filters are normally designed with an impermeable liner and underdrain system that meet the criteria provided in Table 4. 44 below.

**Underdrain Stone.** The underdrain should be covered by a minimum 6-inch gravel layer consisting of clean, double washed No. 57 stone.

**Type of Filter.** There are several design variations of the basic filter that enable designers to use filters at challenging sites or to improve pollutant removal rates. The choice of which filter design to apply depends on available space, hydraulic head, and the level of pollutant removal desired. In ultra-urban situations where surface space is at a premium, underground sand filters are often the only design that can be used. Surface and perimeter filters are often a more economical choice when adequate surface area is available. The most common design variants include the following:

- **Non-Structural Sand Filter (F-1).** The non-structural sand filter is applied to sites less than 2 acres in size and is very similar to a bioretention practice (see Section 4.3 Bioretention), with the following exceptions:
  - The bottom is lined with an impermeable liner and always has an underdrain.
  - The surface cover is sand, turf, or pea gravel.
  - The filter media is 100% sand.
  - The filter surface is not planted with trees, shrubs, or herbaceous materials.
  - The filter has two cells, with a dry or wet sedimentation chamber preceding the sand filter bed.

The non-structural sand filter is the least expensive filter option for treating hotspot runoff. The use of bioretention areas is generally preferred at most other sites.

- **Surface Sand Filter (F-2).** The surface sand filter is designed with both the filter bed and sediment chamber located at ground level. The most common filter media is sand; however, a peat/sand mixture may be used to increase the removal efficiency of the system. In most cases, the filter chambers are created using precast or cast-in-place concrete. Surface sand filters are normally designed to be off-line facilities, so that only the desired design volume is directed to the filter for treatment. However, in some cases they can be installed on the bottom of a dry pond (see Section 4.11 Storage Practices).
- **Underground Sand Filter.** The underground sand filter is modified to install the filtering components underground and is often designed with an internal flow splitter or overflow device that bypasses runoff from larger stormwater events around the filter. Underground sand filters are expensive to construct, but they consume very little space and are well suited to ultra-urban areas.
- **Three-Chamber Underground Sand Filter (F-3).** The three-chamber underground sand filter is a gravity flow system. The facility may be precast or cast-in-place. The first chamber acts as a pretreatment facility removing any floating organic material such as oil, grease, and tree leaves. It should have a submerged orifice leading to a second chamber, and it should be designed to minimize the energy of incoming stormwater before the flow enters the second chamber (i.e., filtering or processing chamber).

The second chamber is the filtering or processing chamber. It should contain the filter material consisting of gravel and sand and should be situated behind a weir. Along the bottom of the structure should be a subsurface drainage system consisting of a parallel perforated PVC pipe system in a stone bed. A dewatering valve should be installed at the top of the filter layer for safety release in cases of emergency. A bypass pipe crossing the second chamber to carry overflow from the first chamber to the third chamber is required.

The third chamber is the discharge chamber. It should also receive the overflow from the first chamber through the bypass pipe when the storage volume is exceeded.

Water enters the first chamber of the system by gravity or by pumping. This chamber removes most of the heavy solid particles, floatable trash, leaves, and hydrocarbons. Then the water flows to the second chamber and enters the filter layer by overtopping a weir. The filtered stormwater is then picked up by the subsurface drainage system that empties it into the third chamber.

Whenever there is insufficient hydraulic head for a three-chamber underground sand filter, a well pump may be used to discharge the effluent from the third chamber into the receiving storm or combined sewer. For three-chamber sand filters in combined-sewer areas, a water trap shall be provided in the third chamber to prevent the back flow of odorous gas.

- **Perimeter Sand Filter (F-4).** The perimeter sand filter also includes the basic design elements of a sediment chamber and a filter bed. The perimeter sand filter typically consists of two parallel trenches connected by a series of overflow weir notches at the top of the partitioning wall, which allows water to enter the second trench as sheet flow. The first trench is a pretreatment chamber removing heavy sediment particles and debris. The second trench consists of the sand filter layer. A subsurface drainage pipe must be installed at the bottom of the second chamber to facilitate the filtering process and convey filter water into a receiving system.

In this design, flow enters the system through grates, usually at the edge of a parking lot. The perimeter sand filter is usually designed as an on-line practice (i.e., all flows enter the system), but larger events bypass treatment by entering an overflow chamber. One major advantage of the perimeter sand filter design is that it requires little hydraulic head and is therefore a good option for sites with low topographic relief.

**Surface Cover.** The surface cover for non-structural and surface sand filters should consist of a 3-inch layer of topsoil on top of the sand layer. The surface may also have pea gravel inlets in the topsoil layer to promote filtration. The pea gravel may be located where sheet flow enters the filter, around the margins of the filter bed, or at locations in the middle of the filter bed.

Underground sand filters should have a pea gravel or No. 57 stone layer on top of the sand layer. This gravel layer helps to prevent bio-fouling or blinding of the sand surface.

**Maintenance Reduction Features.** The following maintenance issues should be addressed during filter design to reduce future maintenance problems:

- **Observation Wells and Cleanouts.** Non-structural and surface sand filters must include an observation well consisting of a 6-inch diameter non-perforated PVC pipe fitted with a lockable cap. It should be installed flush with the ground surface to facilitate periodic inspection and maintenance. In most cases, a cleanout pipe will be tied into the end of all underdrain pipe runs. The portion of the cleanout pipe/observation well in the underdrain layer should be perforated. At least one cleanout pipe must be provided for every 2,000 square feet of filter surface area.

- **Access.** Good maintenance access is needed to allow crews to perform regular inspections and maintenance activities. “Sufficient access” is operationally defined as the ability to get a vacuum truck or similar equipment close enough to the sedimentation chamber and filter to enable cleanouts. Direct maintenance access shall be provided to the pretreatment area and the filter bed. For underground structures, sufficient headroom for maintenance should be provided. A minimum head space of 5 feet above the filter is recommended for maintenance of the structure. However, if 5 feet of headroom is not available, manhole access must be installed.
- **Manhole Access (for underground filters).** Access to the headbox and clearwell of Underground Filters must be provided by manholes at least 30 inches in diameter, along with steps to the areas where maintenance will occur.
- **Visibility.** Stormwater filters should be clearly visible at the site so inspectors and maintenance crews can easily find them. Adequate signs or markings must be provided at manhole access points for Underground Filters.
- **Confined Space Issues.** Underground filters are often classified as a confined space. Consequently, special OSHA rules apply, and training may be needed to protect the workers that access them. These procedures often involve training about confined space entry, venting, and the use of gas probes.

**Filter Material Specifications.** The basic material specifications for filtering practices that utilize sand as a filter media are outlined in Table 4.44.

**Table 4.44. Filtering Practice Material Specifications**

Material	Specification
Surface Cover	Non-structural and surface sand filters: 3-inch layer of topsoil on top of the sand layer. The surface may also have pea gravel inlets in the topsoil layer to promote filtration.  Underground sand filters: Clean, double-washed pea gravel or No. 57 stone on top of the sand layer.
Sand	Clean AASHTO M-6/ASTM C-33 medium aggregate concrete sand with a particle size range of 0.02–0.04 inches in diameter.
Choker Stone and/or Geotextile/Filter Fabric	For choker stone, a 2- to 4-inch layer of choker stone (e.g., typically ASTM D448 No. 8 or No. 89 washed gravel) should be placed between the sand layer and the underdrain stone. Alternatively, if available head is limited, an appropriate geotextile fabric that meets AASHTO M-288 Class 2, latest edition, requirements may be used. The geotextile fabric must have a flow rate of > 125 gpm/ft <sup>2</sup> (ASTM D4491) and an Apparent Opening Size (AOS) equivalent to a US No. 70 or No. 80 sieve.
Underdrain/Perforated Pipe	4- or 6-inch perforated schedule 40 PVC pipe, with three or four rows of 3/8-inch perforations at 6 inches on center.
Underdrain Stone	Use No. 57 stone or the ASTM equivalent (1-inch maximum).
Impermeable Liner	Where appropriate, use a PVC Geomembrane liner or equivalent.



**Filter Sizing.** Filtering devices are sized to accommodate a specified design storm volume (typically SWRv). The volume to be treated by the device is a function of the storage depth above the filter and the surface area of the filter. The storage volume is the volume of ponding above the filter. For a given design volume, Equation 4.23 is used to determine the required filter surface area.

#### Equation 4.23 Minimum Filter Surface Area for Filtering Practices

$$SA_{filter} = \frac{DesignVolume \times d_f}{k \times (h_{avg} + d_f) \times t_d}$$

where:

$SA_{filter}$	=	area of the filter surface (ft <sup>2</sup> )
$DesignVolume$	=	design storm volume, typically the SWRv (ft <sup>3</sup> )
$d_f$	=	filter media depth (thickness) (ft), with a minimum of 1 ft
$k$	=	coefficient of permeability (ft/day) (3.5 ft/day for partially clogged sand)
$h_f$	=	height of water above the filter bed (ft), with a maximum of 5 ft
$h_{avg}$	=	average height of water above the filter bed (ft), one half of the filter height ( $h_f$ )
$t_d$	=	allowable drawdown time (1.67 days)

The coefficient of permeability (ft/day) is intended to reflect the worst-case situation (i.e., the condition of the sand media at the point in its operational life where it is in need of replacement or maintenance). Filtering practices are therefore sized to function within the desired constraints at the end of the media's operational life cycle.

The entire filter treatment system, including pretreatment, shall temporarily hold at least 50% of the design storm volume prior to filtration (see Equation 4.24). This reduced volume takes into account the varying filtration rate of the water through the media, as a function of a gradually declining hydraulic head.

#### Equation 4. 24 Required Ponding Volume for Filtering Practices

$$V_{ponding} = 0.50 \times DesignVolume$$

where:

$V_{ponding}$	=	storage volume required prior to filtration (ft <sup>3</sup> )
$DesignVolume$	=	design storm volume, typically the SWRv (ft <sup>3</sup> )

The total storage volume for the practice ( $S_v$ ) can be determined using Equation 4. 25 below.

### Equation 4.25 Storage Volume for Filtering Practices

$$SSRR = 2.0 \times W_{ppbbppmmppgg}$$

where:

$$\begin{aligned} S_v &= \text{total storage volume for the practice (ft}^3\text{)} \\ V_{ponding} &= \text{storage volume required prior to filtration (ft}^3\text{)} \end{aligned}$$

#### 4.10.5 Filtering System Landscaping Criteria

A dense and vigorous vegetative cover shall be established over the contributing pervious drainage areas before runoff can be accepted into the facility. Filtering practices should be incorporated into site landscaping to increase their aesthetics and public appeal.

Surface filters (e.g., surface and non-structural sand filters) can have a grass cover to aid in pollutant adsorption. The grass should be capable of withstanding frequent periods of inundation and drought.

#### 4.10.6 Filtering System Construction Sequence

**Soil Erosion and Sediment Control.** No runoff shall be allowed to enter the filter system prior to completion of all construction activities, including revegetation and final site stabilization. Construction runoff shall be treated in separate sedimentation basins and routed to bypass the filter system. Should construction runoff enter the filter system prior to final site stabilization, all contaminated materials must be removed and replaced with new clean filter materials before a regulatory inspector approves its completion. The approved soil erosion and sediment control plan shall include specific measures to provide for the protection of the filter system before the final stabilization of the site.

**Filter Installation.** The following is the typical construction sequence to properly install a structural sand filter. This sequence can be modified to reflect different filter designs, site conditions, and the size, complexity, and configuration of the proposed filtering application.

1. **Stabilize Contributing Drainage Area.** Filtering practices should only be constructed after the CDA to the facility is completely stabilized, so sediment from the CDA does not flow into and clog the filter. If the proposed filtering area is used as a sediment trap or basin during the construction phase, the construction notes should clearly specify that, after site construction is complete, the sediment control facility will be dewatered, dredged, and regraded to design dimensions for the post-construction filter.
2. **Install Soil Erosion and Sediment Control Measures for the Filtering Practice.** Stormwater should be diverted around filtering practices as they are being constructed. This is usually not difficult to accomplish for off-line filtering practices. It is extremely important to keep runoff and eroded sediment away from the filter throughout the construction process. Silt fence or other sediment controls should be installed around the perimeter of the filter, and erosion control fabric may be needed during construction on exposed side-slopes with gradients exceeding 4H:1V. Exposed soils in the vicinity of the filtering practice should be rapidly stabilized by hydro-seed, sod, mulch, or other method.
3. **Assemble Construction Materials on Site.** Inspect construction materials to ensure they conform to design specifications and prepare any staging areas.
4. **Clear and Strip.** Bring the project area to the desired subgrade.

5. **Excavate and Grade.** Survey to achieve the appropriate elevation and designed contours for the bottom and side slopes of the filtering practice.
6. **Install Filter Structure.** Install filter structure in design location and check all design elevations (i.e., concrete vaults for surface, underground, and perimeter sand filters). Upon completion of the filter structure shell, inlets and outlets must be temporarily plugged and the structure filled with water to the brim to demonstrate water tightness. Maximum allowable leakage is 5% of the water volume in a 24-hour period. See Appendix E Construction Inspection Checklists for the Stormwater Facility Leak Test form. If the structure fails the test, repairs must be performed to make the structure watertight before any sand is placed into it.
7. **Install Base Material Components.** Install the gravel, underdrains, and choker layers of the filter.
8. **Install Top Sand Component.** Spread sand across filter bed in 1-foot lifts up to the design elevation. Backhoes or other equipment can deliver the sand from outside the filter structure. Sand should be manually raked. Clean water is then added until the sedimentation chamber and filter bed are completely full. The facility is then allowed to drain, hydraulically compacting the sand layers. After 48 hours of drying, refill the structure to the final top elevation of the filter bed.
9. **Install Surface Layer (Surface Sand Filters only).** Add a 3-inch topsoil layer and pea gravel inlets and immediately seed with the permanent grass species. The grass should be watered, and the facility should not be switched on-line until a vigorous grass cover has become established.
10. **Stabilize Surrounding Areas.** Stabilize exposed soils on the perimeter of the structure with temporary seed mixtures appropriate for a buffer. All areas above the normal pool should be permanently stabilized by hydroseed, sod, or seeding and mulch.
11. **Final Inspection.** Conduct the final construction inspection. Multiple construction inspections by a qualified professional are critical to ensure that stormwater filters are properly constructed. Inspections are recommended during the following stages of construction:
  - Initial site preparation, including installation of soil erosion and sediment control measures;
  - Excavation/grading to design dimensions and elevations;
  - Installation of the filter structure, including the water tightness test;
  - Installation of the underdrain and filter bed;
  - Check that turf cover is vigorous enough to switch the facility on-line; and
  - Final inspection after a rainfall event to ensure that it drains properly and all pipe connections are watertight. Develop a punch list for facility acceptance. Log the filtering practice's GPS coordinates and submit them for entry into the BMP maintenance tracking database.

Construction phase inspection checklist for filters and the Stormwater Facility Leak Test form can be found in Appendix E Construction Inspection Checklists.

#### 4.10.7 Filtering System Maintenance Criteria

Maintenance of filters is required and involves several routine maintenance tasks, which are outlined in Table 4.45. A cleanup should be scheduled at least once a year to remove trash and floatables that accumulate in the pretreatment cells and filter bed. Frequent sediment cleanouts in the dry and wet sedimentation chambers are recommended every 1 to 3 years to maintain the function and performance of the filter. If the filter treats runoff from a stormwater hotspot, crews may need to test

the filter bed media before disposing of the media and trapped pollutants. Petroleum hydrocarbon contaminated sand or filter cloth must be disposed of according to State solid waste disposal regulations. Testing is not needed if the filter does not receive runoff from a designated stormwater hotspot, in which case the media can be safely disposed of in a landfill.

**Table 4.45. Typical Annual Maintenance Activities for Filtering Practices**

Frequency	Maintenance Tasks
At least 4 times per growing season	<ul style="list-style-type: none"> <li>Mow grass filter strips and perimeter turf around surface sand filters. Maximum grass heights should be less than 12 inches.</li> </ul>
2 times per year (may be more or less frequently depending on land use)	<ul style="list-style-type: none"> <li>Check to see if sediment accumulation in the sedimentation chamber has exceeded 6 inches. If so, schedule a cleanout.</li> </ul>
Annually	<ul style="list-style-type: none"> <li>Conduct inspection and cleanup.</li> <li>Dig a small test pit in the filter bed to determine whether the first 3 inches of sand are visibly discolored and need replacement.</li> <li>Check to see if inlets and flow splitters are clear of debris and are operating properly.</li> <li>Check concrete structures and outlets for any evidence of spalling, joint failure, leakage, corrosion, etc.</li> <li>Ensure that the filter bed is level and remove trash and debris from the filter bed. Sand or gravel covers should be raked to a depth of 3 inches.</li> </ul>
Every 5 years	<ul style="list-style-type: none"> <li>Replace top sand layer.</li> <li>Till or aerate surface to improve infiltration/grass cover.</li> </ul>
As needed	<ul style="list-style-type: none"> <li>Remove blockages and obstructions from inflows. Trash collected on the grates protecting the inlets shall be removed regularly to ensure the inflow capacity of the BMP is preserved.</li> <li>Stabilize CDA and side-slopes to prevent erosion. Filters with a turf cover should have 95% vegetative cover.</li> </ul>
Upon failure	<ul style="list-style-type: none"> <li>Corrective maintenance is required any time the sedimentation basin and sediment trap do not draw down completely after 72 hours (i.e., no standing water is allowed).</li> </ul>

**Maintenance Inspections.** Regular inspections by a qualified professional are critical to schedule sediment removal operations, replace filter media, and relieve any surface clogging. Frequent inspections are especially needed for underground and perimeter filters, since they are out of sight and can be easily forgotten. Depending on the level of traffic or the particular land use, a filter system may either become clogged within a few months of normal rainfall or could possibly last several years with only routine maintenance. Maintenance inspections should be conducted within 24 hours following a storm that exceeds 0.5 inch of rainfall, to evaluate the condition and performance of the filtering practice.

Note: Without regular maintenance, reconditioning sand filters can be very expensive.

Maintenance inspection checklists for filters and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### 4.10.8 Filtering System Stormwater Compliance Calculations

Filtering practices are credited with 0% retention, but they do receive 80% TSS, 30% TN, and 80% bacteria removal for the storage volume (Sv) provided by the (Table 4.46).

**Table 4.46. Filter Retention and Pollutant Removal**

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 30%
Bacteria Removal	= 80%

The practice must be sized using the guidance detailed in Section 4.8.4 Filtering Design Criteria.

#### 4.11 Storage Practices

Storage Practices				
<b>Definition:</b> Practices that are explicitly designed to provide stormwater detention (2- to 25-year, and/or flood control).				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Low		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Medium	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		60%	10%	60%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
Moderate	Low	Low		
Maintenance Frequency:		SWR <sub>v</sub>		
Routine	Non-Routine	0%		
Quarterly	Every 10–15 years			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Flood control</li><li>▪ Typically less costly than stormwater (wet) ponds for equivalent flood storage</li><li>▪ Provides recreational and other open space opportunities between storm runoff events</li></ul>		<ul style="list-style-type: none"><li>▪ Minimal water quality treatment</li><li>▪ Best suited to large CDAs (at least 10 acres)</li><li>▪ Tends to re-suspend sediment</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Conveyance</li><li>▪ Inlets/outlets</li><li>▪ Forebay</li><li>▪ Ponding area with available storage</li><li>▪ Micropool</li><li>▪ Spillway system(s)</li><li>▪ Liners, as needed</li></ul>		<ul style="list-style-type: none"><li>▪ Depth to seasonal high water table must be at least 6 inches below bottom of practice</li><li>▪ Drawdown of 24 to 48 hours</li><li>▪ Shallow pond with large surface area performs better than deep pond of same volume</li><li>▪ Maintenance access</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Remove debris (inlets/outlets/basin surface)</li><li>▪ Remove sediment buildup</li><li>▪ Repair and revegetate eroded areas.</li></ul>		<ul style="list-style-type: none"><li>▪ Perform structural repairs to inlet and outlets.</li><li>▪ Mow unwanted vegetation</li></ul>		

<sup>1</sup>Credited pollutant load removal

Storage practices are a common BMP used to temporarily detain runoff to reduce peak flows (Figure 4.47).



**Figure 4.47. Dry Extended Detention Pond (Photo: Center for Watershed Protection, Inc.)**

**Definition.** Storage practices are explicitly designed to provide stormwater detention (2- to 25-year, and/or flood control). Design variants include the following:

- S-1     Underground detention vaults and tanks
- S-2     Dry detention ponds
- S-3     Rooftop storage
- S-4     Stone storage under permeable pavement or other BMPs

Detention vaults are box-shaped underground stormwater storage facilities typically constructed with reinforced concrete. Detention tanks are underground storage facilities typically constructed with large diameter concrete or plastic pipe (see Figure 4.44). Both serve as an alternative to surface dry detention for stormwater quantity control, particularly for space-limited areas where there is not adequate land for a dry detention basin or multi-purpose detention area. Prefabricated concrete vaults are available from commercial vendors. In addition, several pipe manufacturers have developed packaged detention systems.

Dry detention ponds are widely applicable for most land uses and are best suited for larger SDAs. An outlet structure restricts stormwater flow, so it backs up and is stored within the basin (see Figure 4.

45). The temporary ponding reduces the maximum peak discharge to the downstream channel, thereby reducing the effective shear stress on the bed and banks of the receiving stream.

Storage practices do not receive any stormwater retention or treatment volume and should be considered only for management of larger storm events. Storage practices are not considered an acceptable practice to meet the SWRV. Storage practices must be combined with a separate facility to meet these requirements. Upland practices can be used to satisfy some, or all, of the stormwater retention requirements at many sites, which can help to reduce the footprint and volume of storage practices.

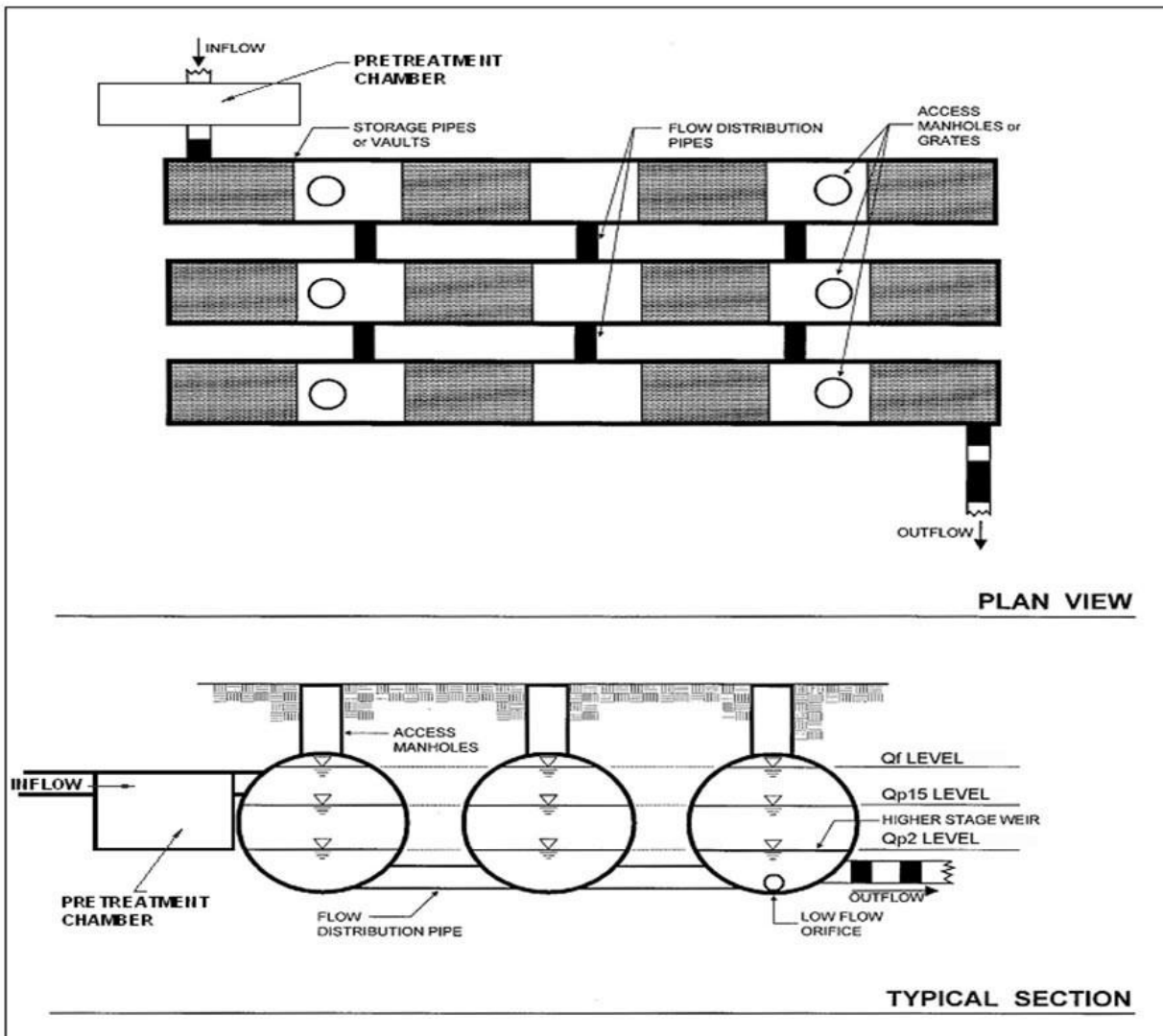
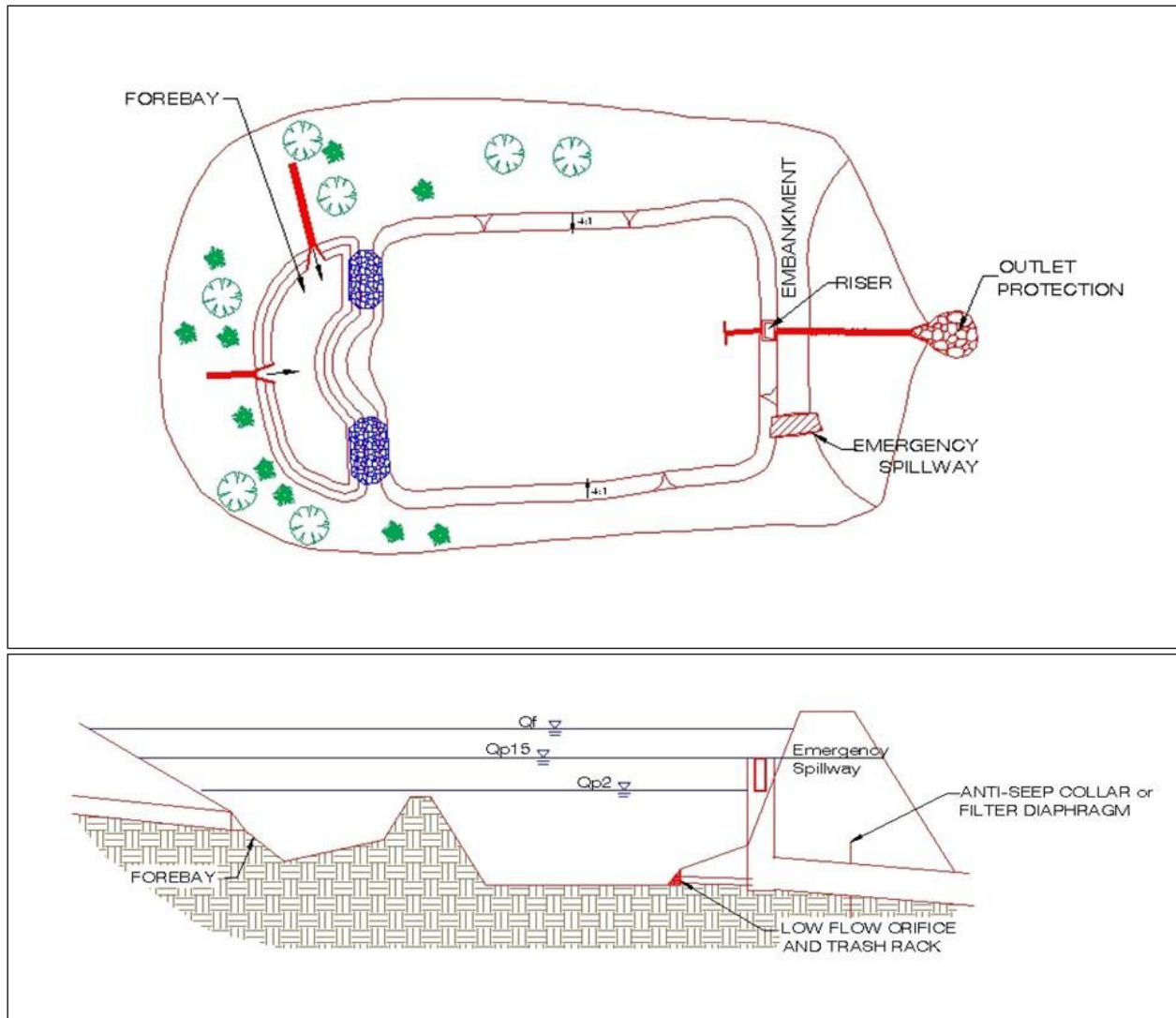


Figure 4.48 Example of an underground detention vault and/or tank (S-1).





**Figure 4.49 Example of a dry detention pond (S-2).**

#### 4.11.1 Storage Feasibility Criteria

The following feasibility issues need to be evaluated when storage practices are considered as the final practice in a treatment train:

**Space Required.** A typical storage practice requires a footprint of 1%–3% of its CDA, depending on the depth of the pond or storage vault (i.e., the deeper the practice, the smaller footprint needed).

**Contributing Drainage Area.** A CDA of at least 10 acres is preferred for dry ponds in order to keep the required orifice size from becoming a maintenance problem. Designers should be aware that small “pocket” ponds will typically (1) have very small orifices that will be prone to clogging, (2) experience fluctuating water levels such that proper stabilization with vegetation is very difficult, and (3) generate more significant maintenance problems.

Underground detention systems can be located downstream of other structural stormwater controls providing treatment of the design storm. For treatment train designs where upland practices are utilized

for treatment of the SWRv, designers can use a site-adjusted Rv or NRCS CN that reflects the volume reduction of upland practices and likely reduce the size and cost of detention (see Storage Practice Sizing in Section 4.8.4 Storage Design Criteria).

The maximum CDA to be served by a single underground detention vault or tank is 25 acres.

**Available Hydraulic Head.** The depth of a storage practice is usually determined by the amount of hydraulic head available at the site (dimension between the surface drainage and the bottom elevation of the site). The bottom elevation is normally the invert of the existing downstream conveyance system to which the storage practice discharges. Depending on the size of the development and the available surface area of the basin, as much as 6 to 8 feet of hydraulic head may be needed for a dry detention practice to function properly for storage. An underground storage practice will require sufficient head room to facilitate maintenance—at least 5 feet depending on the design configuration.

**Setbacks.** Setbacks to structures and property lines must be at least 10 feet, and adequate waterproofing protection must be provided for foundations and basements.

**Depth to Water Table.** Dry ponds are not allowed if the water table will be within 0.5 feet of the floor of the pond. For underground detention vaults and tanks, an anti-flotation analysis is required to check for buoyancy problems in high water table areas.

**Tidal Impacts.** The outlet of a dry detention practice should be located above the tidal mean high water elevation. In tidally impacted areas, detention practices may have minimal benefit, and re-questing a variance for detention requirements may be an option.

**Tailwater Conditions.** The flow depth in the receiving channel should be considered when determining outlet elevations and discharge rates from the dry detention practice. Design tailwater condition elevation shall be supported by a reasonable resource and/or analysis. For direct discharges to tidal waters, a king tide evaluation shall accompany the tailwater condition evaluation.

**Soils.** The permeability of soils is seldom a design constraint for storage practices. Soil infiltration tests should be conducted at proposed dry pond sites to estimate infiltration rates and patterns, which can be significant in HSG A soils and some group B soils. Infiltration through the bottom of the pond is typically encouraged unless it may potentially migrate laterally thorough a soil layer and impair the integrity of the embankment or other structure.

**Structural Stability.** Underground detention vaults and tanks must meet structural requirements for overburden support and traffic loading if appropriate as verified by shop drawings signed by an appropriately licensed professional.

**Geotechnical Tests.** At least one soil boring must be taken at a low point within the footprint of any proposed storage practice to establish the water table elevations and evaluate soil suitability. A geotechnical investigation is required for all underground BMPs, including underground storage systems. Geotechnical testing requirements are outlined in Appendix B Geotechnical Information Requirements for Underground BMPs.

**Utilities.** For a dry pond system, no utility lines shall be permitted to cross any part of the embankment where the design water depth is greater than 2 feet. Typically, utilities require a minimum 5-foot horizontal clearance from storage facilities.

**Perennial Streams.** Locating dry ponds on perennial streams will require both a Section 401 and Section 404 permit from the appropriate state or federal regulatory agency.

**Economic Considerations.** Underground detention can be expensive, but often allows for greater use of a development site. Dry detention ponds are generally inexpensive to construct and maintain. Depending upon the type of development, dry detention practices may be required to treat a larger volume of water than other BMPs. Dry detention practices must store 1 inch of runoff from the site, whereas infiltration practices and other BMPs must capture 1 inch of runoff from only the impervious cover on a site.

#### 4.11.2 Storage Conveyance Criteria

Designers must use accepted hydrologic and hydraulic routing calculations to determine the required storage volume and an appropriate outlet design for storage practices. See Section 3.7.2 Hydrologic and Hydraulic Analysis for a summary of acceptable hydrologic methodologies and models.

For management of the 2-year storm, a control structure with a trash rack designed to release the required predevelopment  $Q_{p2}$  must be provided. Ideally, the channel protection orifice should have a minimum diameter of 3 inches in order to pass minor trash and debris. However, where smaller orifices are required, the orifice must be adequately protected from clogging by an acceptable external trash rack.

As an alternative, the orifice diameter may be reduced if internal orifice protection is used (i.e., a perforated vertical stand pipe with 0.5-inch orifices or slots that are protected by wirecloth and a stone filtering jacket). Adjustable gate valves, weir manholes, and other structures designed for simple maintenance can also be used to achieve this equivalent diameter.

For overbank flood protection, an additional outlet is sized for 2- to 25-year frequency storm event control and can consist of a weir, orifice, outlet pipe, combination outlet, or other acceptable control structure.

Riprap, plunge pools or pads, or other energy dissipators are to be placed at the end of the outlet to prevent scouring and erosion and to provide a non-erosive velocity of flow from the structure to a water course. The design must specify an outfall that will be stable for the 25-year design storm event. The channel immediately below the storage practice outfall must be modified to prevent erosion. This is typically done by calculating channel velocities and flow depths, then placing appropriately sized riprap, over geotextile fabric, which can reduce flow velocities from the principal spillway to non-erosive levels (3.5 to 5.0 feet per second depending on the channel lining material). The storage practice geometry and outfall design may need to be altered in order to yield adequate channel velocities and flow.

Flared pipe sections that discharge at or near the stream invert or into a step pool arrangement should be used at the spillway outlet. An outfall analysis shall be included in the SWMP showing discharge velocities down to the nearest downstream water course. Where indicated, the developer/contractor must secure an off-site drainage easement for any improvements to the downstream channel.

When the discharge is to a manmade pipe or channel system, the system must be adequate to convey the required design storm peak discharge.

If discharge daylight to a channel with dry weather flow, care should be taken to minimize tree clearing along the downstream channel, and to reestablish a forested riparian zone in the shortest possible distance. Excessive use of riprap should be avoided.

The final release rate of the facility shall be modified if any increase in flooding or stream channel erosion would result at a downstream structure, highway, or natural point of restricted streamflow.

The following **additional** conveyance criteria apply to underground detention or ponds:

- **High Flow Bypass (underground detention).** An internal or external high flow bypass or overflow must be included in underground detention designs to safely pass the extreme flood flow.
- **Primary Spillway (dry ponds).** The primary spillway shall be designed with acceptable anti-flotation, anti-vortex, and trash rack devices. The spillway must generally be accessible from dry land. When reinforced concrete pipe is used for the principal spillway to increase its longevity, “O”-ring gaskets (ASTM C361) must be used to create watertight joints, and they should be inspected during installation.
- **Avoid Outlet Clogging (dry ponds).** The risk of clogging in outlet pipes with small orifices can be reduced by the following:
  - ⑦ Providing a micropool at the outlet structure. For more information on micropool extended detention ponds see Section 4.12 Ponds.
  - ⑦ Installing a trash rack to screen the low-flow orifice.
  - ⑦ Using a perforated pipe under a gravel blanket with an orifice control at the end in the riser structure.
- **Emergency Spillway (dry ponds).** Dry ponds must be constructed with overflow capacity to safely pass the 100-year design storm event through either the primary spillway or a vegetated or armored emergency spillway unless waived by Beaufort County Public Works Department.
- **Inlet Protection (dry ponds).** Inflow points into dry pond systems must be stabilized to ensure that non-erosive conditions exist during storm events up to the overbank flood event (i.e., the 25-year storm event).

#### 4.11.3 Storage Pretreatment Criteria

**Dry Pond Pretreatment Forebay.** A forebay must be located at each major inlet to a dry pond to trap sediment and preserve the capacity of the main treatment cell. The following criteria apply to dry pond forebay design:

- A major inlet is defined as an individual storm drain inlet pipe or open channel serving at least 10% of the storage practice’s CDA.
- The forebay consists of a separate cell, formed by an acceptable barrier (e.g., an earthen berm, concrete weir, gabion baskets, etc.).
- The forebay shall be sized to contain 0.1 inches per impervious acre of contributing drainage. The relative size of individual forebays should be proportional to the percentage of the total inflow to the dry pond.

- The forebay should be designed in such a manner that it acts as a level spreader to distribute runoff evenly across the entire bottom surface area of the main storage cell.
- Exit velocities from the forebay shall be non-erosive or an armored overflow shall be provided. Non-erosive velocities are 4 feet per second for the 2-year event and 6 feet per second for the 25-year event.
- The bottom of the forebay may be hardened (e.g., concrete, asphalt, or grouted riprap) in order to make sediment removal easier.
- Direct maintenance access for appropriate equipment shall be provided to the each forebay.

**Underground Detention Pretreatment.** A pretreatment structure to capture sediment, coarse trash, and debris must be placed upstream of any inflow points to underground detention. A separate sediment sump or vault chamber sized to capture 0.1 inches per impervious acre of contributing drainage, or a proprietary structure with demonstrated capability of removing sediment and trash, should be provided at the inlet for underground detention systems that are in a treatment train with off-line water quality treatment structural controls. Refer to Section 0 Proprietary Practices for information on approved proprietary practices.

#### 4.11.4 Storage Design Criteria

**Dry Pond Internal Design Features.** The following apply to dry pond design:

- **No Pilot Channels.** Dry ponds shall not have a low-flow pilot channel, but instead must be constructed in a manner whereby flows are evenly distributed across the pond bottom, to avoid scour, promote attenuation and, where possible, infiltration.
- **Internal Slope.** The maximum longitudinal slope through the pond should be approximately 0.5%–1%.
- **Side Slopes.** Side slopes within the dry pond should generally have a gradient of 3H:1V to 4H:1V. The mild slopes promote better establishment and growth of vegetation and provide for easier maintenance and a more natural appearance. Ponds with side slopes steeper than 5H:1V must be fenced and include a lockable gate.
- **Long Flow Path.** Dry pond designs should have an irregular shape and a long flow path distance from inlet to outlet to increase water residence time, treatment pathways, pond performance, and to eliminate short-cutting. In terms of flow path geometry, there are two design considerations: (1) the overall flow path through the pond, and (2) the length of the shortest flow path (Hirschman et al., 2009):
  - The overall flow path can be represented as the length-to-width ratio OR the flow path ratio. These ratios must be at least 2L:1W (3L:1W preferred). Internal berms, baffles, or topography can be used to extend flow paths and/or create multiple pond cells.
  - The shortest flow path represents the distance from the closest inlet to the outlet. The ratio of the shortest flow to the overall length must be at least 0.4. In some cases—due to site geometry, storm sewer infrastructure, or other factors—some inlets may not be able to meet these ratios. However, the CDA served by these “closer” inlets must constitute no more than 20% of the total CDA.
- **Top of Bank.** Dry ponds shall be provided with a 20-ft maintenance access at the top of bank with a maximum cross slope of 48:1.

**Safety Features.** The following safety features must be considered for storage practices:

- The underground spillway access must be designed and constructed to prevent access by small children.
- End walls above pipe outfalls greater than 48 inches in diameter must be fenced at the top of the wall to prevent a falling hazard.
- Storage practices must incorporate an additional 1 foot of freeboard above the emergency spillway, or 2 feet of freeboard if design has no emergency spillway, for the 100-year storm.
- The emergency spillway must be located so that downstream structures will not be impacted by spillway discharges
- Underground maintenance access should be locked at all times.

**Maintenance Access.** All storage practices shall be designed so as to be accessible to annual maintenance. Unless waived by Beaufort County Public Works Department, a 5H:1V slope and 15-foot-wide entrance ramp is required for maintenance access to dry ponds. Adequate maintenance access must also be provided for all underground detention systems. Access must be provided over the inlet pipe and outflow structure with access steps. Access openings can consist of a standard 30-inch diameter frame, grate and solid cover, a hinged door, or removable panel. Removable panels must be designed with sufficient support so they cannot fall through the opening into the vault when removed.

**Outlets.** Trash racks shall be provided for low-flow pipes and for risers not having anti-vortex devices.

To reduce maintenance problems for small orifices, a standpipe design can be used that includes a smaller inner standpipe with the required orifice size, surrounded by a larger standpipe with multiple openings, and a gravel jacket surrounding the larger standpipe. This design will reduce the likelihood of the orifice being clogged by sediment.

**Detention Vault and Tank Materials.** Underground stormwater detention structures shall be composed of materials as approved by Beaufort County Public Works Department. All construction joints and pipe joints shall be soil-tight. Cast-in-place wall sections must be designed as retaining walls. The maximum depth from finished grade to the vault invert is 20 feet. The minimum pipe diameter for underground detention tanks is 24 inches unless otherwise approved by Beaufort County Public Works Department. Manufacturer's specifications should be consulted for underground detention structures.

**Anti-floatation Analysis for Underground Detention.** Anti-floatation analysis is required to check for buoyancy problems in high water table areas. Anchors shall be designed to counter the pipe and structure buoyancy by at least a 1.2 factor of safety.

**Storage Practice Sizing.** Storage facilities should be sized to control peak flow rates from the 2- to 25-year frequency storm event or other design storm. Design calculations must ensure that the post-development peak discharge does not exceed the predevelopment peak discharge. See Section 3.7.2 Hydrologic and Hydraulic Analysis for a summary of acceptable hydrologic methodologies and models.

For treatment train designs where upland practices are utilized for treatment of the SWRv, designers can use a site-adjusted Rv or NRCS CN that reflects the volume reduction of upland practices to compute the 2- 50-year frequency storm event that must be treated by the storage practice.

#### 4.11.5 Storage Landscaping Criteria

No landscaping criteria apply to underground storage practices.

For dry ponds, a landscaping plan must be provided that indicates the methods used to establish and maintain vegetative coverage within the dry pond. Minimum elements of a plan include the following:

- Delineation of pondscaping zones within the pond.
- Selection of corresponding plant species.
- The planting plan.
- The sequence for preparing the wetland bed, if one is incorporated with the dry pond (including soil amendments, if needed).
- Sources of native plant material.
- The planting plan should allow the pond to mature into a native forest in the right places, but yet keep mowable turf along the embankment and all access areas. The wooded wetland concept proposed by Cappiella et al. (2005) may be a good option for many dry ponds.
- Woody vegetation may not be planted or allowed to grow within 15 feet of the toe of the embankment nor within 25 feet from the principal spillway structure.

#### 4.11.6 Storage Construction Sequence

Construction of underground storage systems must be in accordance with manufacturer's specifications. All runoff into the system should be blocked until the site is stabilized. The system must be inspected and cleaned of sediment after the site is stabilized.

The following is a typical construction sequence to properly install a dry pond. The steps may be modified to reflect different dry pond designs, site conditions, and the size, complexity, and configuration of the proposed facility.

- 1. Use of Dry Pond for Soil Erosion and Sediment Control.** A dry pond may serve as a sediment basin during project construction. Installation of the permanent riser should be initiated during the construction phase, and design elevations should be set with final cleanout of the sediment basin and conversion to the post-construction dry pond in mind. The bottom elevation of the dry pond should be lower than the bottom elevation of the temporary sediment basin. Appropriate procedures must be implemented to prevent discharge of turbid waters when the basin is being converted into a dry pond.
- 2. Stabilize the Contributing Drainage Area.** Dry ponds should only be constructed after the CDA to the pond is completely stabilized. If the propose dry pond site will be used as a sediment trap or basin during the construction phase, the construction notes must clearly indicate that the facility will be dewatered, dredged, and regraded to design dimensions after the original site construction is complete.
- 3. Assemble Construction Materials on Site.** Inspect construction materials to ensure they conform to design specifications and prepare any staging areas.
- 4. Clear and Grade.** Bring the project area to the desired subgrade.
- 5. Soil Erosion and Sediment Controls.** Install soil erosion and sediment control measures prior to construction, including temporary stormwater diversion practices. All areas surrounding the pond that are graded or denuded during construction must be planted with turf grass, native plantings, or other approved methods of soil stabilization.

6. **Install the Spillway Pipe.** Ensure the top invert of the spillway pipe is set to design elevation.
7. **Install the Riser or Outflow Structure.** Once riser and outflow structures are installed, ensure the top invert of the overflow weir is constructed level and at the design elevation.
8. **Construct the Embankment and any Internal Berms.** Construct the embankment and berms in 8- to 12-inch lifts and compact the lifts with appropriate equipment.
9. **Excavate and Grade.** Survey to achieve the appropriate elevation and designed contours for the bottom and side slopes of the dry pond.
10. **Construct the Emergency Spillway.** The emergency spillway must be constructed in cut or structurally stabilized soils.
11. **Install Outlet Pipes.** The installation of outlet pipes must include a downstream riprap protection apron.
12. **Stabilize Exposed Soils.** All areas above the normal pool elevation should be permanently stabilized by hydroseeding or seeding over straw.

**Dry Pond Construction Supervision.** Ongoing construction supervision is recommended to ensure that stormwater ponds are properly constructed. Supervision/inspection is recommended during the following stages of construction:

- Preconstruction meeting
- Initial site preparation including the installation of soil erosion and sediment control measures
- Excavation/Grading (interim and final elevations)
- Installation of the embankment, the riser/primary spillway, and the outlet structure
- Implementation of the pondscaping plan and vegetative stabilization
- Immediately seed or install vegetated ground cover upon completion of sloping and grading of each storage practice, where applicable, within a project.
- Inspect within two weeks to ensure vegetation is in fact holding banks and slopes in place.
- Prior to completion of project, mechanically remove erosion deposition from ponds that occurred during the project. Criteria should be based on erosion of designed bank slopes and loss of storage capacity.
- Final inspection (develop a punch list for facility acceptance)

Construction phase inspection checklist for storage practices and the Stormwater Facility Leak Test form can be found in Appendix E Construction Inspection Checklists.

If the dry pond has a permanent pool, then to facilitate maintenance the contractor should measure the actual constructed dry pond depth at three areas within the permanent pool (forebay, mid-pond, and at the riser), and they should mark and geo-reference them on an as-built drawing. This simple data set will enable maintenance inspectors to determine pond sediment deposition rates in order to schedule sediment cleanouts.



#### 4.11.7 Storage Maintenance Criteria

Typical maintenance activities for storage practices are outlined in Table 4.47. Maintenance requirements for underground storage facilities will generally require quarterly visual inspections from the manhole access points by a qualified professional to verify that there is no standing water or excessive sediment buildup. Entry into the system for a full inspection of the system components (pipe or vault joints, general structural soundness, etc.) should be conducted annually. Confined space entry credentials are typically required for this inspection.

**Table 4.47. Typical Maintenance Activities for Storage Practices.**

Schedule	Maintenance Activity
As needed	<ul style="list-style-type: none"> <li>Water dry pond side slopes to promote vegetation growth and survival.</li> </ul>
Quarterly	<ul style="list-style-type: none"> <li>Remove sediment and oil/grease from inlets, pretreatment devices, flow diversion structures, storage practices, and overflow structures.</li> <li>Ensure that the CDA, inlets, and facility surface are clear of debris.</li> <li>Ensure that the CDA is stabilized. Perform spot-reseeding where needed.</li> <li>Repair undercut and eroded areas at inflow and outflow structures.</li> </ul>
Annual inspection	<ul style="list-style-type: none"> <li>Measure sediment accumulation levels in forebay. Remove sediment when 50% of the forebay capacity has been lost.</li> <li>Inspect the condition of stormwater inlets for material damage, erosion or undercutting. Repair as necessary.</li> <li>Inspect the banks of upstream and downstream channels for evidence of sloughing, animal burrows, boggy areas, woody growth, or gully erosion that may undermine pond embankment integrity.</li> <li>Inspect outfall channels for erosion, undercutting, riprap displacement, woody growth, etc.</li> <li>Inspect condition of principal spillway and riser for evidence of spalling, joint failure, leakage, corrosion, etc.</li> <li>Inspect condition of all trash racks, reverse sloped pipes, or flashboard risers for evidence of clogging, leakage, debris accumulation, etc.</li> <li>Inspect maintenance access to ensure it is free of debris or woody vegetation and check to see whether valves, manholes, and locks can be opened and operated.</li> <li>Inspect internal and external side slopes of dry ponds for evidence of sparse vegetative cover, erosion, or slumping, and make needed repairs immediately.</li> <li>Monitor the growth of wetlands, trees and shrubs planted in dry ponds. Remove invasive species and replant vegetation where necessary to ensure dense coverage.</li> </ul>

Maintenance of storage practices is driven by annual inspections that evaluate the condition and performance of the storage practice. Based on inspection results, specific maintenance tasks will be triggered.

Maintenance inspection checklists for extended detention ponds and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### 4.11.8 Storage Stormwater Compliance Calculations

Storage practices are credited with 0% retention, but they do receive 80% TSS, 30% TN, and 80% bacteria removal for the SWRV (Table 4.48).

Table 4.48. Storage Retention and Pollutant Removal

Retention	= 0%
TSS Removal	= 60%
TN Removal	= 10%
Bacteria Removal	= 60%

#### 4.12 Ponds

Ponds				
<b>Definition:</b> Stormwater storage practices that consist of a combination of a permanent pool, micropool, or shallow marsh that promote a good environment for gravitational settling, biological uptake, and microbial activity.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Medium	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		80%	30%	60%
		Runoff Reductions		
Construction Costs	Maintenance Burden	Volume		
Moderate	Moderate	Low		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	0%		
At least annually	Every 5–7 years			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Moderate to high pollutant removal</li><li>▪ Can be designed as a multi-functional BMP</li><li>▪ Cost effective</li><li>▪ Good for sites with high water table and/or poorly drained soils</li><li>▪ Wildlife habitat potential</li><li>▪ High community acceptance when integrated into a development</li></ul>		<ul style="list-style-type: none"><li>▪ Requires large amount of flat land (1-3% of CDA)</li><li>▪ Must be properly designed, installed, and maintained to avoid nuisance problems</li><li>▪ Routine sediment cleanout may be needed</li><li>▪ Potential for thermal impacts downstream</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Conveyance</li><li>▪ Forebay</li><li>▪ Ponding area with available storage</li><li>▪ Micropool</li><li>▪ Spillway system(s)</li><li>▪ Liners, as needed</li></ul>		<ul style="list-style-type: none"><li>▪ CDA of at least 10 acres and slopes &lt;15%</li><li>▪ Use CN adjustment factor ARC III for CDA that are irrigated with harvested rainwater</li><li>▪ Minimum length to width ratio = 3:1</li><li>▪ Maximum depth of permanent pool = 8’</li><li>▪ 3:1 side slopes or flatter around pond perimeter</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Remove debris from inlet and outlet structures</li><li>▪ Maintain side slopes/remove invasive vegetation</li></ul>		<ul style="list-style-type: none"><li>▪ Monitor sediment accumulation and remove periodically</li></ul>		

<sup>1</sup>Credited pollutant load removal

Stormwater ponds are widely applicable for most land uses and are best suited for larger drainage areas (Figure 4.47); however, they should be considered for use after all other upland retention opportunities have been exhausted and there is still a remaining treatment volume or runoff from larger storms (i.e., 2- to 25-year or flood control events) to manage.

Stormwater ponds receive no retention credit and should be considered mainly for management of larger storm events. Stormwater ponds have both community and environmental concerns (see Section 4.12.1 Pond Feasibility Criteria) that should be considered before choosing stormwater ponds as the appropriate stormwater practice on site.



**Figure 4.48 Wet Pond (photo: Denise Sanger)**

**Definition.** Stormwater ponds are stormwater storage practices that consist of a combination of a permanent pool, micropool, or shallow marsh that promote a good environment for gravitational settling, biological uptake, and microbial activity. Ponds are best suited for larger SDAs. Runoff from each new storm enters the pond and partially displaces pool water from previous storms. The pool also acts as a barrier to resuspension of sediments and other pollutants deposited during prior storms. When sized properly, stormwater ponds have a residence time that ranges from many days to several weeks, which allows numerous pollutant removal mechanisms to operate. Stormwater ponds can also provide storage above the permanent pool to help meet stormwater management requirements for larger storms. Design variants include the following (see Figure 4. 47 and Figure 4. 48):

- C-1 Micropool extended detention pond
- C-2 Wet pond
- C-3 Wet extended detention pond

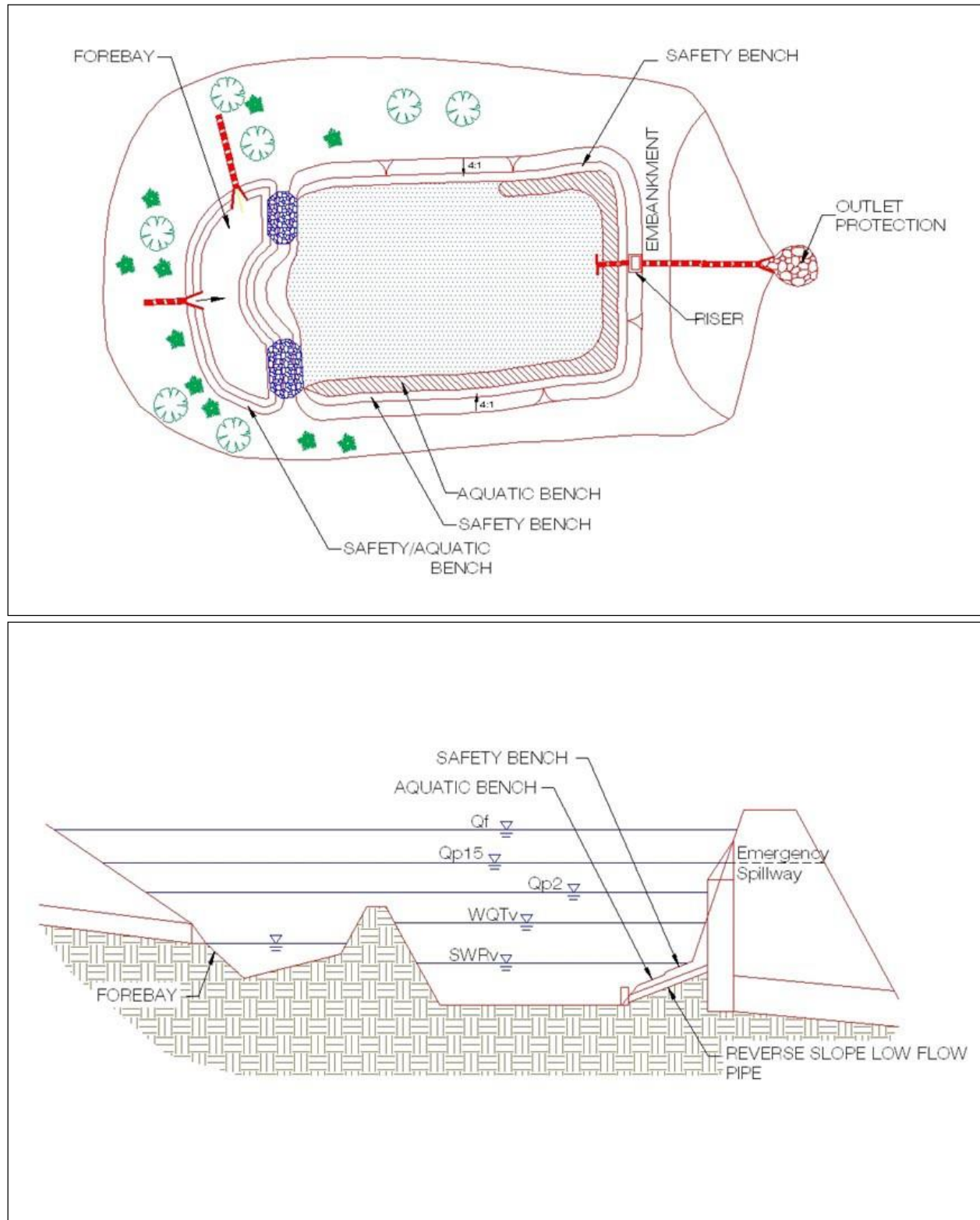
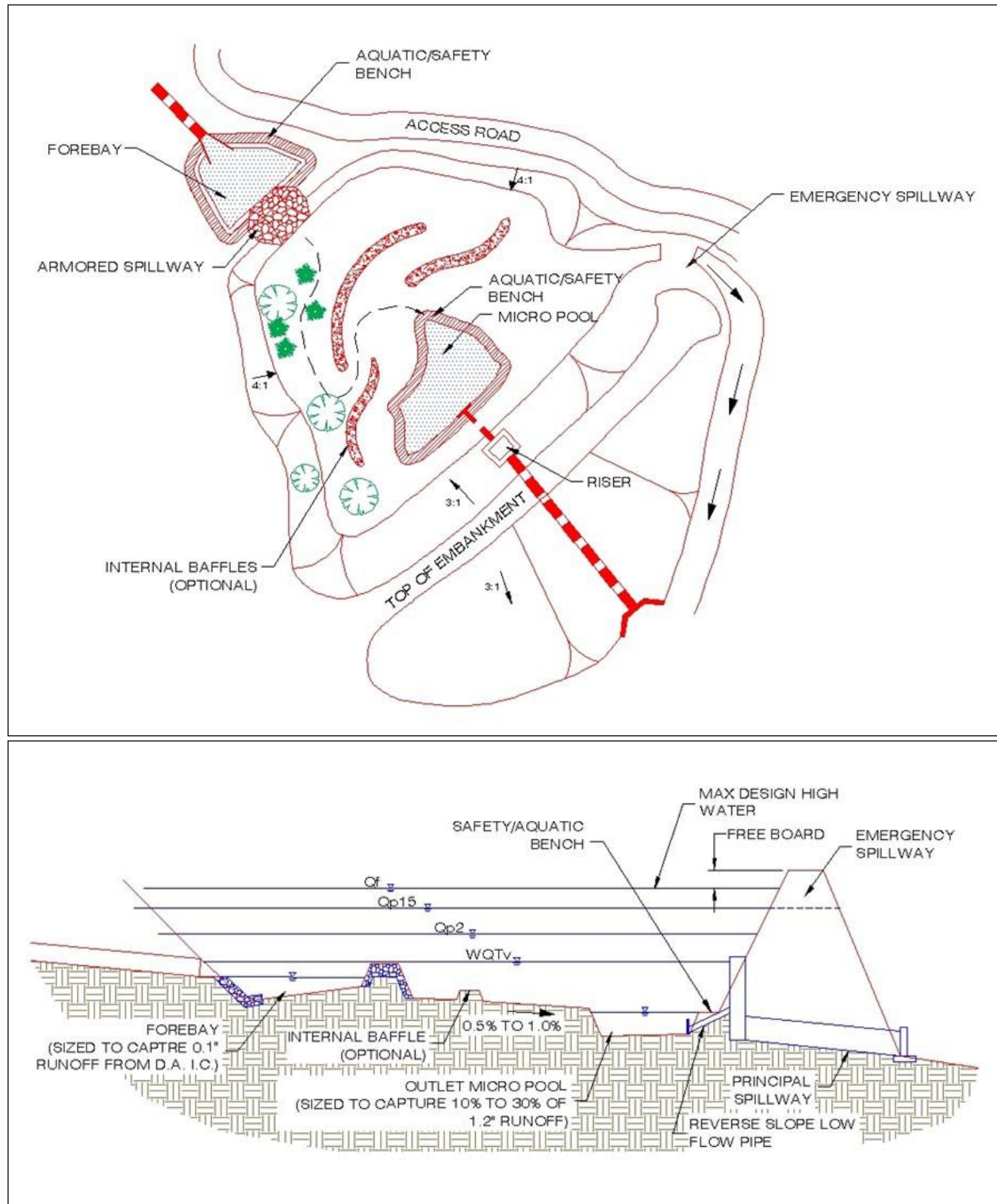


Figure 4. 50 Design schematics for a wet pond (C-2).





**Figure 4.51 Typical extended detention pond (C-3) details.**

#### 4.12.1 Pond Feasibility Criteria

The following feasibility issues need to be considered when ponds are considered a final stormwater management practice of the treatment train.

**Adequate Water Balance.** Wet ponds must have enough water supplied from groundwater, runoff, or baseflow so that the wet pools will not draw down by more than 2 feet after a 30-day summer drought. A simple water balance calculation must be performed using the Equation 4.27 in Section 4.10.4 Pond Design Criteria.

**Contributing Drainage Area.** A CDA of 10 to 25 acres is typically recommended for ponds to maintain constant water elevations. Ponds can still function with CDAs less than 10 acres, but designers should be aware that these “pocket” ponds will be prone to clogging, experience fluctuating water levels, and generate more nuisance conditions.

**Space Requirements.** The surface area of a pond will normally be at least 1%–3% of its CDA, depending on the pond’s depth.

**Site Topography.** Ponds are best applied when the grade of contributing slopes is less than 15%.

**Available Hydraulic Head.** The depth of a pond is usually determined by the hydraulic head available on the site. The bottom elevation is normally the invert of the existing downstream conveyance system to which the pond discharges. Typically, a minimum of 6 to 8 feet of head are needed to hold the wet pool and any additional large storm storage or overflow capacity for a pond to function.

**Setbacks.** Setbacks to structures and property lines must be at least 10 feet and adequate waterproofing protection must be provided for foundations and basements.

**Proximity to Utilities.** For an open pond system, no utility lines shall be permitted to cross any part of the embankment of a wet pool.

**Depth to Water Table.** The depth to the groundwater table is not a major constraint for stormwater ponds because a high water table can help maintain wetland conditions. However, groundwater inputs can also reduce the pollutant removal rates of ponds. Further, if the water table is close to the surface, it may make excavation difficult and expensive.

**Tailwater Conditions.** The flow depth in the receiving channel should be considered when determining outlet elevations and discharge rates from wet pond. Design tailwater condition elevation shall be supported by a reasonable resource and/or analysis. For direct discharges to tidal waters, a king tide evaluation shall accompany the tailwater condition evaluation.

**Soils.** Highly permeable soils will make it difficult to maintain a healthy permanent pool. Soil infiltration tests need to be conducted at proposed pond sites to determine the need for a pond liner or other method to ensure a constant water surface elevation. Underlying soils of HSG C or D should be adequate to maintain a permanent pool. Most HSG A soils and some HSG B soils will require a liner (see Table 3.42). Geotechnical tests should be conducted to determine the saturated hydraulic conductivity and other subsurface properties of the soils beneath the proposed pond.



**Use of or Discharges to Natural Wetlands.** Ponds cannot be located within State waters, including wetlands, without obtaining a Section 404 permit or other permissions from the appropriate state or federal regulatory agency. In addition, the designer should investigate the wetland status of adjacent areas to determine if the discharge from the pond will change the hydroperiod of a downstream natural wetland (see Cappiella et al., 2006, for guidance on minimizing stormwater discharges to existing wetlands).

**Perennial Streams.** Locating ponds on perennial streams will require both US Army COE permits under Clean Water Act Section 401 and Section 404 or other permissions from the appropriate state or federal regulatory agency.

**Economic Considerations.** Wet detention ponds tend to have low construction costs and low space demands (in terms of the land area needed to treat a given volume of water) relative to other LID practices. In addition, the soil excavated to construct ponds can be used as fill, which is often needed for construction on low-lying coastal areas.

**Community and Environmental Concerns.** Ponds can generate the following community and environmental concerns that need to be addressed during design:

- **Aesthetic Issues.** Many residents feel that ponds are an attractive landscape feature, promote a greater sense of community and are an attractive habitat for fish and wildlife. Designers should note that these benefits are often diminished where ponds are under-sized or have small CDAs.
- **Existing Forests.** Construction of a pond may involve extensive clearing of existing forest cover. Designers can expect a great deal of neighborhood opposition if they do not make a concerted effort to save mature trees during pond design and construction. Consideration of Better Site Design Principles is implicit with permitting decisions related to clearing of existing forest cover.
- **Safety Risk.** Pond safety is an important community concern, since both young children and adults have perished by drowning in ponds through a variety of accidents, including falling through thin ice cover. Gentle side slopes and safety benches should be provided to avoid potentially dangerous drop-offs, especially where ponds are located near residential areas.
- **Pollutant Concerns.** Ponds collect and store water and sediment to increase residence time that will increase the likelihood for contaminated water and sediments to be neutralized. However, poorly sized, maintained, and/or functioning ponds can export contaminated sediments and/or water to receiving waterbodies (Mallin, 2000; Mallin et al., 2001; Messersmith, 2007). Further, designers are cautioned that recent research on ponds has shown that some ponds can be hotspots or incubators for algae that generate harmful algal blooms (HABs).
- **Mosquito Risk.** Mosquitoes are not a major problem for larger ponds (Santana et al., 1994; Ladd and Frankenburg, 2003; Hunt et al., 2005). However, fluctuating water levels in smaller or under-sized ponds could pose some risk for mosquito breeding. Mosquito problems can be minimized through simple design features and maintenance operations described in MSSC (2005).
- **Geese and Waterfowl.** Ponds with extensive turf and shallow shorelines can attract nuisance populations of resident geese and other waterfowl, whose droppings add to the nutrient and bacteria loads, thus reducing the removal efficiency for those pollutants. Several design and landscaping features can make ponds much less attractive to geese (see Schueler, 1992).

#### 4.12.2 Pond Conveyance Criteria

**Internal Slope.** The longitudinal slope of the pond bottom should be at least 0.5% to facilitate maintenance.

**Primary Spillway.** The spillway shall be designed with acceptable anti-flotation, anti-vortex and trash rack devices. The spillway must generally be accessible from dry land. When reinforced concrete pipe is used for the principal spillway to increase its longevity, “O-ring” gaskets (ASTM C361) shall be used to create watertight joints.

**Non-Clogging Low-Flow Orifice.** A low-flow orifice must be provided that is adequately protected from clogging by either an acceptable external trash rack or by internal orifice protection that may allow for smaller diameters. Orifices less than 3 inches in diameter may require extra attention during design to minimize the potential for clogging.

- One option is a submerged reverse-slope pipe that extends downward from the riser to an inflow point 1 foot below the normal pool elevation.
- Alternative methods must employ a broad crested rectangular V-notch (or proportional) weir, protected by a half-round CMP that extends at least 12 inches below the normal pool elevation.

**Emergency Spillway.** Ponds must be constructed with overflow capacity to pass the 100-year design storm event through either the primary spillway or a vegetated or armored emergency spillway unless waived by Beaufort County Public Works Department.

**Adequate Outfall Protection.** The design must specify an outfall that will be stable for the 25-year design storm event. The channel immediately below the pond outfall must be modified to prevent erosion and conform to natural dimensions in the shortest possible distance. This is typically done by placing appropriately sized riprap over geotextile fabric, which can reduce flow velocities from the principal spillway to non-erosive levels (3.5 to 5.0 feet per second) depending on the channel lining material. Flared pipe sections, which discharge at or near the stream invert or into a step pool arrangement, should be used at the spillway outlet.

When the discharge is to a manmade pipe or channel system, the system must be adequate to convey the required design storm peak discharge.

If a pond daylights to a channel with dry weather flow, care should be taken to minimize tree clearing along the downstream channel, and to reestablish a forested riparian zone in the shortest possible distance. Excessive use of riprap should be avoided.

The final release rate of the facility shall be modified if any increase in flooding or stream channel erosion would result at a downstream structure, highway, or natural point of restricted streamflow.

**Inlet Protection.** Inflow points into the pond must be stabilized to ensure that non-erosive conditions exist during storm events up to the overbank flood event (i.e., the 25-year storm event). Inlet pipe inverts should generally be located at or slightly below the permanent pool elevation. A forebay shall be provided at each inflow location, unless the inlet is submerged or inflow provides less than 10% of the total design storm inflow to the pond.

**Dam Safety Permits.** The designer must verify whether or not Dam Safety permits or approvals are required for the embankment.

#### 4.12.3 Pond Pretreatment Criteria

**Sediment forebays** are considered to be an integral design feature to maintain the longevity of all ponds. A forebay must be located at each major inlet to trap sediment and preserve the capacity of the main treatment cell. The following criteria apply to forebay design:

- A major inlet is defined as an individual storm drain inlet pipe or open channel serving at least 10% of the pond's CDA.
- The forebay consists of a separate cell, formed by an acceptable barrier (e.g., an earthen berm, concrete weir, gabion baskets, etc.).
- The forebay should be between 4 and 6 feet deep and must be equipped with a variable width aquatic bench for safety purposes. The aquatic bench should be 4 to 6 feet wide at a depth of 1 to 2 feet below the water surface. Small forebays may require alternate geometry to achieve the goals of pretreatment and safety within a small area.
- The forebay shall be sized to contain 0.1 inches of runoff from the contributing drainage impervious area. The relative size of individual forebays should be proportional to the percentage of the total inflow to the pond.
- The bottom of the forebay may be hardened (e.g., with concrete, asphalt, or grouted riprap) to make sediment removal easier.
- The forebay must be equipped with a metered rod in the center of the pool (as measured lengthwise along the low-flow water travel path) for long-term monitoring of sediment accumulation.
- Exit velocities from the forebay shall be non-erosive or an armored overflow shall be provided. Non-erosive velocities are 4 feet per second for the 2-year event, and 6 feet per second for the 25-year event.
- Direct maintenance access for appropriate equipment shall be provided to each forebay.
- Designers of ponds that are used for irrigation should be mindful of pretreatment provisions that help prevent irrigation system pluggages and operational issues.

#### 4.12.4 Pond Design Criteria

**Pond Storage Design.** The pond permanent pool must be sized to store a volume equivalent to the SWRV. Volume storage may be provided in multiple cells. Performance is enhanced when multiple treatment pathways are provided by using multiple cells, longer flowpaths, high surface area to volume ratios, complex microtopography, and/or redundant treatment methods (combinations of pool, ED, and marsh). Volume storage below the permanent pool is not considered in the detention calculations.

**Pond Geometry.** Pond designs should have an irregular shape and a long flow path from inlet to outlet to increase water residence time and pond performance. The minimum length to width ratio (i.e., length relative to width) for ponds is 1.5:1. Greater flowpaths and irregular shapes are recommended. Internal berms, baffles, or vegetated peninsulas can be used to extend flow paths and/or create multiple pond cells.

**Permanent Pool Depth.** The maximum depth of the permanent pool should not generally exceed 8 feet unless the pond is designed for multiple uses.

**Micropool.** A micropool is a 3- to 6-foot-deep pool used to protect the low-flow pipe from clogging and to prevent sediment resuspension. For micropool extended detention ponds, the micropool shall be designed to hold at least 10%–25% of the 85<sup>th</sup> or 95<sup>th</sup> percentile storm event.

**Side Slopes.** Side slopes for ponds should generally have a gradient no steeper than 3H:1V. Mild slopes promote better establishment and growth of vegetation and provide for easier maintenance and a more natural appearance.

**Maximum Extended Detention Levels.** The total storage, including any ponding for larger flooding events (100-year storm) should not extend more than 5 feet above the pond permanent pool unless specific design enhancements to ensure side slope stability, safety, and maintenance are identified and approved.

**Top of Bank.** Storm ponds shall be provided with a 20-ft maintenance access at the top of bank with a maximum cross slope of 48:1.

**Stormwater Pond Benches.** The perimeter of all pool areas greater than 4 feet in depth must be surrounded by two benches, as follows:

- **Safety Bench.** This is a flat bench located just outside of the perimeter of the permanent pool to allow for maintenance access and reduce safety risks. Except when the stormwater pond side slopes are 5H:1V or flatter, provide a safety bench that generally extends 8 to 15 feet outward from the normal water edge to the toe of the stormwater pond side slope. The maximum slope of the safety bench is 5%.
- **Aquatic Bench.** This is a shallow area just inside the perimeter of the normal pool that promotes growth of aquatic and wetland plants. The bench also serves as a safety feature, reduces shoreline erosion, and conceals floatable trash. Incorporate an aquatic bench that generally extends up to 10 feet inward from the normal shoreline, has an irregular configuration, and extends a maximum depth of 18 inches below the normal pool water surface elevation.

**Liners.** When a stormwater pond is located over highly permeable soils, a liner may be needed to sustain a permanent pool of water. If geotechnical tests confirm the need for a liner, acceptable options include the following:

1. a clay liner following the specifications outlined in Table 4.49;
2. a 30-mil- poly-liner;
3. bentonite;
4. use of chemical additives; or
5. an engineering design, as approved on a case-by-case basis by Beaufort County Public Works Department.

A clay liner must have a minimum thickness of 12 inches with an additional 12-inch layer of compacted soil above it, and it must meet the specifications outlined in Table 4.49. Other synthetic liners can be used if the designer can supply supporting documentation that the material will achieve the required performance.

**Table 4.49. Clay Liner Specifications**

Property	Test Method	Unit	Specification
Permeability	ASTM D2434	cm/s	$1 \times 10^{-6}$
Plasticity Index of Clay	ASTM D4318	%	Not less than 15
Liquid Limit of Clay	ASTM D2216	%	Not less than 30
Clay Particles Passing	ASTM D422	%	Not less than 30
Clay Compaction	ASTM D2216	%	95% of standard proctor density

Source: DCR (1999). VA

**Required Geotechnical Testing.** Soil borings must be taken below the proposed embankment, in the vicinity of the proposed outlet area, and in at least two locations within the proposed pond treatment area. Soil boring data is needed to (1) determine the physical characteristics of the excavated material, (2) determine its adequacy for use as structural fill or spoil, (3) provide data for structural designs of the outlet works (e.g., bearing capacity and buoyancy), (4) determine compaction/composition needs for the embankment, (5) determine the depth to groundwater and (6) evaluate potential infiltration losses (and the potential need for a liner).

**Non-clogging Low-Flow (Extended Detention) Orifice.** The low-flow ED orifice shall be adequately protected from clogging by an acceptable external trash rack. The preferred method is a submerged reverse-slope pipe that extends downward from the riser to an inflow point 1 foot below the normal pool elevation. Alternative methods are to employ a broad crested rectangular, V-notch, or proportional weir, protected by a half-round CMP that extends at least 12 inches below the normal pool.

**Riser in Embankment.** The riser should be located within the embankment for maintenance access, safety, and aesthetics. Access to the riser is to be provided by lockable manhole covers and manhole steps within easy reach of valves and other controls. The principal spillway opening can be "fenced" with pipe or rebar at 8-inch intervals for safety purposes.

**Trash Racks.** Trash racks shall be provided for low-flow pipes and for riser openings not having anti-vortex devices.

**Pond Drain.** Ponds should have a drainpipe that can completely or partially drain the permanent pool. In cases where a low-level drain is not feasible (such as in an excavated pond), a pump well must be provided to accommodate a temporary pump intake when needed to drain the pond.

- The drain pipe must have an upturned elbow or protected intake within the pond to help keep it clear of sediment deposition, and a diameter capable of draining the pond within 24 hours.
- The pond drain must be equipped with an adjustable valve located within the riser, where it will not be normally inundated and can be operated in a safe manner.

Care must be exercised during pond drawdowns to prevent downstream discharge of sediments or anoxic water and rapid drawdown. The approving authority shall be notified before draining a pond.

### Safety Features.

- The principal spillway opening must be designed and constructed to prevent access by small children.
- End walls above pipe outfalls greater than 48 inches in diameter must be fenced to prevent a falling hazard.
- Storage practices must incorporate an additional 1 foot of freeboard above the emergency spillway, or 2 feet of freeboard if design has no emergency spillway, for the 100-year storm.
- The emergency spillway must be located so that downstream structures will not be impacted by spillway discharges.
- Both the safety bench and the aquatic bench should be landscaped with vegetation that hinders or prevents access to the pool.
- Warning signs prohibiting swimming must be posted.
- Where permitted, fencing of the perimeter of ponds is discouraged. The preferred method to reduce risk is to manage the contours of the stormwater pond to eliminate drop-offs or other safety hazards. Fencing is required at or above the maximum water surface elevation in the rare situations when the pond slope is a vertical wall.
- Side slopes to the pond shall not be steeper than 3H:1V, and shall terminate on a 15-foot-wide safety bench. Both the safety bench and the aquatic bench may be landscaped to prevent access to the pool. The bench requirement may be waived if slopes are 4H:1V or flatter.

**Maintenance Reduction Features.** Many maintenance issues can be addressed through well designed access. All ponds must be designed for annual maintenance. Good access is needed so crews can remove sediments, make repairs, and preserve pond-treatment capacity. Design for the following:

- ⑦ Adequate maintenance access must extend to the forebay, safety bench, riser, and outlet structure and must have sufficient area to allow vehicles to turn around.
- ⑦ The riser should be located within the embankment for maintenance access, safety, and aesthetics. Access to the riser should be provided by lockable manhole covers and manhole steps within easy reach of valves and other controls.
- ⑦ Access roads must (1) be constructed of load-bearing materials or be built to withstand the expected frequency of use, (2) have a minimum width of 20 feet, and (3) have a profile grade that does not exceed 5H:1V.
- ⑦ A maintenance right-of-way or easement must extend to the stormwater pond from a public or private road.
  - No permanent structures (mechanical, electrical, phone, fences) or landscaping are allowed within the 20' pond maintenance access easement.
- **Material Specifications.** ED ponds are generally constructed with materials obtained on site, except for the plant materials, inflow and outflow devices (e.g., piping and riser materials), possibly stone for inlet and outlet stabilization, and geotextile fabric for lining banks or berms.

- **Pond Sizing.** Stormwater ponds can be designed to capture and treat the remaining stormwater discharged from upstream practices from the design storm (SWR<sub>v</sub>). Additionally, stormwater ponds may be sized to control peak flow rates from the 2- to 25-year frequency storm event or other design storms as required. Design calculations must ensure that the post-development peak discharge does not exceed the predevelopment peak discharge. See Section 3.7.2 Hydrologic and Hydraulic Analysis and Appendix I for a summary of acceptable hydrologic methodologies and models.

For treatment train designs where upland practices are utilized for treatment of the SWR<sub>v</sub>, designers can use a site-adjusted R<sub>v</sub> or NRSC CN that reflects the volume reduction of upland practices to compute the 2- 50-year frequency storm event that must be treated by the stormwater pond.

The pond permanent pool must be sized to store a volume equivalent to the SWR<sub>v</sub> or design volume.

The storage volume (S<sub>v</sub>) of the practice is equal to the volume provided by the pond permanent pool (Equation 4. 26). The total S<sub>v</sub> cannot exceed the design SWR<sub>v</sub>.

#### Equation 4. 26 Pond Storage Volume

$$SSRR = PPDDDDdd ppDDDDDDppDDDDDDDD ppDDDDpp RRDDppvvDDDD$$

- **Water Balance Testing.** A water balance calculation is recommended to document that sufficient inflows to wet ponds and wet ED ponds exist to compensate for combined infiltration and evapotranspiration losses during a 30-day summer drought without creating unacceptable drawdowns (see Equation 4.27, adapted from Hunt et al., 2007). The recommended minimum pool depth to avoid nuisance conditions may vary; however, it is generally recommended that the water balance maintain a minimum 24-inch reservoir.

#### Equation 4. 27 Water Balance Equation for Acceptable Water Depth in a Wet Pond

$$DDPP > EEEE + IIIIII + RREESS - MMMM$$

Where:

<i>DP</i>	=	average design depth of the permanent pool (in.)
<i>ET</i>	=	summer evapotranspiration rate (in.) (assume 8 in.)
<i>INF</i>	=	monthly infiltration loss (assume 7.2 inches at 0.01 in./hour)
<i>RES</i>	=	reservoir of water for a factor of safety (assume 24 in.)
<i>MB</i>	=	measured baseflow rate to the pond, if any convert to pond-inches (in.)

Design factors that will alter this equation are the measurements of seasonal base flow and infiltration rate. The use of a liner could eliminate or greatly reduce the influence of infiltration. Similarly, land use changes in the upstream watershed could alter the base flow conditions over time (e.g., urbanization and increased impervious cover).

Translating the baseflow to inches refers to the depth within the pond. Therefore, Equation 4. 28 can be used to convert the baseflow, measured in cubic feet per second (cfs), to pond-inches:

#### Equation 4. 28 Baseflow Conversion

$$PDDDDd - \text{DDDi}hDDD = \frac{MMM \times 2.592 \times 10^6 \times 12}{SSSS}$$

where:

<i>Pond – inches</i>	=	depth within the pond (in.)
<i>MB</i>	=	measured baseflow rate to the pond (cfs)
$2.592 \times 10^6$	=	conversion factor, converting cfs to ft <sup>3</sup> /month
<i>12</i>	=	conversion factor, converting feet to inches
<i>SA</i>	=	surface area of pond (ft <sup>2</sup> )

#### 4.12.5 Pond Landscaping Criteria

**Pond Benches.** The perimeter of all deep pool areas (4 feet or greater in depth) must be surrounded by two benches:

- A safety bench that extends 8 to 15 feet outward from the normal water edge to the toe of the pond side slope. The maximum slope of the safety bench shall be 6%.
- An aquatic bench that extends up to 10 feet inward from the normal shoreline and has a maximum depth of 18 inches below the normal pool water surface elevation.

**Landscaping and Planting Plan.** A landscaping plan must be provided that indicates the methods used to establish and maintain vegetative coverage in the pond and its buffer (see Section 4.3.5 Bioretention Landscaping Criteria for extended landscaping and planting details). Minimum elements of a landscaping plan include the following:

- Delineation of pondscaping zones within both the pond and buffer.
- Selection of corresponding plant species.
- The planting plan.
- The sequence for preparing the wetland benches (including soil amendments, if needed).
- Sources of native plant material.
- The landscaping plan should provide elements that promote diverse wildlife and waterfowl use within the stormwater wetland and buffers.
- Woody vegetation may not be planted or allowed to grow within 15 feet of the toe of the embankment nor within 25 feet from the principal spillway structure.
- A vegetated buffer should be provided that extends at least 25 feet outward from the maximum water surface elevation of the pond. Permanent structures (e.g., buildings) should not be constructed within the buffer area. Existing trees should be preserved in the buffer area during construction.



- The soils in the stormwater buffer area are often severely compacted during the construction process, to ensure stability. The density of these compacted soils can be so great that it effectively prevents root penetration and, therefore, may lead to premature mortality or loss of vigor. As a rule of thumb, planting holes should be three times deeper and wider than the diameter of the root ball for bare root and ball-and-burlap stock, and five times deeper and wider for container-grown stock.
- Avoid species that require full shade or are prone to wind damage. Extra mulching around the base of trees and shrubs is strongly recommended as a means of conserving moisture and suppressing weeds.

For more guidance on planting trees and shrubs in pond buffers, consult Cappiella et al. (2006).

#### 4.12.6 Pond Construction Sequence

The following is a typical construction sequence to properly install a stormwater pond. The steps may be modified to reflect different pond designs; site conditions; and the size, complexity and configuration of the proposed facility.

**1. Use of Ponds for Soil Erosion and Sediment Control.** A pond may serve as a sediment basin during project construction. If this is done, the volume should be based on the more stringent sizing rule (soil erosion and sediment control requirement versus storage volume requirement). Installation of the permanent riser should be initiated during the construction phase, and design elevations should be set with final cleanout of the sediment basin and conversion to the post-construction pond in mind. The bottom elevation of the pond should be lower than the bottom elevation of the temporary sediment basin. Appropriate procedures must be implemented to prevent discharge of turbid waters when the basin is being converted into a pond.

Approval from Beaufort County Public Works Department must be obtained before any sediment pond can be used for stormwater management.

**2. Stabilize the Contributing Drainage Area.** Ponds should only be constructed after the CDA to the pond is completely stabilized. If the proposed pond site will be used as a sediment trap or basin during the construction phase, the construction notes should clearly indicate that the facility will be de-watered, dredged, and regraded to design dimensions after the original site construction is complete.

**3. Assemble Construction Materials on Site.** Inspect construction materials to ensure they conform to design specifications and prepare any staging areas.

**4. Clear and Strip.** Bring the project area to the desired subgrade.

**5. Soil Erosion and Sediment Controls.** Install soil erosion and sediment control measures prior to construction, including temporary de-watering devices and stormwater diversion practices. All areas surrounding the pond that are graded or denuded during construction must be planted with turf grass, native plantings, or other approved methods of soil stabilization.

**6. Excavate the Core Trench and Install the Spillway Pipe.**

**7. Install the Riser or Outflow Structure.** Once riser and outflow structures are installed ensure the top invert of the overflow weir is constructed level at the design elevation.

**8. Construct the Embankment and any Internal Berms.** These features must be installed in 8- to 12-inch lifts; compact the lifts with appropriate equipment.

**9. Excavate and Grade.** Survey to achieve the appropriate elevation and designed contours for the bottom and side slopes of the pond.

**10. Construct the Emergency Spillway.** The emergency spillway must be constructed in cut or structurally stabilized soils.

**11. Install Outlet Pipes.** The installation of outlet pipes must include a downstream riprap protection apron.

**12. Stabilize Exposed Soils.** Use temporary seed mixtures appropriate for the pond buffer to stabilize the exposed soils. All areas above the normal pool elevation must be permanently stabilized by hydroseeding or seeding over straw.

**13. Plant the Pond Buffer Area.** Establish the planting areas according to the pondscaping plan (see Section 4.12.5 Pond Landscaping Criteria).

**Construction Supervision.** Supervision during construction is recommended to ensure that stormwater ponds are properly constructed, especially during the following stages of construction:

- Preconstruction meeting
- Initial site preparation including the installation of soil erosion and sediment control measures
- Excavation/Grading (interim and final elevations)
- Installation of the embankment, the riser/primary spillway, and the outlet structure
- Implementation of the pondscaping plan and vegetative stabilization
- Immediately seed or install vegetated ground cover upon completion of sloping and grading of each stormwater pond within a project.
- Inspect within two weeks to insure vegetation is in fact holding banks and slopes in place.
- Prior to completion of project, mechanically remove erosion deposition from ponds that occurred during the project. Criteria should be based on erosion of designed bank slopes and loss of storage capacity.
- Final inspection (develop a punch list for facility acceptance)

Construction phase inspection checklist for ponds can be found in Appendix E Construction Inspection Checklists.

To facilitate maintenance, contractors should measure the actual constructed pond depth at three areas within the permanent pool (forebay, mid-pond and at the riser), and they should mark and geo-reference them on an as-built drawing. This simple data set will enable maintenance inspectors to determine pond sediment deposition rates in order to schedule sediment cleanouts.

#### **4.12.7 Pond Maintenance Criteria**

Maintenance is needed so stormwater ponds continue to operate as designed on a long-term basis. Ponds normally have fewer routine maintenance requirements than other stormwater control measures. Stormwater pond maintenance activities vary regarding the level of effort and expertise required to perform them. Routine stormwater pond maintenance, such as mowing and removing debris and trash, is needed several times each year (see Table 4.50). More significant maintenance (e.g., removing accumulated sediment) is needed less frequently but requires more skilled labor and special equipment. Inspection and repair of critical structural features (e.g., embankments and risers) needs to

be performed by a qualified professional (e.g., a structural engineer) who has experience in the construction, inspection, and repair of these features.

**Table 4.50. Pond Maintenance Tasks and Frequency.**

Frequency	Maintenance Items
During establishment, as needed (first year)	<ul style="list-style-type: none"> <li>Inspect the site at least twice after storm events that exceed a 1/2 inch of rainfall.</li> <li>Plant the aquatic benches with emergent wetland species, following the planting recommendations contained in Section 4.11.6 Stormwater Wetland Landscaping Criteria.</li> <li>Stabilize any bare or eroding areas in the CDA or around the pond buffer.</li> <li>Water trees and shrubs planted in the pond buffer during the first growing season. In general, consider watering every 3 days for first month, and then weekly during the remainder of the first growing season (April through October), depending on rainfall.</li> </ul>
Quarterly or after major storms (>1 inch of rainfall)	<ul style="list-style-type: none"> <li>Mowing (twice a year)</li> <li>Remove debris and blockages</li> <li>Repair undercut, eroded, and bare soil areas</li> </ul>
Twice a year	<ul style="list-style-type: none"> <li>Mowing of the buffer and pond embankment</li> </ul>
Annually	<ul style="list-style-type: none"> <li>Shoreline cleanup to remove trash, debris, and floatables</li> <li>A full maintenance inspection</li> <li>Open up the riser to access and test the valves</li> <li>Repair broken mechanical components, if needed</li> </ul>
Once—during the second year following construction	<ul style="list-style-type: none"> <li>Pond buffer and aquatic bench reinforcement plantings</li> </ul>
Every 5 to 7 years	<ul style="list-style-type: none"> <li>Forebay sediment removal</li> </ul>
From 5 to 25 years	<ul style="list-style-type: none"> <li>Repair pipes, the riser, and spillway, as needed</li> </ul>

Sediment removal in the pond pretreatment forebay should occur every 5 to 7 years or after 50% of total forebay capacity has been lost. The designer should also check to see whether removed sediments can be spoiled on site or must be hauled away. Sediments excavated from ponds are not usually considered toxic or hazardous. They can be safely disposed of by either land application or land filling. Sediment testing may be needed prior to sediment disposal if the pond serves a pollutant hotspot land use, as the sediment could be potentially toxic or hazardous (Weinstein et al., 2008). In lieu of local regulations for sediment testing, the parameters in Table 4.51 may be used.

**Table 4.51. Ceiling Levels Governing Management of Accumulated Sediment<sup>1</sup>**

Parameter	Ceiling Level (ppm or mg/kg)
Total Arsenic	8
Total Cadmium	10
Total Chromium	100

Total Lead	250
pH	Less than 5 or greater than 10 standard units
Electrical Conductivity	8 deciSiemens/meter (dS/m) at 25°C
<sup>1</sup> Excerpt from Wisconsin Administrative Code NR 528.03, Table 2	

**Maintenance Plans.** Maintenance plans must clearly outline how vegetation in the pond and its buffer will be managed or harvested in the future. Periodic mowing of the stormwater buffer is only required along maintenance rights-of-way and the embankment. The remaining buffer can be managed as a meadow (mowing every other year) or forest. The maintenance plan should schedule a shoreline cleanup at least once a year to remove trash and floatables. For information on chemical control methods for aquatic plants, consult Clemson's fact sheet entitled "Aquatic Weed Control Overview" available online at <http://www.clemson.edu/extension/hgic/plants/other/landscaping/hgic1714.html>.

**Maintenance Inspections.** Maintenance of a pond is driven by annual inspections by a qualified professional who evaluates the condition and performance of the pond. Based on inspection results, specific maintenance tasks will be triggered.

Maintenance inspection checklist for stormwater ponds and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law. However, sediment testing may be needed prior to sediment disposal because sediments excavated from ponds could be contaminated.

#### 4.12.8 Pond Stormwater Compliance Calculations

Stormwater ponds are credited with 0% retention, but they do receive 80% TSS, 30% TN, and 60% bacteria removal for the storage volume (Sv) provided by in the permanent pool (Table 4.52).

**Table 4.52. Pond Retention and Pollutant Removal**

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 30%
Bacteria Removal	= 60%

#### 4.13 Stormwater Wetlands

Stormwater Wetlands				
<b>Definition:</b> Practices that create shallow marsh areas to treat urban stormwater, which often incorporate small permanent pools and/or extended detention storage. Stormwater wetlands are explicitly designed to provide stormwater detention for larger storms (2- to 25-year, or flood control events) above the design storm (SWRv) storage.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Medium	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		80%	25%	60%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
Moderate	Moderate	Low		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	0%		
At least annually	Every 2 years			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ High removal of typical stormwater pollutants</li><li>▪ Provides habitat for wildlife</li><li>▪ Attractive when integrated into site development</li><li>▪ Good for sites with high water table and/or poorly drained soils</li></ul>		<ul style="list-style-type: none"><li>▪ Requires large amount of flat land (3% of CDA)</li><li>▪ Must be properly designed, installed, and maintained to avoid nuisance problems</li><li>▪ Needs constant source of water</li><li>▪ Routine sediment cleanout may be needed</li><li>▪ Potential for thermal impacts downstream</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Conveyance</li><li>▪ Forebay</li><li>▪ Deep ponding area</li><li>▪ High marsh and transition zones</li><li>▪ Micropool</li><li>▪ Spillway system(s)</li></ul>		<ul style="list-style-type: none"><li>▪ CDA must be large enough to sustain permanent water level</li><li>▪ Flow path through the wetland system should be at least 2L:1W</li><li>▪ 25% of pool depth should be 18-48 inches</li><li>▪ Water balance must be maintained</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Reinforce plantings as needed</li><li>▪ Remove accumulated sediments</li><li>▪ Remove invasive vegetation</li></ul>		<ul style="list-style-type: none"><li>▪ Thin/harvest vegetation every 2 years on embankments and access areas; elsewhere every 5–10 years</li></ul>		

<sup>1</sup>Credited pollutant load removal

Stormwater wetlands, sometimes called constructed wetlands, are shallow depressions that receive stormwater inputs for water quality treatment. Runoff from each new storm displaces runoff from previous storms, and the long residence time allows multiple pollutant removal processes to operate. The wetland environment provides an ideal environment for gravitational settling, biological uptake, and microbial activity. Wetlands include various design adaptations to allow them to be applied in specific settings. For example, some designs incorporate trees within the wetland area.

Stormwater wetlands should be considered for use after all other upland retention opportunities have been exhausted and there is still a remaining treatment volume or runoff from larger storms (i.e., 2- to 25-year or flood control events) to manage. Stormwater wetlands receive no stormwater retention credit and should be considered mainly for management of larger storm events. Stormwater wetlands have both community and environmental concerns (see Section 4.13.1 Stormwater Wetland Feasibility Criteria) that should be considered before choosing stormwater ponds for the appropriate stormwater practice on site.



Figure 4.52 Stormwater Wetland at Carolina Forest Recreation Center, Myrtle Beach (photo: Kathryn Ellis).

**Definition.** Practices that create shallow marsh areas to treat urban stormwater, which often incorporate small permanent pools and/or extended detention storage. Stormwater wetlands are explicitly designed to provide stormwater detention for larger storms (2 – 25-year, or flood control events) above the design storm (SWRv) storage. Wetlands are typically less than 1 foot deep (although they have greater depths at the forebay and in micropools) and possess variable microtopography to promote dense and diverse wetland cover. Design variants include the following:

W-1     Shallow wetland

W-2     Extended detention shallow wetland

Several stormwater wetland design features are illustrated in Figure 4. 48 through Figure 4. 52.

*Note: All of the pond performance criteria presented in Section 4.10-Ponds also apply to the design of stormwater wetlands. Additional criteria that govern the geometry and establishment of created wetlands are presented in this section.*

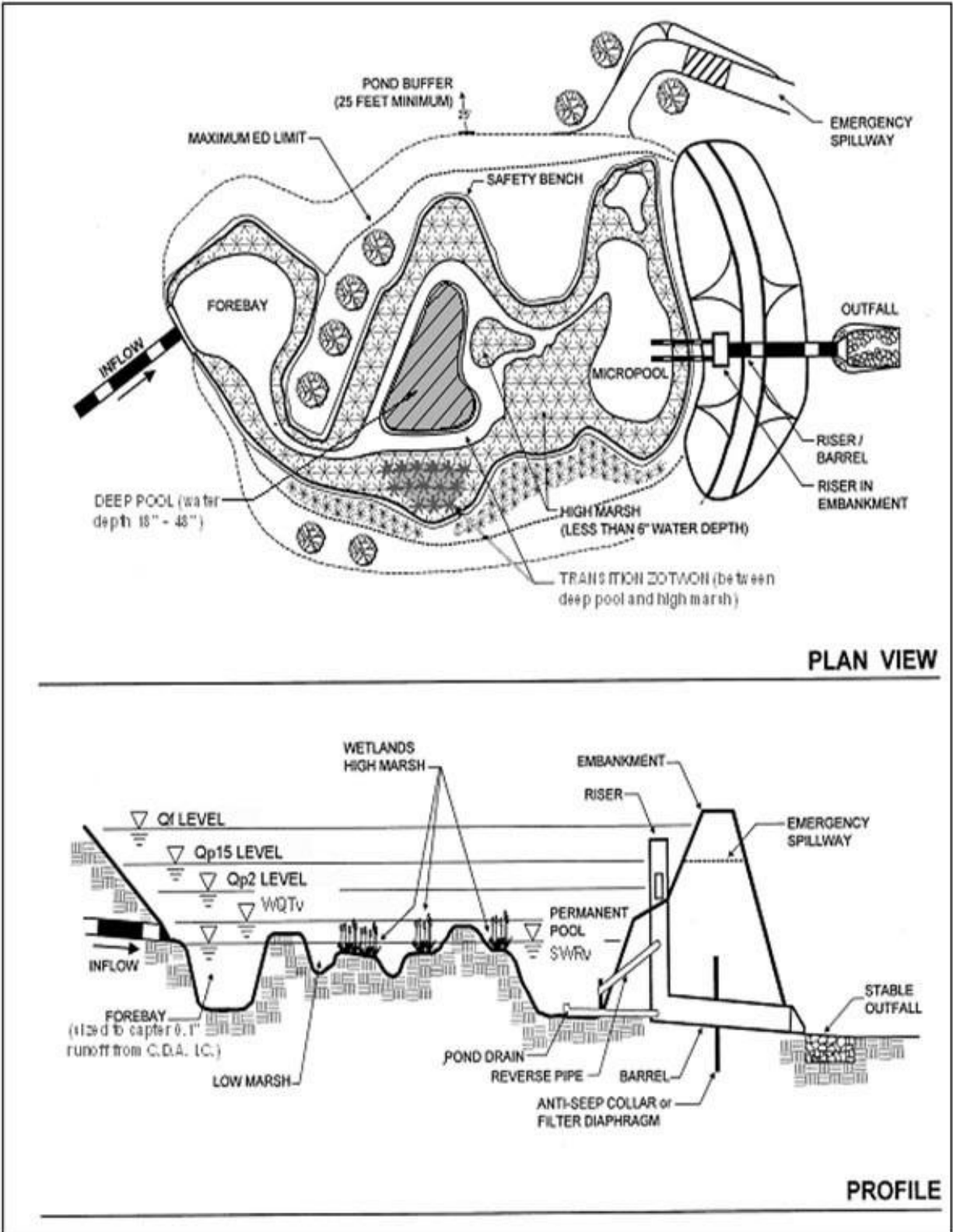
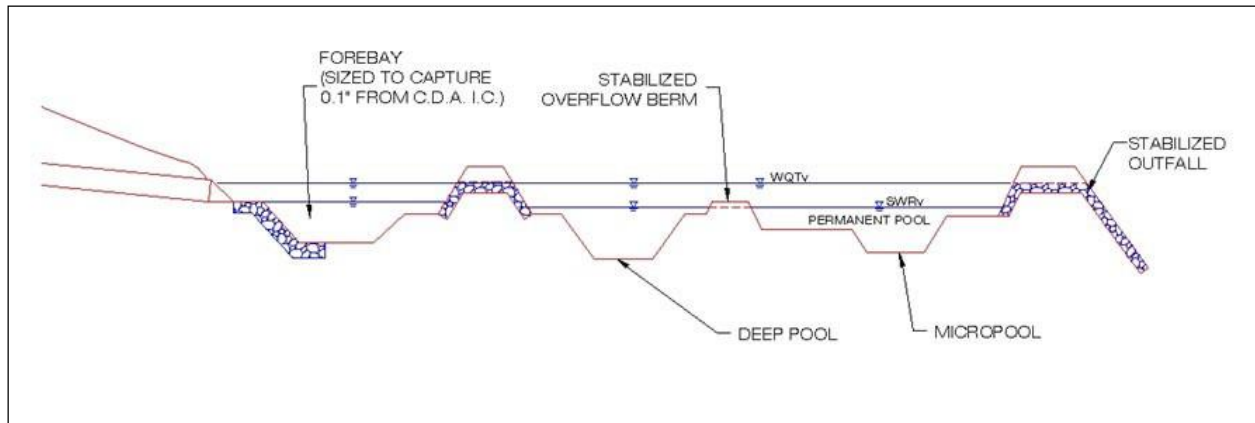
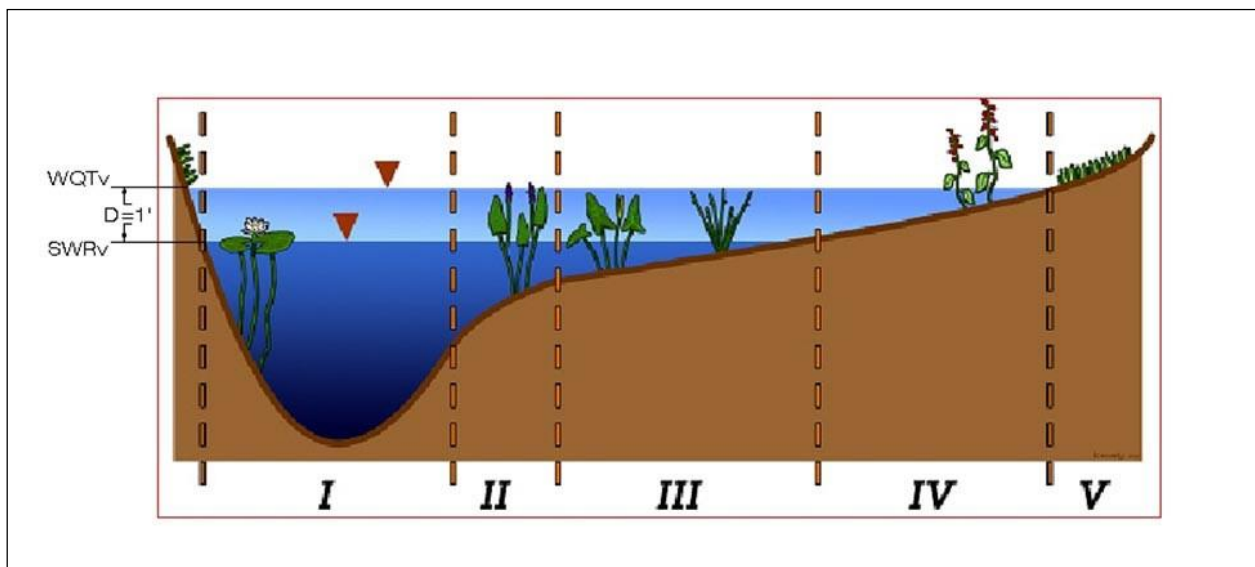


Figure 4.53 Example of extended detention shallow wetland.





**Figure 4.54** Cross section of a typical stormwater wetland.



**Figure 4.55** Interior wetland zones

- (I) Deep Pool (depth -48 to -18 inches),
- (II) Transition Zone (depth -18 to -6 inches),
- (III and IV) High Marsh Zone (depth -6 to +6 inches),
- (IV) Temporary Inundation Area, and
- (V) Upper Bank

Adapted from Hunt et al., 2007

#### 4.13.1 Stormwater Wetland Feasibility Criteria

Constructed wetland designs are subject to the following site constraints:

**Adequate Water Balance.** Stormwater wetlands must have enough water supplied from groundwater, runoff, or baseflow so that the permanent pools will not draw down by more than 2 feet after a 30-day summer drought. A simple water balance calculation must be performed using the equation provided in Section 4.11.4 Stormwater Wetland Design Criteria.

**Contributing Drainage Area.** The CDA must be large enough to sustain a permanent water level within the stormwater wetland. If the only source of wetland hydrology is stormwater runoff, then several dozen acres of CDA are typically needed to maintain constant water elevations. Smaller CDAs are acceptable if the bottom of the stormwater wetland intercepts the groundwater table or if the designer or approving agency is willing to accept periodic wetland drawdown.

**Space Requirements.** Constructed wetlands normally require a footprint that takes up about 3% of the CDA, depending on the average depth of the wetland and the extent of its deep pool features.

**Site Topography.** Stormwater wetlands are best applied when the grade of contributing slopes is less than 8%.

**Steep Slopes.** A modification of the constructed wetland (and linear wetland or wet swale system) is the regenerative stormwater conveyance (RSC) or step pool storm conveyance channel. The RSC can be used to bring stormwater down steeper grades through a series of step pools. This can serve to bring stormwater down outfalls where steep drops on the edge of the tidal receiving system can create design challenges. A description of this practice is provided in Section 4.9 Open Channel Systems.

**Available Hydraulic Head.** The depth of a constructed wetland is usually constrained by the hydraulic head available on the site. The bottom elevation is fixed by the elevation of the existing downstream conveyance system to which the wetland will ultimately discharge. Because constructed wetlands are typically shallow, the amount of head needed (usually a minimum of 2 to 4 feet) is typically less than for wet ponds.

**Setbacks.** Setbacks to structures and property lines must be at least 10 feet and adequate waterproofing protection must be provided for foundations and basements.

**Depth to Water Table.** The depth to the groundwater table is not a major constraint for constructed wetlands, since a high water table can help maintain wetland conditions. However, designers should keep in mind that high groundwater inputs may increase excavation costs (refer to Section 4.12 Ponds).

**Soils.** Soil tests should be conducted to determine the saturated hydraulic conductivity and other subsurface properties of the soils underlying the proposed stormwater wetland. Highly permeable soils will make it difficult to maintain a healthy permanent pool. Underlying soils of HSG C or D should be adequate to maintain a permanent pool. Most HSG A soils and some HSG B soils will require a liner (see Table 4.49 in Section 4.12 Ponds).

**Use of or Discharges to Natural Wetlands.** Constructed wetlands may not be located within jurisdictional waters, including wetlands, without obtaining a Section 404 permit from the appropriate federal regulatory agency. In addition, designer should investigate the status of adjacent wetlands to determine if the discharge from the constructed wetland will change the hydroperiod of a downstream natural wetland. See Cappiella et al. (2006) for guidance on minimizing stormwater discharges to existing wetlands.

**Regulatory Status.** Constructed wetlands built for the express purpose of stormwater treatment are generally not considered jurisdictional wetlands, but designers should check with their wetland regulatory authorities to ensure the status.

**Perennial Streams.** Locating a constructed wetland along or within a perennial stream will require both Section 401 and Section 404 permits from the state or federal regulatory authority.

**Economic Considerations.** If space is available, wetlands can be a very cost-effective stormwater practice.

**Community and Environmental Concerns.** In addition to the community and environmental concerns that exist for stormwater ponds, the following must be addressed during design of stormwater wetlands:

- **Aesthetics and Habitat.** Constructed wetlands can create wildlife habitat and can also become an attractive community feature. Designers should think carefully about how the wetland plant community will evolve over time, since the future plant community seldom resembles the one initially planted.
- **Existing Forests.** Given the large footprint of a constructed wetland, there is a strong chance that the construction process may result in extensive tree clearing. The designer should preserve mature trees during the facility layout and may consider creating a wooded wetland (see Cappiella et al., 2006).
- **Safety Risk.** Constructed wetlands are safer than other types of ponds, although forebays and micropools must be designed with aquatic benches to reduce safety risks.
- **Mosquito Risk.** Mosquito control can be a concern for stormwater wetlands if they are under-sized or have a small CDA. Deepwater zones serve to keep mosquito populations in check by providing habitat for fish and other pond life that prey on mosquito larvae. Few mosquito problems are reported for well-designed, properly sized, and frequently maintained constructed wetlands; however, no design can eliminate them completely. Simple precautions can be taken to minimize mosquito breeding habitat within constructed wetlands (e.g., constant inflows, benches that create habitat for natural predators, and constant pool elevations—MSSC, 2005).

#### 4.13.2 Stormwater Wetland Conveyance Criteria

- The slope profile within individual stormwater wetland cells should generally be flat from inlet to outlet (adjusting for microtopography). The recommended maximum elevation drop between wetland cells is 1 foot or less.
- Since most constructed wetlands are on-line facilities, they need to be designed to safely pass the maximum design storm (e.g., the 25-year and 100-year design storms). While the ponding depths for the more frequent 2-year storm are limited in order to avoid adverse impacts to the planting pallet, the overflow for the less frequent 25-100-year storms must likewise be carefully designed to minimize the depth of ponding. A maximum depth of 4 feet over the wetland pool is recommended.
- While many options are available for setting the normal pool elevation, it is strongly recommended that removable flashboard risers be used, given their greater operational flexibility to adjust water levels following construction (see Hunt et al., 2007). Also, a weir can be designed to accommodate passage of the larger storm flows at relatively low ponding depths.

#### 4.13.3 Stormwater Wetland Pretreatment Criteria

Sediment regulation is critical to sustain stormwater wetlands. Consequently, a forebay shall be located at the inlet and a micropool shall be located at the outlet. A micropool is a 3- to 6-foot-deep pool used to protect the low-flow pipe from clogging and to prevent sediment resuspension. Forebays are

designed in the same manner as stormwater ponds (see Section 4.12.3 Pond Pretreatment Criteria). The design of forebays should consider the possibility of heavy trash loads from public areas.

#### 4.13.4 Stormwater Wetland Design Criteria

**Internal Design Geometry.** Research and experience have shown that the internal design geometry and depth zones are critical in maintaining the pollutant removal capability and plant diversity of stormwater wetlands. Stormwater wetland performance is enhanced when the wetland has multiple cells, longer flowpaths, and a high ratio of surface area to volume. Whenever possible, constructed wetlands should be irregularly shaped with long, sinuous flow paths. The following design elements are required for stormwater wetlands:

**Multiple-Cell Wetlands.** Stormwater wetlands can be divided into at least four internal sub-cells of different elevations: the forebay, a micro-pool outlet, and two additional cells. Cells can be formed by sand berms (anchored by rock at each end), back-filled coir fiber logs, or forested peninsulas (extending as wedges across 95% of the wetland width). The vegetative target is to ultimately achieve a 50-50 mix of emergent and forested wetland vegetation within all four cells.

The first cell (the forebay) is deeper and is used to receive runoff from the pond cell or the inflow from a pipe or open channel and distribute it as sheetflow into successive wetland cells. The surface elevation of the second cell is the normal pool elevation. It may contain a forested island or a sand wedge channel to promote flows into the third cell, which is 3 to 6 inches lower than the normal pool elevation. The purpose of the wetland cells is to create an alternating sequence of aerobic and anaerobic conditions to maximize pollutant removal. The fourth wetland cell is located at the discharge point and serves as a micro-pool with an outlet structure or weir.

**Extended Detention Ponding Depth.** When extended detention is provided for management of larger storm events, the total ED volume shall not comprise more than 50% of the total volume stored by the stormwater wetland, and its maximum water surface elevation shall not extend more than 3 feet above the normal pool.

**Deep Pools.** Approximately 25% of the stormwater surface area must be provided in at least three deeper pools—located at the inlet (forebay), center, and outlet (micropool) of the wetland—with each pool having a depth of from 18 to 48 inches. Refer to the sizing based on water balance below for additional guidance on the minimum depth of the deep pools.

**High Marsh Zone.** Approximately 70% of the stormwater wetland surface area must exist in the high marsh zone (-6 inches to +6 inches, relative to the normal pool elevation).

**Transition Zone.** The low marsh zone is no longer an acceptable wetland zone, and is only allowed as a short transition zone from the deeper pools to the high marsh zone (-6 to -18 inches below the normal pool elevation). In general, this transition zone should have a maximum slope of 5H:1V (or preferably flatter) from the deep pool to the high marsh zone. It is advisable to install biodegradable erosion control fabrics or similar materials during construction to prevent erosion or slumping of this transition zone.

**Flow Path.** In terms of the flow path, there are two design objectives:

- The overall flow path through the stormwater wetland can be represented as the length-to-width ratio OR the flow path ratio. A minimum overall flow path of 2:1 must be provided across the stormwater wetland.
- The shortest flow path represents the distance from the closest inlet to the outlet. The ratio of the shortest flow path to the overall length must be at least 0.5. In some cases—due to site geometry, storm sewer infrastructure, or other factors—some inlets may not be able to meet these ratios. However, the CDA served by these “closer” inlets must constitute no more than 20% of the total CDA.

**Side Slopes.** Side slopes for the stormwater wetland should generally have gradients of 4H:1V or flatter. These mild slopes promote better establishment and growth of the wetland vegetation. They also contribute to easier maintenance and a more natural appearance.

**Micro-Topographic Features.** Stormwater wetlands must have internal structures that create variable micro-topography, which is defined as a mix of above-pool vegetation, shallow pools, and deep pools that promote dense and diverse vegetative cover.

**Stormwater Wetland Material Specifications.** Stormwater wetlands are generally constructed with materials obtained on site, except for the plant materials, inflow and outflow devices (e.g., piping and riser materials), possibly stone for inlet and outlet stabilization, and geotextile fabric for lining banks or berms. Plant stock should be nursery grown, unless otherwise approved (e.g. by the local regulatory authority), and must be healthy and vigorous native species free from defects, decay, disfiguring roots, sun-scald, injuries, abrasions, diseases, insects, pests, and all forms of infestations or objectionable disfigurements, as determined during the local plan review.

**Stormwater Wetland Sizing.** Stormwater wetlands can be designed to capture and treat the remaining stormwater discharged from upstream practices from the design storm (SWR<sub>v</sub>). Additionally, stormwater wetlands can be sized to control peak flow rates from the 2- 50-year frequency storm event or other design storm. Design calculations must ensure that the post-development peak discharge does not exceed the predevelopment peak discharge. See Section 3.7.2 Hydrologic and Hydraulic Analysis for a summary of acceptable hydrologic methodologies and models.

For treatment train designs where upland practices are utilized for treatment of the SWR<sub>v</sub>, designers can use a site-adjusted R<sub>v</sub> or NRCS CN that reflects the volume reduction of upland practices to compute the 2- 100-year frequency storm event that must be treated by the stormwater wetland.

The wetland permanent pools (volume stored in deep pools and pool depths) must be sized to store a volume equivalent to the SWR<sub>v</sub> or design volume.

The storage volume (S<sub>v</sub>) of the practice is equal to the volume provided by the wetland permanent pool (Equation 4.29). The total S<sub>v</sub> cannot exceed the SWR<sub>v</sub>.

#### Equation 4. 29 Stormwater Wetland Storage Volume

$$SSRR = SS000000DDSSpp000000 SS0000pppDDdd pp0000DDpp00000000 pp0000pp RRDDppvvDDDD$$

**Sizing for Minimum Pool Depth.** Initially, it is recommended that there be no minimum CDA requirement for the system, although it may be necessary to calculate a water balance for the wet pond cell when its CDA is less than 10 acres (Refer to Section 4.12 Ponds).

Similarly, if the hydrology for the constructed wetland is not supplied by groundwater or dry weather flow inputs, a simple water balance calculation must be performed, using Equation 4.30 (Hunt et al., 2007), to assure the deep pools will not go completely dry during a 30-day summer drought.

Equation 4.30 Water Balance for Acceptable Water Depth in a Stormwater Wetland

$$DDPP = \frac{RF_m}{EF} \times \frac{WS}{WL} - \frac{ET}{WWLL} - \frac{INF}{RES} - \frac{RES}{RES}$$

Where:

<i>DP</i>	=	depth of pool (in.)
<i>RF<sub>m</sub></i>	=	monthly rainfall during drought (in.)
<i>EF</i>	=	fraction of rainfall that enters the stormwater wetland (in.) (CDA × Rv)
<i>WS/WL</i>	=	ratio of contributing drainage area to stormwater wetland surface area
<i>ET</i>	=	summer evapotranspiration rate (in.) (assume 8 in.)
<i>INF</i>	=	monthly infiltration loss (assume 7.2 inches at 0.01 in./hr)
<i>RES</i>	=	reservoir of water for a factor of safety (assume 6 in.)

Using Equation 4.30, setting the groundwater and (dry weather) base flow to zero and assuming a worst-case summer rainfall of 0 inches, the minimum depth of the pool calculates as follows (Equation 4.31):

**Equation 4.31 Minimum Depth of the Permanent Pool**

$$DDPP = \frac{RF_m}{EF} - \frac{ET}{WWLL} - \frac{INF}{RES} - \frac{RES}{RES} = 21.2$$

Where:

<i>DP</i>	=	depth of pool (in.)
<i>RF<sub>m</sub></i>	=	monthly rainfall during drought (in.)
<i>ET</i>	=	summer evapotranspiration rate (in.) (assume 8 in.)
<i>INF</i>	=	monthly infiltration loss (assume 7.2 inches at 0.01 in./hr)
<i>RES</i>	=	reservoir of water for a factor of safety (assume 6 in.)

Therefore, unless there is other input, such as base flow or groundwater, the minimum depth of the pool should be at least 22 inches (rather than the 18-inch minimum depth noted in Section 4.11.4 Stormwater Wetland Design Criteria).

#### 4.13.5

##### **Stormwater Wetland Construction Sequence**

The construction sequence for stormwater wetlands depends on site conditions, design complexity, and the size and configuration of the proposed facility. The following two-stage construction sequence is recommended for installing an on-line stormwater wetland facility and establishing vigorous plant cover.

##### **Stage 1 Construction Sequence: Wetland Facility Construction.**

1. **Stabilize Contributing Drainage Area.** Stormwater wetlands should only be constructed after the CDA to the wetland is completely stabilized. If the proposed stormwater wetland site will be used as a sediment trap or basin during the construction phase, the construction notes must clearly indicate that the facility will be de-watered, dredged, and re-graded to design dimensions after the original site construction is complete.
2. **Assemble Construction Materials on Site.** Inspect construction materials to ensure they conform to design specifications and prepare any staging areas.
3. **Clear and Strip.** Bring the project area to the desired subgrade.
4. **Install Soil Erosion and Sediment Control Measures** prior to construction, including sediment basins and stormwater diversion practices. All areas surrounding the stormwater wetland that are graded or denuded during construction of the wetland are to be planted with turf grass, native plant materials, or other approved methods of soil stabilization. Grass sod is preferred over seed to reduce seed colonization of the stormwater wetland. During construction, the stormwater wetland must be separated from the CDA so that no sediment flows into the wetland areas. In some cases, a phased or staged soil erosion and sediment control plan may be necessary to divert flow around the stormwater wetland area until installation and stabilization are complete.
5. **Excavate the Core Trench for the Embankment and Install the Spillway Pipe.**
6. **Install the Riser or Outflow Structure** and ensure that the top invert of the overflow weir is constructed level and at the proper design elevation (flashboard risers are strongly recommended by Hunt et al., 2007).
7. **Construct the Embankment and any Internal Berms** in 8- to 12-inch lifts and compact them with appropriate equipment.
8. **Excavate and Grade.** Survey to achieve the appropriate elevation and designed contours for the bottom and side slopes of the stormwater wetland. This is normally done by “roughing up” the interim elevations with a skid loader or other similar equipment to achieve the desired topography across the wetland. Spot surveys should be made to ensure that the interim elevations are 3 to 6 inches below the final elevations for the wetland.
9. **Install Micro-Topographic Features and Soil Amendments** within the stormwater wetland area. Since most stormwater wetlands are excavated to deep sub-soils, they often lack the nutrients and organic matter needed to support vigorous growth of wetland plants. It is therefore essential to add sand, compost, topsoil, or wetland mulch to all depth zones in the stormwater wetland. The importance of soil amendments in excavated stormwater wetlands cannot be over-emphasized; poor survival and future wetland coverage are likely if soil amendments are not added. The planting soil should be a high organic content loam or sandy loam, placed by mechanical methods, and spread by hand. Planting soil depth should be at least 4 inches for shallow wetlands. No machinery should be allowed to traverse over the planting soil during or after construction. Planting soil should be tamped as directed in the design

specifications, but it should not be overly compacted. After the planting soil is placed, it should be saturated and allowed to settle for at least one week prior to installation of plant materials.

**10. Construct the Emergency Spillway** in cut or structurally stabilized soils.

**11. Install Outlet Pipes.** The installation of outlet pipes must include a downstream riprap protection apron.

**12. Stabilize Exposed Soils** with temporary seed mixtures appropriate for a wetland environment. All wetland features above the normal pool elevation should be temporarily stabilized by hydro-seeding or seeding over straw.

## **Stage 2 Construction Sequence: Establishing the Wetland Vegetation.**

**13. Finalize the Stormwater Wetland Landscaping Plan.** At this stage the engineer, landscape architect, and wetland expert work jointly to refine the initial wetland landscaping plan after the stormwater wetland has been constructed. Several weeks of standing time is needed so that the designer can more precisely predict the following:

- Where the inundation zones are located in and around the stormwater wetland; and
- Whether the final grade and wetland microtopography will persist over time.

This allows the designer to select appropriate species and additional soil amendments, based on field confirmation of soils properties and the actual depths and inundation frequencies occurring within the stormwater wetland.

**14. Open Up the Stormwater Wetland Connection.** Once the final grades are attained, the pond and/or CDA connection should be opened to allow the wetland cell to fill up to the normal pool elevation. Gradually inundate the stormwater wetland to avoid erosion of unplanted features. Inundation must occur in stages so that deep pool and high marsh plant materials can be placed effectively and safely. Wetland planting areas should be at least partially inundated during planting to promote plant survivability.

**15. Measure and Stake Planting Depths** at the onset of the planting season. Depths in the stormwater wetland should be measured to the nearest inch to confirm the original planting depths of the planting zone. At this time, it may be necessary to modify the plan to reflect altered depths or a change in the availability of wetland plant stock. Surveyed planting zones should be marked on the as-built or design plan, and their locations should also be identified in the field, using stakes or flags.

**16. Propagate the Stormwater Wetland.** Two techniques are used in combination to propagate the emergent community over the wetland bed:

**17. Initial Planting of Container-Grown Wetland Plant Stock.** The transplanting window extends from early March through May. Planting after these dates can decrease the chance of survival, since emergent wetland plants need a full growing season to build the root reserves needed to get through the winter. It is recommended that plants be ordered at least 6 months in advance to ensure the availability and on-time delivery of desired species.

**18. Broadcasting Wetland Seed Mixes.** The higher wetland elevations should be established by broadcasting wetland seed mixes to establish diverse emergent wetlands. Seeding of switchgrass or wetland seed mixes as a ground cover is recommended for all zones above 3 inches below the normal pool elevation. Hand broadcasting or hydroseeding can be used to spread seed, depending on the size of the wetland cell.



**19. Install Goose Protection to Protect Newly Planted or Newly Growing Vegetation.** This is particularly critical for newly established emergent and herbaceous plants, as predation by Canada geese can quickly decimate wetland vegetation. Goose protection can consist of netting, webbing, or string installed in a crisscross pattern over the surface area of the stormwater wetland, above the level of the emergent plants.

**20. Plant the Stormwater Wetland Fringe and Buffer Area.** This zone generally extends from 1 to 3 feet above the normal pool elevation (from the shoreline fringe to about half of the maximum water surface elevation for the 2-year storm). Consequently, plants in this zone are infrequently inundated (5 to 10 times per year) and must be able to tolerate both wet and dry periods.

**Construction Supervision.** Supervision during construction is recommended to ensure that stormwater wetlands are properly constructed and established. Multiple site visits and inspections by a qualified professional are recommended during the following stages of the stormwater wetland construction process:

- Preconstruction meeting
- Initial site preparation including the installation of soil erosion and sediment control measures
- Excavation/Grading (interim and final elevations)
- Installation of the embankment, the riser/primary spillway, and the outlet structure
- Implementation of the pondscaping plan and vegetative stabilization
- Immediately seed or install vegetated ground cover upon completion of sloping and grading, where applicable, of each stormwater wetland within a project.
- Inspect within two weeks to ensure vegetation is in fact holding banks and slopes in place.
- Prior to completion of project, mechanically remove erosion deposition from ponds that occurred during the project. Criteria should be based on erosion of designed bank slopes and loss of storage capacity.
- Final inspection (develop a punch list for facility acceptance)

Construction inspection checklist for Stormwater Wetlands can be found in Appendix E Construction Inspection Checklists.

#### **4.13.6 Stormwater Wetland Landscaping Criteria**

An initial stormwater wetland landscaping plan is required for any stormwater wetland and should be jointly developed by the engineer and a wetlands expert or experienced landscape architect. The plan should outline a detailed schedule for the care, maintenance, and possible reinforcement of vegetation in the wetland and its buffer for up to 10 years after the original planting.

The plan should outline a realistic, long-term planting strategy to establish and maintain desired wetland vegetation. The plan should indicate how wetland plants will be established within each inundation zone (e.g., wetland plants, seed-mixes, volunteer colonization, and tree and shrub stock) and whether soil amendments are needed to get plants started. At a minimum, the plan should contain the following:

- Plan view(s) with topography at a contour interval of no more than 1 foot and spot elevations throughout the cell showing the stormwater wetland configuration, different planting zones (e.g.,

high marsh, deep water, upland), microtopography, grades, site preparation, and construction sequence.

- A plant schedule and planting plan specifying emergent, perennial, shrub and tree species, quantity of each species, stock size, type of root stock to be installed, and spacing. To the degree possible, the species list for the constructed wetland should contain plants found in similar local wetlands.

The following general guidance is provided:

- **Use Native Species Where Possible.** Table 4.53 provides a list of common native shrub and tree species and Table 4.54 provides a list of common native emergent, submergent, and perimeter plant species, all of which have proven to do well in stormwater wetlands in the mid-Atlantic region and are generally available from most commercial nurseries. Other native species can be used that appear in state-wide plant lists. The use of native species is strongly encouraged, but in some cases, non-native ornamental species may be added as long as they are not invasive. Invasive species such as cattails (*Typha latifolia*), common reed (*Phragmites australis*), and purple loosestrife (*Lythrum salicaria*) must not be planted.
- **Match Plants to Inundation Zones.** The various plant species shown in Table 4.53 and Table 4.54 should be matched to the appropriate inundation zone. The first four inundation zones are particularly applicable to stormwater wetlands, as follows:

**Zone 1** -6 inches to -12 inches below the normal pool elevation

**Zone 2** -6 inches to the normal pool elevation

**Zone 3** From the normal pool elevation to +12 inches above

**Zone 4** +12 inches to +36 inches above the normal pool elevation (i.e., above ED Zone)

Note: The Low Marsh Zone (-6 to -18 inches below the normal pool elevation) has been dropped since experience has shown that few emergent wetland plants flourish in this deeper zone.

- **Aggressive Colonizers.** To add diversity to the stormwater wetland, five to seven species of emergent wetland plants should be planted, using at least four emergent species designated as aggressive colonizers (shown in bold in Table 4.54). No more than 25% of the high marsh wetland surface area needs to be planted. If the appropriate planting depths are achieved, the entire stormwater wetland should be colonized within 3 years. Individual plants should be planted 18 inches on center within each single species "cluster."
- **Suitable Tree Species.** The major shift in stormwater wetland design is to integrate trees and shrubs into the design, in tree islands, peninsulas, and fringe buffer areas. Deeper-rooted trees and shrubs that can extend to the stormwater wetland's local water table are important for creating a mixed wetland community. Table 4.53 above presents some recommended tree and shrub species for different inundation zones. A good planting strategy includes varying the size and age of the plant stock to promote a diverse structure. Using locally grown container or bare root stock is usually the most successful approach if planting in the spring. It is recommended that buffer planting areas be over-planted with a small stock of fast-growing successional species to achieve quick canopy closure and shade out invasive plant species. Trees may be planted in clusters to share rooting space on compacted wetland side-slopes. Planting holes should be amended with compost (a 2:1 ratio of loose soil to compost) prior to planting.
- **Pre- and Post-Nursery Care.** Plants should be kept in containers of water or moist coverings to protect their root systems and keep them moist when in transporting them to the planting location.

As much as 6 to 9 months of lead time may be needed to fill orders for wetland plant stock from aquatic plant nurseries. Consult local regulatory authorities for information on area suppliers.

**Table 4.53. Popular, Versatile, and Available Native Trees and Shrubs for Stormwater Wetlands**

Shrubs		Trees	
Common and <i>Scientific</i> Names	Zone <sup>1</sup>	Common and <i>Scientific</i> Names	Zone <sup>1</sup>
Button Bush ( <i>Cephalanthus occidentalis</i> )	2, 3	Atlantic White Cedar ( <i>Chamaecyparis thyoides</i> )	2, 3
Common Winterberry ( <i>Ilex verticillata</i> )	3, 4	Bald Cypress ( <i>Taxodium distichum</i> )	2, 3
Elderberry ( <i>Sambucus canadensis</i> )	3	Black Willow ( <i>Salix nigra</i> )	3, 4
Indigo Bush ( <i>Amorpha fruticosa</i> )	3	Box Elder ( <i>Acer Negundo</i> )	2, 3
Inkberry ( <i>Ilex glabra</i> )	2, 3	Green Ash ( <i>Fraxinus pennsylvanica</i> )	3, 4
Smooth Alder ( <i>Alnus serrulata</i> )	2, 3	Grey Birch ( <i>Betula populifolia</i> )	3, 4
Spicebush ( <i>Lindera benzoin</i> )	3, 4	Red Maple ( <i>Acer rubrum</i> )	3, 4
Swamp Azalea ( <i>Azalea viscosum</i> )	2, 3	River Birch ( <i>Betula nigra</i> )	3, 4
Swamp Rose ( <i>Rosa palustris</i> )	2, 3	Swamp Tupelo ( <i>Nyssa biflora</i> )	2, 3
Sweet Pepperbush ( <i>Clethra alnifolia</i> )	2, 3	Sweetbay Magnolia ( <i>Magnolia virginiana</i> )	3, 4
		Sweetgum ( <i>Liquidambar styraciflua</i> )	3, 4
		Sycamore ( <i>Platanus occidentalis</i> )	3, 4
		Water Oak ( <i>Quercus nigra</i> )	3, 4
		Willow Oak ( <i>Quercus phellos</i> )	3, 4

<sup>1</sup>Zone 1: -6 to -12 inches below the normal pool elevation

Zone 2: -6 inches to the normal pool elevation

Zone 3: From the normal pool elevation to +12 inches

Zone 4: +12 to +36 inches; above ED zone

Source: Virginia DCR Stormwater Design Specification No. 13: Constructed Wetlands Version 1.8. 2010.

Table 4.54. Popular, Versatile, and Available Native Emergent and Submergent Vegetation for Stormwater Wetlands

Plant	Zone <sup>1</sup>	Form	Inundation Tolerance	Wildlife Value	Notes
Arrow Arum ( <i>Peltandra virginica</i> )	2	Emergent	Up to 1 ft	High; berries are eaten by wood ducks	Full sun to partial shade
<b>Broad-Leaf Arrowhead (Duck Potato)</b> ( <i>Sagittaria latifolia</i> )	2	Emergent	Up to 1 ft	Moderate; tubers and seeds eaten by ducks	Aggressive colonizer
Blueflag Iris* ( <i>Iris versicolor</i> )	2, 3	Emergent	Up to 6 in.	Limited	Full sun (to flower) to partial shade
Broomsedge ( <i>Andropogon virginianus</i> )	2, 3	Perimeter	Up to 3 in.	High; songbirds and browsers; winter food and cover	Tolerant of fluctuating water levels and partial shade
<b>Bulltongue Arrowhead</b> ( <i>Sagittaria lancifolia</i> )	2, 3	Emergent	0 to 24 in.	Waterfowl, small mammals	Full sun to partial shade
<b>Burreed</b> ( <i>Sparganium americanum</i> )	2, 3	Emergent	0 to 6 in.	Waterfowl, small mammals	Full sun to partial shade
Cardinal Flower* ( <i>Lobelia cardinalis</i> )	3	Perimeter	Periodic inundation	Attracts hummingbirds	Full sun to partial shade
<b>Common Rush</b> ( <i>Juncus spp.</i> )	2, 3	Emergent	Up to 12 in.	Moderate; small mammals, waterfowl, songbirds	Full sun to partial shade
<b>Common Three Square</b> ( <i>Scirpus pungens</i> )	2	Emergent	Up to 6 in.	High; seeds, cover, waterfowl, songbirds	Fast colonizer; can tolerate periods of dryness; full sun; high metal removal
Duckweed ( <i>Lemna sp.</i> )	1, 2	Submergent / Emergent	Yes	High; food for waterfowl and fish	May biomagnify metals beyond concentrations found in the water
Joe Pye Weed ( <i>Eupatorium purpureum</i> )	2, 3	Emergent	Drier than other Joe-Pye Weeds; dry to moist areas; periodic inundation	Butterflies, songbirds, insects	Tolerates all light conditions
<b>Lizard's Tail</b> ( <i>Saururus cernus</i> )	2	Emergent	Up to 1 ft	Low; except for wood ducks	Rapid growth; shade-tolerant

Plant	Zone <sup>1</sup>	Form	Inundation Tolerance	Wildlife Value	Notes
Marsh Hibiscus ( <i>Hibiscus moscheutos</i> )	2, 3	Emergent	Up to 3 in.	Low; nectar	Full sun; can tolerate periodic dryness
<b>Pickerelweed</b> ( <i>Pontederia cordata</i> )	2, 3	Emergent	Up to 1 ft	Moderate; ducks, nectar for butterflies	Full sun to partial shade
Pond Weed ( <i>Potamogeton pectinatus</i> )	1	Submergent	Yes	Extremely high; waterfowl, marsh and shore birds	Removes heavy metals from the water
Rice Cutgrass ( <i>Leersia oryzoides</i> )	2, 3	Emergent	Up to 3 in.	High; food and cover	Prefers full sun, although tolerant of shade; shoreline stabilization
<b>Sedges</b> ( <i>Carex spp.</i> )	2, 3	Emergent	Up to 3 in.	High; waterfowl, songbirds	Wetland and upland species
<b>Softstem Bulrush</b> ( <i>Scirpus validus</i> )	2, 3	Emergent	Up to 2 ft	Moderate; good cover and food	Full sun; aggressive colonizer; high pollutant removal
<b>Smartweed</b> ( <i>Polygonum spp.</i> )	2	Emergent	Up to 1 ft	High; waterfowl, songbirds; seeds and cover	Fast colonizer; avoid weedy aliens, such as <i>P. Perfoliatum</i>
<b>Spatterdock</b> ( <i>Nuphar luteum</i> )	2	Emergent	Up to 1.5 ft	Moderate for food, but High for cover	Fast colonizer; tolerant of varying water levels
Switchgrass ( <i>Panicum virgatum</i> )	2, 3, 4	Perimeter	Up to 3 in.	High; seeds, cover; waterfowl, songbirds	Tolerates wet/dry conditions
Sweet Flag* ( <i>Acorus calamus</i> )	2, 3	Perimeter	Up to 3 in.	Low; tolerant of dry periods	Tolerates acidic conditions; not a rapid colonizer
Waterweed ( <i>Elodea canadensis</i> )	1	Submergent	Yes	Low	Good water oxygenator; high nutrient, copper, manganese, and chromium removal
Wild celery ( <i>Valisneria americana</i> )	1	Submergent	Yes	High; food for waterfowl; habitat for fish and invertebrates	Tolerant of murky water and high nutrient loads
Wild Rice ( <i>Zizania aquatica</i> )	2	Emergent	Up to 1 ft	High; food, birds	Prefers full sun
<b>Woolgrass Bulrush</b> ( <i>Scirpus cyperinus</i> )	3, 4	Emergent	Yes	High: waterfowl, small mammals	Fresh tidal and non-tidal, swamps, forested wetlands, meadows, ditches

Aggressive colonizers are shown in bold type

<sup>1</sup>Zone 1: -6 to -12 inches below the normal pool elevation

Plant	Zone <sup>1</sup>	Form	Inundation Tolerance	Wildlife Value	Notes
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Zone 2: -6 inches to the normal pool elevation

Zone 3: From the normal pool elevation to +12 inches

Zone 4: +12 to +36 inches; above ED zone

\*Not a major colonizer, but adds color

Source: Virginia DCR Stormwater Design Specification No. 13: Constructed Wetlands Version 1.8. 2010.

#### 4.13.7 Stormwater Wetland Maintenance Criteria

Successful establishment of constructed wetland areas requires that the following tasks be undertaken in the first 2 years:

- **Initial Inspections.** During the first 6 months following construction, the site should be inspected by a qualified professional at least twice after storm events that exceed 0.5 inch of rainfall.
- **Spot Reseeding.** Inspections should include looking for bare or eroding areas in the CDA or around the wetland buffer and make sure they are immediately stabilized with grasscover.
- **Watering.** Trees planted in the buffer and on wetland islands and peninsulas need watering during the first growing season. In general, consider watering every 3 days for first month, and then weekly during the first growing season (April through October), depending on rainfall.
- **Reinforcement Plantings.** Regardless of the care taken during the initial planting of the stormwater wetland and buffer, it is probable that some areas will remain unvegetated and some species will not survive. Poor survival can result from many unforeseen factors, such as predation, poor quality plant stock, water level changes, and drought. Thus, it is advisable to budget for an additional round of reinforcement planting after one or two growing seasons. Construction contracts should include a care and replacement warranty extending at least two growing seasons after initial planting, to selectively replant portions of the stormwater wetland that fail to fill in or survive. If a minimum coverage of 50% is not achieved in the planted wetland zones after the second growing season, a reinforcement planting will be required.

Managing vegetation is an important ongoing maintenance task at every constructed wetland and for each inundation zone. Following the design criteria above should result in a reduced need for regular mowing of the embankment and access roads. Vegetation within the stormwater wetland, however, will require some annual maintenance.

Designers should expect significant changes in wetland species composition to occur over time. Inspections should carefully track changes in wetland plant species distribution over time. Invasive plants should be dealt with as soon as they begin to colonize the stormwater wetland. As a general rule, control of undesirable invasive species (e.g., cattails and Phragmites) should commence when their coverage exceeds more than 15% of a wetland cell area. Although the application of herbicides is not recommended, some types (e.g., Glyphosate) have been used to control cattails with some success. Extended periods of dewatering may also work, since early manual removal provides only short-term relief from invasive species. While it is difficult to exclude invasive species completely from stormwater wetlands, their ability to take over the entire wetland can be reduced if the designer creates a wide range of depth zones and a complex internal structure within the wetland.

- ☐ For more information on invasive plants, consult the South Carolina Exotic Pest Plant Council. Resources are available online at <http://www.se-eppc.org/southcarolina/invasivePlants.cfm>.
- For more information related to chemical control methods for aquatic plants, please review the fact sheet “Aquatic Weed Control Overview” provided by Clemson’s Cooperative Extension Service and available online at <http://www.clemson.edu/extension/hgic/plants/other/landscaping/hgic1714.html>.

Thinning or harvesting of excess forest growth may be periodically needed to guide the forested stormwater wetland into a more mature state. Vegetation may need to be harvested periodically if the constructed wetland becomes overgrown. Thinning or harvesting operations should be scheduled to occur approximately 5 and 10 years after the initial stormwater wetland construction. Removal of woody species on or near the embankment and maintenance access areas should be conducted every 2 years.

Designers should refer to Section 4.12.7 Pond Maintenance Criteria for additional maintenance responsibilities associated with stormwater wetlands. Ideally, maintenance of constructed wetlands should be driven by annual inspections by a qualified professional that evaluates the condition and performance of the stormwater wetland. Based on inspection results, specific maintenance tasks will be triggered.

Maintenance inspection checklist for stormwater wetlands and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### 4.13.8 Stormwater Wetland Stormwater Compliance Calculations

Stormwater wetlands are credited with 0% retention, but they do receive 80% TSS, 30% TN, and 60% bacteria removal for the storage volume (Sv) provided by in the permanent pool (Table 4.55).

**Table 4.55. Stormwater Wetland Retention and Pollutant Removal**

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 25%
Bacteria Removal	= 60%

#### 4.14 Tree Planting & Preservation

Tree Planting and Preservation						
Definition: Existing trees can be preserved or new trees can be planted to reduce stormwater runoff.						
Site Applicability		BMP Performance Summary				
Land Uses	Required Footprint	WQ Improvement: Moderate to High				
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>		Bacteria <sup>1</sup>	
		N/A	N/A		N/A	
		Runoff Reductions				
Construction Costs	Maintenance Burden	Volume				
Low	Low	Low				
Maintenance Frequency:		SWR <sub>v</sub> *				
Routine	Non-Routine	T-1 Small	T-1 Large	T-2 Small	T-2 Large	T-2 Special
At least annually	Every 10–15 years	5 ft <sup>3</sup>	10 ft <sup>3</sup>	10 ft <sup>3</sup>	20 ft <sup>3</sup>	30 ft <sup>3</sup>
Advantages/Benefits		Disadvantages/Limitation				
<ul style="list-style-type: none"><li>▪ High community acceptance</li><li>▪ Relatively low maintenance requirements</li><li>▪ Increases property value</li><li>▪ Easily incorporated with other practices</li><li>▪ Excellent for soils</li></ul>		<ul style="list-style-type: none"><li>▪ Preserved trees must be protected during construction</li><li>▪ Must be within LOD</li><li>▪ Must maintain tree health</li></ul>				
Components		Design considerations				
<ul style="list-style-type: none"><li>▪ Inventory of existing trees</li><li>▪ Identification of trees to preserve or plant</li><li>▪ Preference for Special trees</li><li>▪ Average tree spread</li></ul>		<ul style="list-style-type: none"><li>▪ Inventory of existing trees</li><li>▪ Identification of trees to preserve or plant</li><li>▪ Preference for Special trees</li><li>▪ Slope-steep slopes must be terraced/benched</li><li>▪ Maintenance access</li></ul>				
Maintenance Activities						
<ul style="list-style-type: none"><li>▪ If staked during establishment, remove stakes within 1 year of planting</li></ul>		<ul style="list-style-type: none"><li>▪ Maintain appropriate mulch cover</li><li>▪ Ensure tree health</li></ul>				

<sup>1</sup>Credited pollutant load removal

\*Per planted/preserved tree



Easily combined with other practices, tree planting and preservation provide stormwater interception, beauty, and shade, thereby increasing aesthetics and property values. See Figure 4. 57



**Figure 4. 56 Tree Planting and Preservation in Bioretention**  
**Photo: Center for Watershed Protection**

**Definition.** Existing trees can be preserved or new trees can be planted to reduce stormwater runoff. The design includes the following:

- T-1 Tree planting
- T-2 Tree preservation

Tree canopy can intercept a significant amount of rainfall before it becomes runoff, particularly if the tree canopy covers impervious surfaces, as in the case of street trees. Through the processes of evapotranspiration and nutrient uptake, trees—even when located on a development site—have the capacity to reduce stormwater runoff volumes and improve water quality. Further, through root growth, trees can improve the infiltration capacity of the soils in which they grow.

Both tree planting and tree preservation can contribute to stormwater management on a site. Note that retention credit is available for preserved trees only when they are within the limits of disturbance of a project. Preserved trees outside of the limits of disturbance may offer an opportunity for additional retention when they constitute an area of natural cover and stormwater is conveyed to that area.

#### 4.14.1 Preserving Existing Trees during Construction

The preferred method for increasing tree cover at a development site is to preserve existing trees during construction, particularly where mature trees are present. Existing trees are preserved during construction through a four-step process:

1. Inventory existing trees.
2. Identify trees to preserve.
3. Protect trees and soil during construction.
4. Protect trees after construction.

**Inventory Existing Trees.** An inventory of existing trees and forested areas at the development site must be conducted before any site design, clearing, or construction takes place, as specified by the DDOT UFD. The inventory must be conducted by one of the following qualified professionals, which includes, but is not limited to:

- South Carolina Licensed Forester
- South Carolina Licensed Tree Expert
- South Carolina Experienced Forester
- South Carolina Licensed Landscape Architect
- International Society of Arboriculture (ISA) Certified Arborist

The inventory must include a survey of existing trees and determine their size, species, condition, and ecological value. Locations of trees and forest stands must be recorded.

**Identify Trees to Preserve.** From the tree inventory, individual trees can be identified for preservation and protection during site development. Preserved trees fall into three categories of retention credit: tree species with an average mature spread less than or equal to 40 feet ("small" trees) receive 10 cubic feet of retention credit; trees species with an average mature spread greater than or equal to 40 feet ("large" trees) receive 20 cubic feet of retention credit; and trees with an existing diameter greater than 14" ("Special" trees) receive 30 cubic feet of retention credit, regardless of mature spread size. Additional selection criteria may include tree species, size, condition, and location (see Table 4.56).

**Table 4.56. Selecting Priority Trees and Forests for Preservation**

Selection Criteria	Examples of Priority Tree and Forests to Conserve
Species	<ul style="list-style-type: none"> <li>▪ Rare, threatened, or endangered species</li> <li>▪ Specimen trees</li> <li>▪ High quality tree species (e.g., white oaks and sycamores because they are structurally strong and live longer than trees such as silver maple and cottonwood)</li> <li>▪ Species that are tolerant of specific site conditions and soils</li> </ul>
Size	<ul style="list-style-type: none"> <li>▪ Trees over a specified diameter at breast height (DBH) or other size measurement</li> <li>▪ Trees designated as national, state, or local champions</li> <li>▪ Contiguous forest stands</li> </ul>

Selection Criteria	Examples of Priority Tree and Forests to Conserve
Condition	<ul style="list-style-type: none"> <li>▪ Healthy trees that are structurally sound in “fair” or better condition</li> <li>▪ High quality forest stands with high forest structural diversity</li> </ul>
Location	<ul style="list-style-type: none"> <li>▪ Trees located where they will provide direct benefits at the site (e.g., shading, privacy, windbreak, buffer from adjacent land use)</li> <li>▪ Forest stands that are connected to off-site forests that create wildlife habitat and corridors</li> <li>▪ Trees located in protected natural areas such as floodplains, stream buffers, wetlands, erodible soils, critical habitat areas, and steep slopes.</li> <li>▪ Forest stands that are connected to off-site non-forested natural areas or protected land (e.g., has potential to provide wildlife habitat)</li> </ul>

Trees selected for preservation and protection must be clearly marked both on construction drawings and at the actual site. Flagging or fencing is typically used to protect trees at the construction site. Areas of trees to preserve should be marked on the site map and walked during preconstruction meetings.

**Protect Trees and Soil During Construction.** Physical barriers must be properly installed around the Critical Root Zone (CRZ) of trees to be preserved. The CRZ shall be determined by a landscape professional from the above list, and in general is equal to 1.5 feet of tree protection (radius of circle) for every 1 inch in tree diameter. For example, a 10-inch diameter tree would have a CRZ radius extending 15 feet from the tree. The barriers must be maintained and enforced throughout the construction process. Tree protection barriers include highly visible, well-anchored temporary protection devices, such as 6-foot-tall chain link fencing.

All protection devices must remain in place throughout construction.

When excavation is proposed immediately adjacent to the CRZ, roots must first be pruned at the edge of the excavation with a trenching machine, vibratory knife or rock saw to a depth of 18 inches. Any requirements here may be superseded by the requirements of the CDC.

**Protect Trees After Construction.** Maintenance covenants, as described below, are required to ensure that preserved trees are protected.

#### 4.14.2 Planting Trees

**Considerations at Development Sites.** New development sites provide many opportunities to plant new trees. Planting trees at development sites is done in three steps:

1. Select tree species.
2. Evaluate and improve planting sites.
3. Plant and maintain trees.

**Tree Species.** Planted trees fall into two categories of retention: tree species with an average mature spread less than or equal to 40 feet (“small” trees) receive 5 cubic feet of retention and trees species with an average mature spread greater than or equal to 40 feet (“large” trees) receive 10 cubic feet of retention. Trees to be planted must have a minimum caliper size of 1.5 inches.

**Planting Sites.** Ideal planting sites within a development are those that create interception opportunities around impervious surfaces. These include areas along pathways, roads, islands and median strips, and parking lot interiors and perimeters. Other areas of a development site may benefit from planting trees (including stream valleys and floodplains, areas adjacent to existing forest, steep slopes, and portions of the site where trees would provide buffers, screening, noise reduction, or shading).

It is important to evaluate and record the conditions, such as soil type, soil pH, soil compaction, and the hydrology of proposed planting sites to ensure they are suitable for planting. These evaluations provide a basis for species selection and determination of the need for any special site preparation techniques.

A minimum of 1,500 cubic feet of rootable soil volume must be provided per large tree. In planting arrangements that allow for shared rooting space amongst multiple trees, a minimum of 1,000 cubic feet of rootable soil volume must be provided for each large tree. Rootable soil volume must be within 3 feet of the surface.

Smaller trees with an average mature spread of less than or equal to 40 feet must have a minimum of 600 cubic feet of rootable soil volume. In planting arrangements that permit shared rooting space amongst multiple trees, a minimum of 400 cubic feet of rootable soil volume must be provided for each tree. Rootable soil volume must be within 3 feet of the surface.

Site characteristics determine what tree species will flourish there and whether any of the conditions, such as soils, can be improved through the addition of compost or other amendments. Table 4.57 presents methods for addressing common constraints to urban tree planting.

**Table 4.57. Methods for Addressing Urban Planting Constraints**

Potential Impact	Potential Resolution
Limited Soil Volume	<ul style="list-style-type: none"> <li>Provide 1,500 cubic feet of rootable soil volume per large tree (greater than or equal to 40-foot spread) and 600 cubic feet of rootable soil volume per small tree (less than or equal to 40-foot spread). This soil must be within 3 feet of the surface.</li> <li>Use planting arrangements that allow shared rooting space. A minimum of 1,000 cubic feet of rootable soil volume must be provided for each tree in shared rooting space arrangements. A minimum of 400 cubic feet of rootable soil volume must be provided for each small tree in shared rooting arrangements.</li> </ul>
Poor Soil Quality	<ul style="list-style-type: none"> <li>Test soil and perform appropriate restoration.</li> <li>Select species tolerant of soil pH, compaction, drainage, etc.</li> <li>Replace very poor soils if necessary.</li> </ul>
Air Pollution	<ul style="list-style-type: none"> <li>Select species tolerant of air pollutants.</li> </ul>
Damage from Lawnmowers	<ul style="list-style-type: none"> <li>Use mulch to protect trees.</li> </ul>
Damage from Vandalism	<ul style="list-style-type: none"> <li>Use tree cages or benches to protect trees.</li> <li>Select species with inconspicuous bark or thorns.</li> <li>Install lighting nearby to discourage vandalism.</li> </ul>
Damage from Vehicles	<ul style="list-style-type: none"> <li>Provide adequate setbacks between vehicle parking stalls and trees.</li> </ul>

Potential Impact	Potential Resolution
Damage from animals such as deer, rodents, rabbits, and other herbivores	<ul style="list-style-type: none"> <li>▪ Use protective fencing or chemical retardants.</li> </ul>
Exposure to pollutants in stormwater runoff	<ul style="list-style-type: none"> <li>▪ Select species that are tolerant of specific pollutants, such as oils and metals.</li> </ul>
Soil moisture extremes	<ul style="list-style-type: none"> <li>▪ Select species that are tolerant of inundation or drought.</li> <li>▪ Install underdrains if necessary.</li> <li>▪ Select appropriate backfill soil and mix thoroughly with site soil.</li> <li>▪ Improve soil drainage with amendments and tillage if needed.</li> </ul>
Increased temperature	<ul style="list-style-type: none"> <li>▪ Select drought tolerant species.</li> </ul>
Increased wind	<ul style="list-style-type: none"> <li>▪ Select drought tolerant species.</li> </ul>
Abundant populations of invasive species	<ul style="list-style-type: none"> <li>▪ Control invasive species prior to planting.</li> <li>▪ Continually monitor for and remove invasive species.</li> </ul>
Conflict with infrastructure	<ul style="list-style-type: none"> <li>▪ Design the site to keep trees and infrastructure separate.</li> <li>▪ Provide appropriate setbacks from infrastructure.</li> <li>▪ Select appropriate species for planting near infrastructure.</li> <li>▪ Use alternative materials to reduce conflict.</li> </ul>
Disease or insect infestation	<ul style="list-style-type: none"> <li>▪ Select resistant species</li> </ul>

Planting trees at development sites requires prudent species selection, a maintenance plan, and careful planning to avoid impacts from nearby infrastructure, runoff, vehicles or other urban elements.

**Trees Along Streets and in Parking Lots.** When considering a location for planting, clear lines of sight must be provided, as well as safe travel surfaces, and overhead clearance for pedestrians and vehicles. Also, ensure enough soil volume for healthy tree growth. Usable soil must be uncompacted and may not be covered by impervious material. Having at least a 6-foot-wide planting strip or locating sidewalks between the trees and street allows more rooting space for trees in adjacent property.

Select tree species that are drought tolerant, can grow in poor or compacted soils, and are tolerant to typical urban pollutants (oil and grease, metals, and chlorides). Additionally, select species that do not produce excessive fruits, nuts, or leaf litter, that have fall color, spring flowers or some other aesthetic benefit, and can be limbed up to 6 feet to provide pedestrian and vehicle traffic underneath.

**Planting Techniques.** Prepare a hole no deeper than the root ball or mass but two to three times wider than the spread of the root ball or mass. The majority of the roots on a newly planted tree will develop in the top 12 inches of soil and spread out laterally. There are some additional considerations depending on the type of plant material being used (Table 4.58).

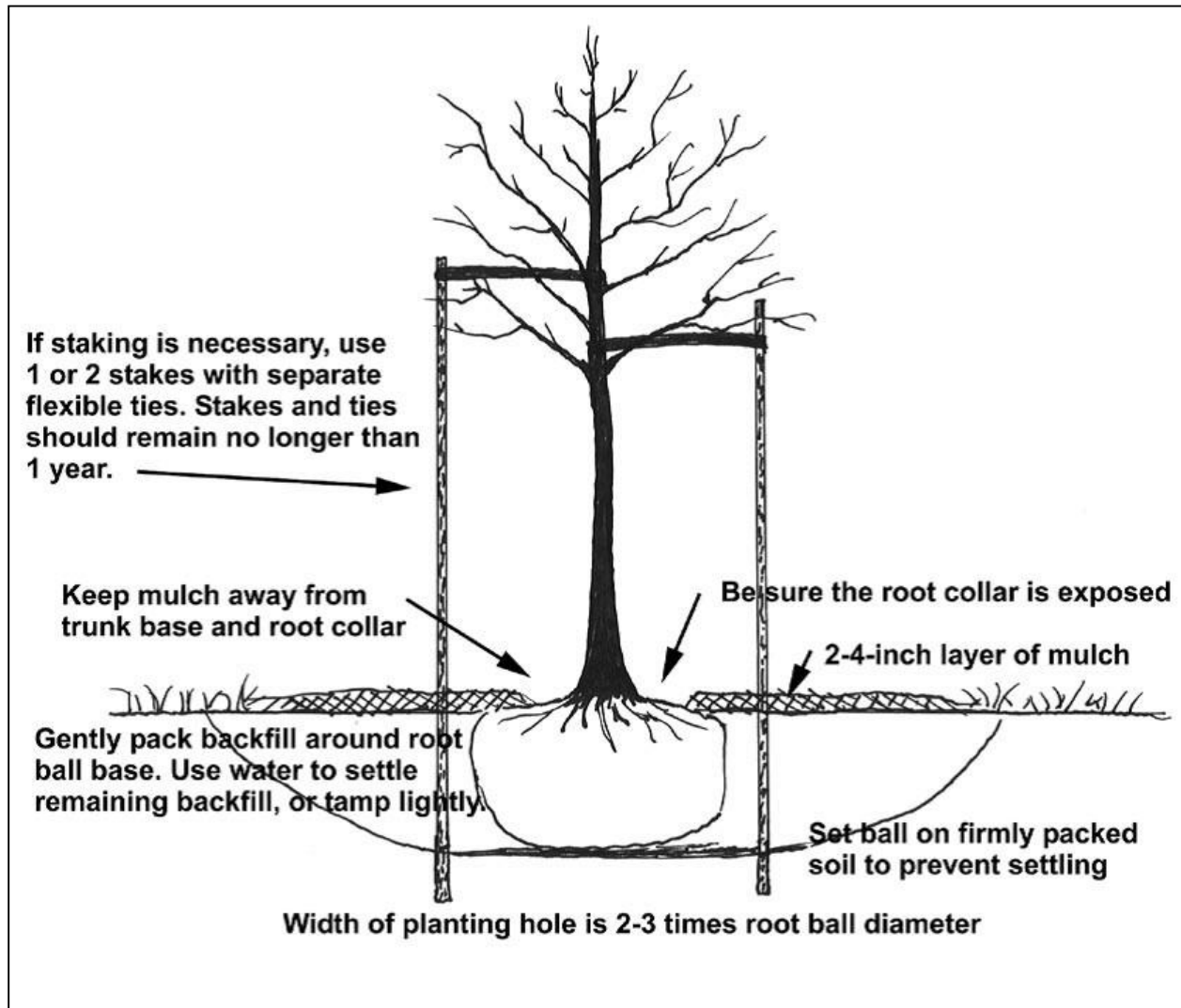
**Table 4.58. Tree Planting Techniques**

Plant Material	Planting Technique	Planting Season
Bare root	Hand plant	Spring or fall when tree is dormant
Container grown	Hand plant or use mechanical planting tools (e.g., auger)	Spring or fall, summer if irrigated
Balled and burlapped	Use backhoe (or other specialized equipment) or hand plant	Spring or fall

Sources: Palone and Todd (1998), WSAHGP (2002)

One of the most important planting guidelines is to make sure the tree is not planted too deeply. The root collar, the lowest few inches of trunk just above its junction with the roots (often indicated by a flare), should be exposed. Trees planted too deeply have buried root collars, and are weakened, stressed, and predisposed to pests and disease. Trees planted too deeply can also form adventitious roots (roots that form from non-root tissue) near the soil surface in an attempt to compensate for the lack of available oxygen to buried roots. Adventitious roots are not usually large enough to provide support for a large tree and may eventually lead to collapse. ISA (2005) provides additional guidance on how to avoid planting too deeply. It is generally better to plant the tree a little high, that is, with the base of the trunk flare 2 to 3 inches above the soil, rather than at or below the original growing level.

Proper handling during planting is essential to avoid prolonged transplant shock and ensure a healthy future for new trees and shrubs. Trees should always be handled by the root ball or container, never by the trunk. Specifications for planting a tree are illustrated in Figure 4.58. Trees must be watered well after planting.



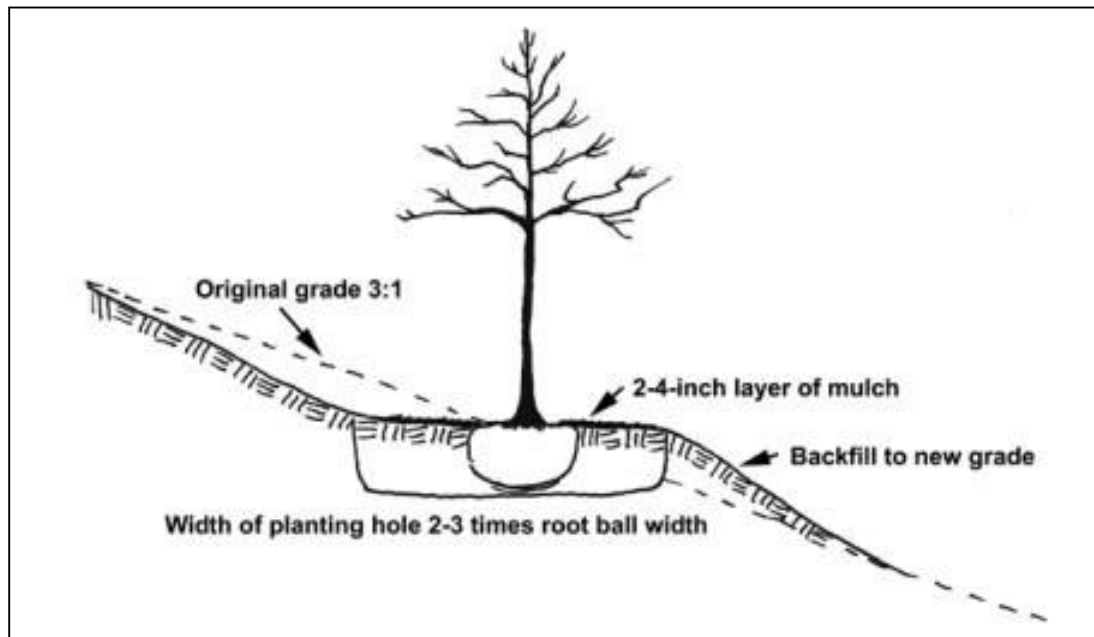
**Figure 4.57. Tree planting guidelines. Adapted from Flott, 2004 and ISA, 2003b.**

Steep slopes require additional measures to ensure planting success and reduce erosion, especially if the slope receives stormwater runoff from upland land uses. Depending on the steepness of the slope and the runoff volume, rill or gully erosion may occur on these slopes, requiring a twofold approach: controlling the stormwater and stabilizing the slope.

Erosion control blankets are recommended to temporarily stabilize soil on slopes until vegetation is established. Erosion control fabrics come in a variety of weights and types and should be combined with vegetation establishment such as seeding. Other options for stabilizing slopes include applying compost or bark mulch, plastic sheeting, or sodding.

Trees will add stability to slopes because of their deep roots, provided they are not planted by digging rows of pits across a slope. Required maintenance will include mowing (if slopes are not too steep) and establishing cover on bare or eroded areas.

Planting methods for slopes steeper than 3H:1V involve creating a level planting space on the slope (see Figure 4.59). A terrace can be dug into the slope in the shape of a step by cutting into the existing slope and using the excavated soil as fill to create the step area. A low soil berm (or rock berm) can be formed at the front edge of each step or terrace to slow the flow of water. Trees can also be planted in clusters on slopes (using the above method) to limit potential for desiccation. Staggering tree placement and mulching will prevent water from running straight downhill.



**Figure 4.58** Trees planted on steep slopes require a constructed level planting surface.

#### **Post-Planting Tree Protection**

**Mulching:** Once the tree has been properly planted, 2 to 4 inches (maximum) of organic mulch must be spread over the soil surface out to the drip line (the outermost circumference of the tree canopy) of the tree. A mulch-free area, 2 to 3 inches wide at the base of the tree, must be provided to avoid moist bark conditions and prevent decay.

If planting a cluster of trees, mulch the entire planting area, ensuring a 2- to 3-inch wide mulch free area at the base of each tree.

Slow-decomposing organic mulches, such as shredded bark, compost, leaf mulch, or wood chips provide many added benefits for trees. Mulch that contains a combination of chips, leaves, bark, and twigs is ideal for reforestation sites. Grass clippings and sawdust are not recommended as mulches because they decompose rapidly and require frequent application, resulting in reduced benefits.

For well-drained sites, up to 4 inches of mulch may be applied. For poorly drained sites, a thinner layer of mulch should be applied. Mulch should never be more than 4 inches deep or applied right next to the tree trunk; however, a common sight in many landscaped areas is the “mulch volcano.” This over-mulching technique can cause oxygen and moisture-level problems, and decay of the living bark at the base of the tree.



**Staking:** Studies have shown that trees will establish more quickly and develop stronger trunk and root systems if they are not staked at the time of planting. Staking for support may be necessary only for top-heavy trees or at sites where vandalism or windy exposure are a concern.

If staking is necessary for support, two stakes used in conjunction with a wide flexible tie material will hold the tree upright, provide flexibility, and minimize injury to the trunk. To prevent damage to the root ball, stakes should be placed in undisturbed soil beyond the outer edges of the root ball.

Perhaps the most important part of staking is its removal. Over time, guy wires (or other tie material) can cut into the growing trunk bark and interfere with the movement of water and nutrients within the tree. Staking material should be removed within 1 year of planting.

#### **4.14.3 Tree Inspection Criteria**

An initial inspection by a qualified professional should be done to ensure the tree has been planted, watered, and protected correctly with locations flagged if appropriate. For newly planted trees, transplant shock is common and causes stress on the tree. For this reason, newly planted trees should be inspected more frequently than established trees. The time it takes for a tree to become established varies with the size at planting, species, stock, and site conditions, but generally, trees should be inspected every few months during the first 3 years after planting, to identify problems and implement repairs or modify maintenance strategies.

After the first 3 years, annual inspections are sufficient to check for problems. Trees should also be inspected after major storm events for any damage that may have occurred. The inspection should take only a few minutes per tree, but prompt action on any problems encountered results in healthier, stronger trees. Inspections should include an assessment of overall tree health, an assessment of survival rate of the species planted, cause of mortality, if maintenance is required, insect or disease problems, tree protection adjustment, and weed control condition.

Construction inspection checklist for tree planting and preservation can be found in Appendix E Construction Inspection Checklists.

#### **4.14.4 Tree Maintenance Criteria**

Water newly planted trees regularly (at least once a week) during the first growing season. Water trees less frequently (about once a month) during the next two growing seasons. After 3 growing seasons, water trees only during drought. The exact watering frequency will vary for each tree and site.

A general horticultural rule of thumb is that trees need 1 inch of rainfall per week during the growing season. This means new trees need a minimum of 25 gallons of water a week to stay alive (<http://caseytrees.org/get-involved/water/>). Water trees deeply and slowly near the roots. Light, frequent watering of the entire plant can encourage roots to grow at the surface. Soaker hoses and drip irrigation work best for deep watering of trees. It is recommended that slow leak watering bags or tree buckets are installed to make watering easier and more effective. Continue watering until mid-fall, tapering off during lower temperatures.

Pruning is usually not needed for newly planted trees but may be beneficial for tree structure. If necessary, prune only dead, diseased, broken or crossing branches at planting. As the tree grows, lower branches may be pruned to provide clearance above the ground, or to remove dead or damaged limbs.

Maintenance inspection checklist for tree planting and preservation and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### 4.15 Proprietary Practices

Proprietary Practices				
<b>Definition:</b> Manufactured stormwater treatment practices that utilize settling, filtration, absorptive/adsorptive materials, vortex separation, vegetative components, and/or other appropriate technology to manage the impacts stormwater runoff. Performance varies based on manufacturer’s design.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		Varies*	Varies*	Varies*
		Runoff Reductions		
Construction Costs	Maintenance Burden	Volume		
Moderate	Moderate	Varies*		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	Refer to Device Manufacturers Specifications		
At least annually	Variable			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ On- or off-line treatment</li><li>▪ Useful in challenging stormwater site designs</li><li>▪ Water quality treatment</li></ul>		<ul style="list-style-type: none"><li>▪ Devices can be costly</li><li>▪ Most devices do not provide retention</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Pretreatment</li><li>▪ Conveyance</li><li>▪ Bypass mechanism</li></ul>		<ul style="list-style-type: none"><li>▪ Must safely overflow or bypass flow from 2- to 25-year design storms.</li><li>▪ Manufacturer’s specifications</li><li>▪ Adequate maintenance access required</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Based on manufacturer’s specifications</li></ul>		<ul style="list-style-type: none"><li>▪ Routine inspection for proper function</li></ul>		

<sup>1</sup>Credited pollutant load removal

\*Varies according to proprietary practice

**Definition.** Proprietary practices are manufactured stormwater treatment practices that utilize settling, filtration, absorptive/adsorptive materials, vortex separation, vegetative components, and/or other appropriate technology to manage the impacts stormwater runoff. The design includes the following:

#### M-1 Proprietary practices

Proprietary practices may be used to achieve treatment compliance, provided they have been approved by the State and meet the performance criteria outlined in this specification. Historically, proprietary practices do not provide retention volume. A proprietary practice will not be valued for retention volume unless the practice can demonstrate the occurrence of retention processes.

##### **4.15.1 Proprietary Practice Feasibility Criteria**

Individual proprietary practices will have different site constraints and limitations. Manufacturer's specifications should be consulted to ensure that proprietary practices are feasible for application on a site-by-site basis.

##### **4.15.2 Proprietary Practice Conveyance Criteria**

All proprietary practices must be designed to safely overflow or bypass flows from larger storm events to downstream drainage systems. The overflow associated with the 2- to 25-year design storms must be controlled so that velocities are non-erosive at the outlet point (i.e., to prevent downstream erosion).

Manufactured treatment devices may be constructed on-line or off-line. On-line systems receive upstream runoff from all storms, providing runoff treatment for the stormwater quality design storm and conveying the runoff from larger storms through an overflow. In off-line devices, most, or all, of the runoff from storms larger than the stormwater quality design storm bypass the device through an upstream diversion or other mechanism.

##### **4.15.3 Proprietary Practice Pretreatment Criteria**

Individual proprietary practices may require pretreatment or may be appropriate for use as pretreatment devices. Manufacturer's specifications should be consulted to determine the device-specific pretreatment requirements.

##### **4.15.4 Proprietary Practice Design Criteria**

The basic design parameters for a proprietary practice will depend on the techniques it employs to control stormwater runoff and remove particulate and dissolved pollutants from runoff. In general, the design of devices that treat runoff with no significant storage and flow rate attenuation must be based upon the peak design flow rate. However, devices that do provide storage and flow rate attenuation must be based, at a minimum, on the design storm runoff volume and, in some instances, on a routing of the design runoff hydrograph. Hydrologic design is discussed further in Appendix I Hydrology and Hydraulics Design Requirements.

Proprietary practices approval is contingent on adherence to the New Jersey Department of Environmental Protection Certification (NJDEP) protocols and testing. The NJDEP Certification Process includes details of the verification process and the required data submittals for determination of proprietary practice performance. The current NJDEP version should be followed and is included in the References below.

Adequate maintenance access must be provided for all proprietary practice systems. Access, with access steps, as applicable, must be provided for the inlet pipe, outflow structure, and over any other functional components.

#### **4.15.5 Proprietary Practice Landscaping Criteria**

Proprietary devices may or may not require landscaping considerations. Manufacturer's specifications should be consulted to determine any landscaping requirements for the device.

#### **4.15.6 Proprietary Practice Construction Sequence**

The construction and installation of individual proprietary practices will vary based on the specific proprietary practice. Manufacturer's specifications should be consulted to determine the device specific construction sequencing requirements.

Construction inspection checklist for generic structural BMPs can be found in Appendix E Construction Inspection Checklists.

#### **4.15.7 Proprietary Practice Maintenance Criteria**

In order to ensure effective and long-term performance of a proprietary practice, regular maintenance tasks and inspections are required.

All proprietary practices should be inspected by a qualified professional and maintained in accordance with the manufacturer's instructions and/or recommendations and any maintenance requirements associated with the device's verification by Beaufort County Public Works Department.

Maintenance inspection checklist for generic structural BMPs and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### **4.15.8 Proprietary Practice Stormwater Compliance Calculations**

Proprietary practices receive retention credit when explicitly approved by the Beaufort County Public Works Department. Pollutant removal (TSS EMC reduction) may be awarded for specific practices provided they meet the performance criteria outlined in Section 4.15.4 Proprietary Practice Design Criteria.

#### **4.16 Conservation Area**

If a site includes a Conservation Area which is protected under a conservation easement or equivalent form of protection, a portion of the conservation area may be “removed” from the site for the purposes of calculating the stormwater retention volume (SWRv). There are four scenarios that could qualify for a conservation area credit.

##### **4.16.1 Scenario 1: Natural Conservation Area**

Scenario 1 is applicable if a portion of the post-developed area is left in its natural condition and protected, in perpetuity, by a conservation easement or equivalent form of protection. If this scenario is applicable, subtract 100% of the protected natural area from the total site area when calculating the SWRv.

##### **4.16.2 Scenario 2: Reforestation/Revegetation**

Scenario 2 is applicable if a portion of the post-developed area employs site reforestation/revegetation and is protected, in perpetuity, by a conservation easement or equivalent form of protection. If this application is used alone, subtract 50% of the reforested/revegetated area from the total site area when calculating the SWRv.

##### **4.16.3 Scenario 3: Soil Restoration**

Scenario 3 is applicable if a portion of the post-developed area employs soil restoration and is protected, in perpetuity, by a conservation easement or equivalent form of protection. If this application is used alone, subtract 50% of the soil restoration area from the total site area when calculating the SWRv.

##### **4.16.4 Scenario 4: Reforestation/Revegetation & Soil Restoration**

Scenario 4 is applicable if the same portion of the post-developed area employs site reforestation/revegetation as well as soil restoration and is protected, in perpetuity, by a conservation easement or equivalent form of protection, subtract 100% of the acres of development with restored soils in a reforested and revegetated area from the total site area when calculating the SW

## Chapter 5. Erosion & Sediment Control

Sedimentation involves three basic geologic processes: erosion, transportation, and deposition. These are natural geologic phenomena; however, land development activities may initiate severe, highly undesirable and damaging alterations in the natural sedimentation cycle by drastically accelerating the erosion and transportation process. Receiving waters are the final destination for sediment transport and deposition. However, natural streams and lakes are not capable of handling the excessive sediments created by this accelerated cycle. Therefore, excessive sediment loads result in turbid waters and heavy deposition over the substrate. The impact of these events directly affects the propagation of aquatic life, which relies on clear substrates and water to feed and reproduce. Sediment-laden waters affect human activities through the degradation of waters used for aquatic recreation and sport fishing and complicate water treatment processes. Consequently, minimizing the occurrence of erosion and effective control of sediment transport is imperative to all.

### 5.1 Sedimentation Cycle

Soil erosion is usually caused by the impact force of raindrops and by the sheer stress of runoff flowing in rills and streams. Raindrops falling on bare or sparsely vegetated soil detach soil particles; runoff, in the form of sheet flow along the ground, picks up and carries these particles to surface waters. As the runoff gains velocity and concentration, it detaches more soil particles, cuts deeper rills and gullies into the surface of the soil, and adds to its own sediment load. Coalescing rivulets produce streams which have a larger volume and usually an increased velocity. These increasing streams have a greater capacity to remove sediment and transport it downstream. The further the runoff runs uncontrolled, the greater its erosive force and the greater the resulting damage. As the distance and volume of uncontrolled flow increase, the control becomes increasingly difficult. At some point, the energy in the stream dissipates to level that can no longer support the transport of the sediment. At this time, the sediment falls out of the water column and deposits. Over time the sediment will either be incorporated into the substrate or be re-suspended for further transport.

### 5.2 Factors Influencing Erosion

The erosion potential of a site is principally determined by the soil type, vegetative cover, topography, climate, and season. These factors contribute to the detachment of soil particles and their transport off-site.

- **Soil Type** – Erodibility, the amount of energy needed to break down soil structure, is dependent on soil composition and texture. Soils with high erodibility require less energy to detach soil particles.
- **Vegetative Cover** – Vegetation shields soils from the impact energy of raindrops and traps suspended sediment from runoff.
- **Topography** – Steeper and longer slopes generate runoff with more velocity and energy to erode and transport more sediment.
- **Climate** – Rainfall frequency and intensity cumulatively contribute energy in the form of raindrop impact and runoff volume to detach and transport soil particles.
- **Season** – Seasonal variations in wind, temperature, humidity, and rainfall may create more ideal conditions for erosion.

### 5.3 Concepts of Erosion & Sediment Control

Principles of erosion and sedimentation control are based on minimizing the effects of the soil and climatologic factors just discussed. None of the following concepts provide a singular solution for controlling those factors, nor can they all be performed at every site. However, the integration of as many concepts as possible provides the most effective erosion and sedimentation control:

- A. Compatible Site Planning
  - Minimize development within sensitive areas (e.g. highly erosive soils).
  - Limit the length and steepness of the designed slopes.
  - Maintain natural vegetative cover when possible.
- B. Disturbed Areas Reduction
  - Minimize the extent of the disturbed area and the duration of exposure.
  - Phase or stage development so that only the areas that are actively being developed are disturbed.
  - Minimize large or critical area grading during the season of maximum erosion potential.
- C. Disturbed Areas Protection
  - Complete grading as quickly as possible.
  - Establish permanent vegetation as soon as possible on disturbed areas.
  - Divert runoff from disturbed areas.
- D. Sediment Retention within Site Boundaries
  - Filter runoff as it flows from a disturbed area.
  - Impound sediment-laden runoff temporarily so that the soil particles are deposited onsite.

The NPDES Phase II storm water regulations enacted by the Clean Water Act of 1972 and promulgated by Stormwater Phase II Final Rule (1999) require that any activity disturbing an acre or greater of land, or a smaller project part of a larger common plan for development or sale, obtain NPDES construction permit coverage. This regulation differs somewhat from the South Carolina state regulations relating to areas of disturbance. Any land disturbing activity in the *Beaufort County* that meets the aforementioned criteria of one acre or more of disturbance will need to will comply with the state process for permitting. Application and issuance of an approved permit under the South Carolina state regulations for erosion and sedimentation control will meet the requirements for coverage under NPDES Phase II as well (DHEC, 2012).

### 5.4 General Criteria

All construction site activities must adhere to the SCDHEC General Permit SC0010000 for Large and Small Site Construction Activities. In addition, the *Beaufort County* will require as a minimum, implementation of the following construction site BMPs:

#### Single Family Development, not part of a larger common plan of development:

1. Silt Fencing buried a minimum of 6 inches below disturbed grade, where applicable;
2. In areas where more than two feet of fill material has been placed or in areas adjacent to all wetlands, silt fencing meeting the requirements of SCDOT must be used;



3. Temporary gravel driveways a minimum of 15 feet by 10 feet, where applicable; and
4. Sediment barriers surrounding all catch basins or drop inlets on site and sediment socks on all catch basins or drop inlets adjoining to the site.

**Single Family and Multi-Family Development, part of a larger common plan of development, and Non-residential Development:**

1. Silt Fencing buried a minimum of 6 inches below disturbed grade;
2. Temporary gravel driveways a minimum of 15 feet by 10 feet;
3. Sediment barriers surrounding all catch basins or drop inlets on site and sediment socks on all catch basins or drop inlets adjoining to the site;
4. Flow dissipation devices, such as check dams, in all swales and ditches;
5. Temporary stabilization shall be placed within 7 days after construction activity is complete unless construction activity is going to resume within 21 days;
6. Floating pump suctions for all temporary or permanent ponds or pumping of excavations;
7. Discharge velocities shall be reduced to provide non-erosive flows from dewatering for all temporary or permanent ponds or pumping of excavations;
8. Site inspections must be performed by a *Beaufort County* qualified individual. Copies of inspection reports shall be provided to the *Beaufort County* within 7 days of inspection;
9. Temporary stockpile areas and appropriate BMPs to be identified on plans; and
10. Two rows of silt fence are required between land disturbing activities and adjacent wetlands.

## Ch 6. Enforcement and Violations

Beaufort County is required to conform to the most recent revisions of the NPDES General Permit for Discharges from Regulated SMS4, permit #SCR03000, NPDES General Permit for Stormwater Discharges from Construction Activities, Permit #SCR100000, and the Southern Lowcountry Design Manual and Ordinance. Stormwater runoff can carry pollutants to our local waterways through a variety of means. In order to control these discharges, Beaufort County is required to enforce and issue violations to property owners, contractors, subcontractors, developers, etc that have land disturbance or BMP's installed on property to ensure they are maintained and in compliance with the permits and ordinances cited above.

The escalating enforcement plan (EEP) was developed to help contractors manage and reduce potential impacts on active construction sites to the maximum extent practicable (MEP) through effective enforcement procedures.

- Any deficiencies or non-compliance issues identified during a County inspection will be reported to the project contractor, on-site supervisor, property owner, and/or engineer for addressing. Some corrective measures may require immediate, 48-hr, 72-hr, or 96-hr action depending on the nature of the violation.
- BMP's experiencing frequent failures can be required by staff to be replaced with alternative control methods. All changes should be communicated with the Stormwater Management Department and documented in the OS-SWPPP.
- Failure to address concerns or implement required changes may result in notices of violation, stop work orders, or fines.
- Sites with repeated violations may be subject to additional compliance actions, special inspection schedules or inspections as determined by the Stormwater Management Department.

### 2. Enforcement

If the County determines a project is in noncompliance with the Stormwater Ordinance or SoLoCo Manual, then the inspector may direct conformity by proceeding with an appropriate enforcement action. The County uses enforcement actions that include verbal warnings, Notices of Violation, Stop Work Orders, and/or civil penalties. The enforcement mechanism to be utilized will depend on the circumstances as described in the following sections.

### 3. Notice of Violation

The inspector will issue a Notice of Violation (NOV) for the first offenses of non-compliance with the County Stormwater Ordinance. The purpose of the NOV is to give notice of the deficiencies, identify expected corrective results and provide a reasonable timeframe to the contractor/land owner/developer prior to the County taking further action to ensure compliance. All NOV's shall be issued shall be issued per the ordinance and noted in the project file. A Notice of Violation may be issued in the following cases, but not limited to, when there is:

- Failure to coordinate an initial inspection (residential) or pre-construction meeting (commercial) prior to construction.

- Failure comply with the approved Stormwater design plans to include failure to properly install and maintain BMP measures.
- Failure to properly maintain permanent Stormwater management structures.
- Failure to comply with any portion of the Stormwater ordinance.

The contractor and land owner will be informed the inspection has failed inspection within 48-hrs of the failure. The inspector may issue a verbal Notice of Violation, but will also make the NOV available via an emailed PDF. Based on the severity of the failure and the discretion of the inspector, the contractor will be given 48 – 96 hrs to make corrective actions. The contractor may request an on-site meeting within the specified time frame to review site deficiencies and corrective actions taken. The contractor may request an extension to resolve violation issues, but it is at the discretion of the inspector to approve the request.

NOV's do not have to be issued for the same compliance failures before escalating to a Stop Work Order. A NOV will be void upon the next passed inspection.

#### 4. Stop Work Order

An inspector will issue a Stop Work Order if compliance cannot be obtained through the issuance of NOV's or a violation is so severe immediate action must be taken. These actions can include, but are not limited to, the following:

- Construction Activities are occurring without County permits and/or an approved SWPPP.
- Past enforcement actions taken by the County have not been addressed with appropriate and prompt action to the satisfaction of the Stormwater Manager.
- Non-compliance with the approved plans has resulted in a health or safety issue.
- Offsite sedimentation resulting from non-compliance with the approved SWPPP has eliminated or severely degraded a use in a downstream water body or that such degradation is imminent.
- Non-compliance with the approved SWPPP has caused severe damage to adjacent land.
- Failure to comply with any other provisions of the Stormwater Ordinance.

If a Stop Work Order is issued, a sign will be placed at the main entrance of the site. All construction activities must immediately cease and will not begin again until the violation has been mitigated. A Stop Work Order will remain in effect for a minimum of 24 hours. The contractor or land owner must call the inspector to schedule a re-inspection. In the event the inspector is not satisfied with efforts of compliance, a fine may be issued in accordance with the Stormwater Ordinance. A stop work order will be void after the next passed inspection.

#### 5. Civil Penalties

Violations may be subject the contractor/land owner to civil penalties outlined in the Stormwater Ordinance for each violation. Each day a violation continues constitutes a new and separate violation.

#### 6. Criminal Penalties

In addition to any applicable civil penalties, and person who negligently, willfully, or intentionally violates any provision of the Ordinance shall be guilty of a misdemeanor and shall be punished within the jurisdictional limits of the magistrate's court. The Stormwater Manager may issue a notice to appear

for a violation of this ordinance. Civil penalties imposed are outlined in the Stormwater Ordinance. Each day a violation continues constitutes a new and separate violation.

PART II - BUILDING AND LAND DEVELOPMENT ORDINANCES  
Chapter 99 STORMWATER MANAGEMENT

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## **Chapter 99 STORMWATER MANAGEMENT<sup>1</sup>**

### **ARTICLE I. IN GENERAL**

**Secs. 99-1—99-100. Reserved.**

### **ARTICLE II. STORMWATER MANAGEMENT UTILITY**

#### **Sec. 99-101. Findings of fact.**

The county council of Beaufort County, South Carolina, makes the following findings of fact:

- (a) The professional engineering and financial analyses conducted on behalf of and submitted to the county properly assesses and defines the stormwater management problems, needs, goals, program priorities, costs of service, need for interlocal cooperation, and funding opportunities of the county.
- (b) Given the problems, needs, goals, program priorities, costs of service, needs for interlocal cooperation, and funding opportunities identified in the professional engineering and financial analyses submitted to the county, it is appropriate to authorize the establishment of a separate enterprise accounting unit which shall be dedicated specifically to the management, construction, maintenance, protection, control, regulation, use, and enhancement of stormwater systems and programs in Beaufort County in concert with other water resource management programs.
- (c) Stormwater management is applicable and needed throughout the unincorporated portions of Beaufort County, but interlocal cooperation between the county and the incorporated cities and towns within the county is also essential to the efficient provision of stormwater programs, services, systems, and facilities. Intense urban development in some portions of the county has radically altered the natural hydrology of the area and the hydraulics of stormwater systems, with many natural elements having been replaced or augmented by manmade facilities. Other areas of the county remain very rural in character, with natural stormwater systems predominating except along roads where ditches and culverts have been installed. As a result, the specific program, service, system, and facility demands differ from area to area in the county. While the county manages, operates, and improves stormwater programs, services, systems and facilities in the rural as well as urban areas, the need for improved stormwater management is greatest in the urban areas and nearby, including areas within incorporated cities and towns. Therefore, a stormwater utility service area subject to stormwater service fees should encompass, in so far as possible through interlocal agreements, the entirety of Beaufort County and the stormwater management utility service fee rate structure should reflect the amount of impervious area on individual properties and the runoff impact from water quantity and water quality.

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<sup>1</sup>Editor's note(s)—Ord. No. 2015/24 , adopted Sept. 28, 2015, amended and replaced ch. 99 to read as herein set out. Former ch. 99 pertained to the same subject matter, and derived from Ord. No. 2005/33 , adopted Sept. 22, 2005; and Ord. No. 2009/21 , adopted May 26, 2009.



- (d) The stormwater needs in Beaufort County include, but are not limited to, protecting the public health, safety, and welfare. Provision of stormwater management programs, services, systems, and facilities therefore renders and/or results in both service and benefit to individual properties, property owners, citizens, and residents of the county and to properties, property owners, citizens, and residents of the county concurrently in a variety of ways as identified in the professional engineering and financial analyses.
- (e) The service and benefit rendered or resulting from the provision of stormwater management programs, services, systems, and facilities may differ over time depending on many factors and considerations, including, but not limited to, location, demands and impacts imposed on the stormwater programs, systems, and facilities, and risk exposure. It is not practical to allocate the cost of the county's stormwater management programs, services, systems, and facilities in direct and precise relationship to the services or benefits rendered to or received by individual properties or persons over a brief span of time, but it is both practical and equitable to allocate the cost of stormwater management among properties and persons in proportion to the long-term demands they impose on the county's stormwater programs, services, systems, and facilities which render or result in services and benefits.
- (f) Beaufort County presently owns and operates stormwater management systems and facilities that have been developed, installed, and acquired through various mechanisms over many years. The future usefulness and value of the existing stormwater systems and facilities owned and operated by Beaufort County, and of future additions and improvements thereto, rests on the ability of the county to effectively manage, construct, protect, operate, maintain, control, regulate, use, and enhance the stormwater systems and facilities in the county, in concert with the management of other water resources in the county and in cooperation with the incorporated cities and towns. In order to do so, the county must have adequate and stable funding for its stormwater management program operating and capital investment needs.
- (g) The county council finds, concludes, and determines that a stormwater management utility provides the most practical and appropriate means of properly delivering stormwater management services and benefits throughout the county, and the most equitable means to fund stormwater services in the county through stormwater service fees and other mechanisms as described in the professional engineering and financial analyses prepared for the county.
- (h) The county council finds, concludes, and determines that a schedule of stormwater utility service fees be levied upon and collected from the owners of all lots, parcels of real estate, and buildings that discharge stormwater or subsurface waters, directly or indirectly, to the county stormwater management system and that the proceeds of such charges so derived be used for the stormwater management system.
- (i) The county council finds that adjustments and credits against stormwater utility service fees are an appropriate means to grant properties providing stormwater management program services that would otherwise be provided by the county and will afford Beaufort County cost savings. These reductions will be developed by the public works director and will be reviewed on an annual basis to allow for any modifications to practices required by Beaufort County.

The county council finds that both the total gross area and impervious area on each property are the most important factors influencing the cost of stormwater management in Beaufort County and, the runoff impact from water quantity and water quality.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-102. Establishment of a stormwater management utility and a utility enterprise fund.**

There is hereby established within the environmental engineering division of Beaufort County a stormwater management utility for the purpose of conducting the county's stormwater management program. The county administrator shall establish and maintain a stormwater management utility enterprise fund in the county budget and accounting system, which shall be and remain separate from other funds. All revenues of the utility shall be placed into the stormwater management utility enterprise fund and all expenses of the utility shall be paid from the fund, except that other revenues, receipts, and resources not accounted for in the stormwater management utility enterprise fund may be applied to stormwater management programs, services, systems, and facilities as deemed appropriate by the Beaufort County Council. The county administrator may designate within the stormwater management utility enterprise fund such sub-units as necessary for the purpose of accounting for the geographical generation of revenues and allocation of expenditures pursuant to interlocal governmental agreements with the cities and towns of Beaufort County.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2020/18, 5-26-2020 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-103. Purpose and responsibility of the utility.**

The Beaufort County Stormwater Management Utility is established for the purpose of managing, acquiring, constructing, protecting, operating, maintaining, enhancing, controlling, and regulating the use of stormwater drainage systems in the county. The utility shall, on behalf of the county and the citizens of the county: administer the stormwater management program; perform studies and analyses as required; collect service fees; system development fees, in-lieu of construction fees and other funding as allowed by law, and obtain and administer grants and loans as authorized by the county council; prepare capital improvement plans and designs; perform routine maintenance and remedial repair of the stormwater systems; acquire, construct, and improve stormwater systems; acquire necessary lands, easements, rights-of-way, rights-of-entry and use, and other means of access to properties to perform its duties; regulate the on-site control, conveyance, and discharge of stormwater from properties; obtain federal and state permits required to carry out its purpose; enter into operating agreements with other agencies; allocate funds pursuant to interlocal governmental agreements; educate and inform the public about stormwater management; and perform, without limitation except by law, any stormwater management functions and activities necessary to ensure the public safety, protect private and public properties and habitat, and enhance the natural environment and waters of the county.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-104. Limitation of scope of responsibility.**

The purpose and responsibility of the stormwater management utility shall be limited by the following legal and practical considerations:

- (a) Beaufort County owns or has legal access for purposes of operation, maintenance and improvement only to those stormwater systems and facilities which:
  - (1) Are located within public streets, other rights-of-way, and easements;
  - (2) Are subject to easements, rights-of-entry, rights-of-access, rights-of-use, or other permanent provisions for adequate access for operation, maintenance, monitoring, and/or improvement of systems and facilities; or
  - (3) Are located on public lands to which the county has adequate access for operation, maintenance, and/or improvement of systems and facilities.



- (b) Operation, maintenance, and/or improvement of stormwater systems and facilities which are located on private property or public property not owned by Beaufort County and for which there has been no public dedication of such systems and facilities for operation, maintenance, monitoring, and/or improvement of the systems and facilities shall be and remain the legal responsibility of the property owner, except as that responsibility may be otherwise affected by the laws of the State of South Carolina and the United States of America.
- (c) It is the express intent of this article to protect the public health, safety, and welfare of all properties and persons in general, but not to create any special duty or relationship with any individual person or to any specific property within or outside the boundaries of the county. Beaufort County expressly reserves the right to assert all available immunities and defenses in any action seeking to impose monetary damages upon the county, its officers, employees and agents arising out of any alleged failure or breach of duty or relationship as may now exist or hereafter be created.
- (d) To the extent any permit, plan approval, inspection or similar act is required by the county as a condition precedent to any activity or change upon property not owned by the county, pursuant to this or any other regulatory ordinance, regulation, or rule of the county or under federal or state law, the issuance of such permit, plan approval, or inspection shall not be deemed to constitute a warranty, express or implied, nor shall it afford the basis for any action, including any action based on failure to permit or negligent issuance of a permit, seeking the imposition of money damages against the county, its officers, employees, or agents.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-105. Boundaries and jurisdiction.**

The boundaries and jurisdiction of the stormwater management utility shall encompass all those portions of unincorporated Beaufort County, as they may exist from time to time and such additional areas lying inside the corporate limits of those cities and towns in Beaufort County as shall be subject to interlocal agreements for stormwater management as approved by county council and participating municipal councils.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-106. Definitions.**

Unless the context specifically indicates otherwise, the meaning of words and terms used in this article shall be as set forth in S.C. Code § 48-14-20, and 26 S.C. Code Regulation 72-301, *mutatis mutandis*.

*Abatement.* Any action deemed necessary by the county or its officers or agents to remedy, correct, control, or eliminate a condition within, associated with, or impacting a stormwater drainage system or the water quality of receiving waters shall be deemed an abatement action.

*Adjustments.* Adjustments shall mean a change in the amount of a stormwater service fee predicated upon the determination reached by the public works director and referenced to the adjustments and credit manual.

*Bill class.* Every property falls into one of several bill classes. The bill class determines the fee calculation of that property.

*Condominiums.* Properties with individual ownership of a particular dwelling unit in a building and the common right to share, with other co-owners, in the general and limited common elements of the real property.

*Countywide infrastructure operation and maintenance and capital projects.* The county maintains some typically larger infrastructure within each of the four municipalities in addition to within the unincorporated area.

The rate structure will allocate the costs for the county to maintain just the countywide drainage infrastructure across the entire rate base in all jurisdictions based on infrastructure linear feet per jurisdiction.

*Customers of the stormwater management utility.* Customers of the stormwater management utility shall be broadly defined to include all persons, properties, and entities served by and/or benefiting, directly and indirectly, from the utility's acquisition, management, construction, improvement, operation, maintenance, extension, and enhancement of the stormwater management programs, services, systems, and facilities in the county, and by its control and regulation of public and private stormwater systems, facilities, and activities related thereto.

*Developed land.* Developed land shall mean property altered from its natural state by construction or installation of improvements such as buildings, structures, or other impervious surfaces, or by other alteration of the property that results in a meaningful change in the hydrology of the property during and following rainfall events. Existing county maintained dirt roads which are improved and/or paved as part of Beaufort County's Dirt Road Paving Program as set forth in Beaufort County Policy Statement 15 and Policy Statement 17 and existing private dirt roads which are improved or paved and where the project is not related to a pending or proposed development of adjacent land are deemed not to constitute "developed land".

*Exemption.* Exemption shall mean not applying to or removing the application of the stormwater management utility service fee from a property. No permanent exemption shall be granted based on taxable or non-taxable status or economic status of the property owner.

*Fixed costs.* Costs associated with the public service provided equally to each property owner. These costs include, but are not limited to, the following: billing and collections, data management and updating, programming, and customer support.

*Gross area.* Gross area is the acreage of a parcel as identified by the Beaufort County Assessor records.

*Hydrologic response.* The hydrologic response of a property is the manner whereby stormwater collects, remains, infiltrates, and is conveyed from a property. It is dependent on several factors including, but not limited to, the size and overall intensity of development of each property, its impervious area, shape, topographic, vegetative, and geologic conditions, antecedent moisture conditions, and groundwater conditions and the nature of precipitation events. Extremely large undeveloped properties naturally attenuate but do not eliminate entirely the discharge of stormwater during and following rainfall events.

*Jurisdictional infrastructure operations, maintenance and capital projects.* Each of the five jurisdictions maintains its own stormwater drainage infrastructure and funds those costs from utility revenue. Revenue from this fee component will be returned to the service provider, the individual jurisdiction.

*Impervious surfaces.* Impervious surfaces shall be a consideration in the determination of the development intensity factor. Impervious surfaces are those areas that prevent or impede the infiltration of stormwater into the soil as it entered in natural conditions prior to development. Common impervious surfaces include, but are not limited to, rooftops, sidewalks, walkways, patio areas, driveways, parking lots, storage areas, compacted gravel and soil surfaces, awnings and other fabric or plastic coverings, and other surfaces that prevent or impede the natural infiltration of stormwater runoff that existed prior to development.

*Minimum charge.* A charge that reflects the minimum amount of demand a property will place on the service provider.

*MS4 permit.* Each jurisdiction within Beaufort County will be subject to the federally mandated MS4 permit requirements. Compliance requirements include, but are not limited to, monitoring, plan review, inspections, outreach and public education.

*Nonresidential properties.* Properties developed for uses other than permanent residential dwelling units and designated by the assigned land use code in the Beaufort County tax data system.

*Other developed lands.* Other developed lands shall mean, but not be limited to, mobile home parks, commercial and office buildings, public buildings and structures, industrial and manufacturing buildings, storage

buildings and storage areas covered with impervious surfaces, parking lots, parks, recreation properties, public and private schools and universities, research facilities and stations, hospitals and convalescent centers, airports, agricultural uses covered by impervious surfaces, water and wastewater treatment plants, and lands in other uses which alter the hydrology of the property from that which would exist in a natural state. Properties that are used for other than single-family residential use shall be deemed other developed lands for the purpose of calculating stormwater service fees.

*Residential dwelling classifications.* The following categories will identify the appropriate dwelling unit classifications to be utilized in applying the stormwater utility fee structure to the designations contained in the Beaufort County tax data system:

- Single-family
- Apartments
- Townhouses
- Condominiums
- Mobile home

*Salt water marsh.* Those parcels, typically contiguous to water, identified as inundated daily due to tidal action and unbuildable. These properties are 100 percent below mean high tide and/or beyond established critical line as defined by the South Carolina Department of Health and Environmental Control's Office of Coastal Resource Management (DHEC-OCRM). The county tax assessor's office shall make this determination based on best available data.

*Stormwater management programs, services, systems and facilities.* Stormwater management programs, services, systems and facilities are those administrative, engineering, operational, regulatory, and capital improvement activities and functions performed in the course of managing the stormwater systems of the county, plus all other activities and functions necessary to support the provision of such programs and services. Stormwater management systems and facilities are those natural and manmade channels, swales, ditches, swamps, rivers, streams, creeks, branches, reservoirs, ponds, drainage ways, inlets, catch basins, pipes, head walls, storm sewers, lakes, and other physical works, properties, and improvements which transfer, control, convey or otherwise influence the movement of stormwater runoff and its discharge to and impact upon receiving waters.

*Stormwater service fees.* Stormwater service fees shall mean the service fee imposed pursuant to this article for the purpose of funding costs related to stormwater programs, services, systems, and facilities. These fees will be calculated based upon the impervious and gross area at an 80/20 allocation; stormwater service fee categories; any state agricultural exemptions or caps; an account administrative fee, countywide jurisdiction operation maintenance and capital project fees; and jurisdictional operation, maintenance and capital project fee.

*Single-family unit (SFU).* The single-family unit shall be defined as the impervious area measurements obtained from a statistically representative sample of all detached single-family structures within Beaufort County. The representative value will be 4,906 square feet.

*Stormwater service fee categories.* The appropriate categories for determining SFUs will be as follows:

	SFU Calculation (SFUs equal)
Tier 1: Single-family unit ( $\leq 2,521$ square feet)	Dwelling units x 0.5
Tier 2: Single-family unit (2,522 to 7,265 square feet)	Dwelling units x 1
Tier 3: Single-family unit ( $\geq 7,266$ square feet)	Dwelling units x 1.5
Mobile home	Dwelling units x 0.36
Apartments	Dwelling units x 0.39
Townhouses	Dwelling units x 0.60

Condominiums	Dwelling units x 0.27
Commercial	Impervious area * 4,906 sq. ft.*

\* Commercial billed at a rate of one SFU per 4,906 square feet or a portion thereof.

*Submerged property.* Those parcels, typically contiguous to water, identified as eroded due to tidal action and unbuildable. These properties are 100 percent below mean low tide and/or beyond established critical line as defined by South Carolina Department of Health and Environment Control's Office of Coastal Resource Management (DHEC-OCRM). The county tax assessor's office shall make this determination based on best available data.

*Townhomes.* See Condominiums.

*Variable costs.* An impervious and gross area rate structure that allocates some cost to each of the two variables based on the amount of impervious surface and gross area.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2016/26, 9-26-2016 ; Ord. No. 2018/6, 3-12-2018 ; Ord. No. 2021/04, 1-11-2021)

### **Sec. 99-107. Reserved.**

Editor's note(s)—Ord. No. 2016/38 , adopted Oct. 24, 2016, deleted § 99-107, which pertained to requirements for on-site stormwater systems; enforcement, methods, and inspections, and derived from Ord. No. 2015/24 , adopted Sept. 28, 2015.

### **Sec. 99-108. General funding policy.**

- (a) It shall be the policy of Beaufort County that funding for the stormwater management utility program, services, systems, and facilities shall be equitably derived through methods which have a demonstrable relationship to the varied demands and impacts imposed on the stormwater program, services, systems, and facilities by individual properties or persons and/or the level of service rendered by or resulting from the provision of stormwater programs, systems and facilities. Stormwater service fee rates shall be structured so as to be fair and reasonable, and the resultant service fees shall bear a substantial relationship to the cost of providing services and facilities throughout the county. Similarly situated properties shall be charged similar rentals, rates, fees, or licenses. Service fee rates shall be structured to be consistent in their application and shall be coordinated with the use of any other funding methods employed for stormwater management within the county, whether wholly or partially within the unincorporated portions of the county or within the cities and towns. Plan review and inspection fees, special fees for services, fees in-lieu of regulatory requirements, impact fees, system development fees, special assessments, general obligation and revenue bonding, and other funding methods and mechanisms available to the county may be used in concert with stormwater service fees and shall be coordinated with such fees in their application to ensure a fair and reasonable service fee rate structure and overall allocation of the cost of services and facilities.
- (b) The cost of stormwater management programs, systems, and facilities subject to stormwater service fees may include operating, capital investment, and non-operating expenses, prudent operational and emergency reserve expenses, and stormwater quality as well as stormwater quantity management programs, needs, and requirements.
- (c) To the extent practicable, adjustments to the stormwater service fees will be calculated by the Beaufort County Public Works Director or his/her designee in accordance with the standards and procedures adopted by the public works director's office.

- (d) The stormwater service fee rate may be determined and modified from time to time by the Beaufort County Council so that the total revenue generated by said fees and any other sources of revenues or other resources allocated to stormwater management by the county council to the stormwater management utility shall be sufficient to meet the cost of stormwater management services, systems, and facilities, including, but not limited to, the payment of principle and interest on debt obligations, operating expense, capital outlays, nonoperating expense, provisions for prudent reserves, and other costs as deemed appropriate by the county council.

Beaufort County service fee rate will be based on impervious and gross area at an 80/20 allocation; stormwater service fee categories; any state agricultural exemptions or caps; an account administrative fee, countywide jurisdiction operation maintenance and jurisdictional operation, maintenance and capital project fee. The rates are set by the Beaufort County Stormwater Rate Study adopted August 24, 2015.

The gross area charge for all parcels, except master account properties for condominiums, is calculated in equivalent units as follows:

First 2 acres	\$X
For every acre above 2 acres and up to 10 acres	0.5 x \$X
For every acre above 10 acres, and up to 100 acres	0.4 x \$X
For every acre above 100 acres	0.3 x \$X

Condominium accounts will receive a minimum gross area charge of 0.2 x \$X. The master account associated with the condominium subdivision will not receive a gross area charge.

Each municipal jurisdiction may have a different fee predicated upon the municipal jurisdiction's revenue needs. The stormwater service fee rates shall be adopted by the municipal jurisdictions and may be amended from time to time by the individual governing body.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2016/26, 9-26-2016 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-109. Exemptions and credits applicable to stormwater service fees.**

Except as provided in this section, no public or private property shall be exempt from stormwater utility service fees. No exemption, credit, offset, or other reduction in stormwater service fees shall be granted based on the age, tax, or economic status, race, or religion of the customer, or other condition unrelated to the stormwater management utility's cost of providing stormwater programs, services, systems, and facilities. A stormwater management utility service fee credit manual shall be prepared by the public works director specifying the design and performance standards of on-site stormwater services, systems, facilities, and activities that qualify for application of a service fee credit, and how such credits shall be calculated.

- (a) *Credits.* The following types of credits against stormwater service fees shall be available:
- (1) Freshwater wetlands. All properties except those classified as detached single-family dwelling units may receive a credit against the stormwater service fee applicable to the property based on granting and dedicating a perpetual conservation easement on those portions of the property that are classified as freshwater wetlands and as detailed in the stormwater management utility service fee credit manual. The conservation easement shall remove that portion of the subject property from any future development.
  - (2) Salt water marsh. All properties except those classified as detached single-family dwelling units may receive a credit against the stormwater service fee applicable to the property based on those portions of the property that are classified as salt water marsh and as detailed in the stormwater management utility service fee credit manual.

- (3) Submerged properties. All properties may receive a credit against the stormwater service fee applicable to the property based on those portions of the property that are classified as submerged and as detailed in the stormwater management utility service fee credit manual.
  - (4) Those properties that apply for consideration of an adjustment shall satisfy the requirements established by the Beaufort County Public Works Director or his/her designee and approved reduced stormwater service fee.
- (b) *Exemptions.* The following exemptions from the stormwater service fees shall be allowed:
- (1) Improved public road rights-of-way that have been conveyed to and accepted for maintenance by the state department of transportation and are available for use in common for vehicular transportation by the general public.
  - (2) Improved public road rights-of-way that have been conveyed to and accepted for maintenance by Beaufort County and are available for use in common for vehicular transportation by the general public.
  - (3) Improved private roadways that are shown as a separate parcel of land on the most current Beaufort County tax maps and are used by more than one property owner to access their property.
  - (4) Improved private roadways that are not shown as a separate parcel of land on the most current Beaufort County tax maps but are used by more than one property owner to access their property.
  - (5) Railroad tracks shall be exempt from stormwater service fees. However, railroad stations, maintenance buildings, or other developed land used for railroad purposes shall not be exempt from stormwater service fees.
  - (6) Condominium boat slips shall be exempt from stormwater service fees.
  - (7) Properties determined by the assessor having 100 percent of the gross area of the property submerged, salt water marsh, or freshwater wetland will not receive an administrative charge, if applicable in the utility rate structure, after the applicable credit defined in paragraph (a) above has been applied to the account.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2016/26, 9-26-2016 ; Ord. No. 2020/18, 5-26-2020 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-110. Stormwater service fee billing, delinquencies and collections.**

- (a) *Method of billing.* A stormwater service fee bill may be attached as a separate line item to the county's property tax billing or may be sent through the United States mail or by alternative means, notifying the customer of the amount of the bill, the date the fee is due (January 15), and the date when past due (March 17 - see Title 12, Section 45-180 of the South Carolina State Code). The stormwater service fee bill may be billed and collected along with other fees, including, but not limited to, the Beaufort County property tax billing, other Beaufort County utility bills, or assessments as deemed most effective and efficient by the Beaufort County Council. Failure to receive a bill is not justification for non-payment. Regardless of the party to whom the bill is initially directed, the owner of each parcel of land shall be ultimately obligated to pay such fees and any associated fines or penalties, including, but not limited to, interest on delinquent service fees. If a customer is under-billed or if no bill is sent for a particular property, Beaufort County may retroactively bill for a period of up to one-year, but shall not assess penalties for any delinquency during that previous unbilled period.

- (b) *Declaration of delinquency.* A stormwater service fee shall be declared delinquent if not paid within 60 days of the date of billing or upon the date (March 17) of delinquency of the annual property tax billing if the stormwater service fee is placed upon the annual property tax billing or enclosed with or attached to the annual property tax billing.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-111. Appeals.**

Any customer who believes the provisions of this article have been applied in error may appeal in the following manner and sequence:

- (a) An appeal of a stormwater service fee must be filed in writing with the Beaufort County Public Works Director, or his/her designee within 30 days of the fee being mailed or delivered to the property owner and stating the reasons for the appeal. In the case of stormwater service fee appeals, the appeal shall include a survey prepared by a registered land surveyor or professional engineer containing information on the impervious surface area and any other feature or conditions that influence the development of the property and its hydrologic response to rainfall events.
- (b) Using information provided by the appellant, the county public works director or his/her designee shall conduct a technical review of the conditions on the property and respond to the appeal in writing within 30 days after receipt of the appeal. In response to an appeal, the county public works director or his/her designee may adjust the stormwater service fee applicable to the property in conformance with the general purposes and intent of this article.
- (c) A decision of the public works director or his/her designee that is adverse to an appellant may be further appealed to the county administrator or his/her designee within 30 days of the adverse decision. The appellant, stating the grounds for further appeal, shall deliver notice of the appeal to the county administrator or his designee. The county administrator or his designee shall issue a written decision on the appeal within 30 days. All decisions by the county administrator or his designee shall be served on the customer personally or by registered or certified mail, sent to the billing address of the customer. All decisions of the county administrator or his designee shall be final.
- (d) The appeal process contained in this section shall be a condition precedent to an aggrieved customer seeking judicial relief. Any decisions of the county administrator or his designee may be reviewed upon application for writ of certiorari before a court of competent jurisdiction, filed within 30 days of the date of the service of the decision.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-112. No suspension of due date.**

No provision of this article allowing for an administrative appeal shall be deemed to suspend the due date of the service fee with payment in full. Any adjustment in the service fee for the person pursuing an appeal shall be made by refund of the amount due.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-113. Enforcement and penalties.**

Any person who violates any provision of this article may be subject to a civil penalty of not more than \$1,000.00, or such additional maximum amount as may become authorized by state law, provided the owner or

other person deemed to be in violation has been notified of a violation. Notice shall be deemed achieved when sent by regular United States mail to the last known address reflected on the county tax records, or such other address as has been provided by the person to the county. Each day of a continuing violation may be deemed a separate violation. If payment is not received or equitable settlement reached within 30 days after demand for payment is made, a civil action may be filed on behalf of the county in the circuit court to recover the full amount of the penalty. This provision on penalties shall be in addition to and not in lieu of other provisions on penalties, civil or criminal, remedies and enforcement that may otherwise apply.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-114. Investment and reinvestment of funds and borrowing.**

Funds generated for the stormwater management utility from service fees, fees, rentals, rates, bond issues, other borrowing, grants, loans, and other sources shall be utilized only for those purposes for which the utility has been established as specified in this article, including, but not limited to: regulation; planning; acquisition of interests in land, including easements; design and construction of facilities; maintenance of the stormwater system; billing and administration; water quantity and water quality management, including monitoring, surveillance, private maintenance inspection, construction inspection; public information and education, and other activities which are reasonably required. Such funds shall be invested and reinvested pursuant to the same procedures and practices established by Title 12, Section 45-70 of the South Carolina State Code for investment and reinvestment of funds. County council may use any form of borrowing authorized by the laws of the State of South Carolina to fund capital acquisitions or expenditures for the stormwater management utility. County council, in its discretion and pursuant to standard budgetary procedures, may supplement such funds with amounts from the general fund.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-115. Responsibilities of the stormwater management utility.**

The county stormwater management utility shall perform adequate studies throughout the area served by the utility to determine the following:

- (1) Baseline study of water quality in the receiving waters;
- (2) Identification of pollutants carried by stormwater runoff into the receiving waters;
- (3) Recommended mitigation efforts to address pollutants carried by stormwater runoff into the receiving waters;
- (4) Inventory of the existing drainage system;
- (5) Recommended maintenance practices and standards of the existing drainage system;
- (6) Identification of capital improvements to the system to include construction or installation of appropriate BMPs;
- (7) A five-year spending plan;
- (8) Ensure compliance with the federally mandated MS4 permit requirements;
- (9) Efficient utility administration including, but not limited to, billing, collection, defining rate structures, data management and customer support.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )



## Sec. 99-116. Stormwater management utility board.

- (1) *Purpose.* In compliance with and under authority of Beaufort County Ordinance 2001/23, the Beaufort County Council hereby establishes the stormwater management utility board (hereinafter referred to as the "SWU board") to advise the council as follows:
- (a) To determine appropriate levels of public stormwater management services for residential, commercial, industrial and governmental entities within Beaufort County;
  - (b) To recommend appropriate funding levels for provision of services in the aforementioned sectors;
  - (c) To advise the staff of the stormwater management utility on master planning efforts and cost of service/rate studies; and
  - (d) To support and promote sound stormwater management practices that mitigates non-point source pollution and enhances area drainage within Beaufort County.

Municipal councils are encouraged to organize similar boards to advise them on stormwater management programs and priorities within their boundaries.

In keeping with discussions held during the formation of the stormwater utility, it is anticipated that the municipalities will appoint staff professionals as their representative on the advisory board.

- (2) *Stormwater districts.* Stormwater districts are hereby established as follows:

District 1 - City of Beaufort

District 2 - Town of Port Royal

District 3 - Town of Hilton Head Island

District 4 - Town of Bluffton

District 5 - Unincorporated Sheldon Township

District 6 - Unincorporated Port Royal Island

District 7 - Unincorporated Lady's Island

District 8 - Unincorporated St. Helena Island Islands East

District 9 - Unincorporated Bluffton Township and Daufuskie Island

- (3) *Membership.*

- (a) The SWU board is formed in accordance with Beaufort County Ordinance 92-28 and shall consist of a total of seven voting representatives from each of the following districts as noted below:

No. of Reps.	Stormwater District	Area
1	5	Unincorporated Sheldon Township
1	6	Unincorporated Port Royal Island
1	7	Unincorporated Lady's Island
1	8	Unincorporated St. Helena Island Islands East
2	9	Unincorporated Bluffton Township and Daufuskie Island
1	—	"At large"

All members of the SWU board will be appointed by county council and shall be residents of those districts or "at large" members from unincorporated Beaufort County.

- (b) The SWU board shall also consist of one nonvoting (ex officio) representative from the following districts:

Stormwater District	Municipality
1	City of Beaufort
2	Town of Port Royal
3	Town of Hilton Head Island
4	Town of Bluffton

All ex officio members from municipalities shall be appointed by their respective municipal councils for four-year terms.

- (c) All citizen members shall be appointed for a term of four years. The terms shall be staggered with one or two members appointed each year.
- (d) While no other eligibility criteria is established, it is recommended that members possess experience in one or more of the following areas: Stormwater management (drainage and water quality) issues, strategic planning, budget and finance issues or established professional qualifications in engineering, construction, civil engineering, architectural experience, commercial contractor or similar professions.

(4) *Officers.*

- (a) *Officers.* Selection of officers and their duties as follows:

1. *Chairperson and vice-chair.* At an annual organizational meeting, the members of the SWU board shall elect a chairperson and vice-chairperson from among its members. The chair's and vice-chair's terms shall be for one year with eligibility for reelection. The chair shall be in charge of all procedures before the SWU board, may administer oaths, may compel the attendance of witnesses, and shall take such action as shall be necessary to preserve order and the integrity of all proceedings before the SWU board. In the absence of the chair, the vice-chair shall act as chairperson.
2. *Secretary.* The county professional staff member shall appoint a secretary for the SWU board. The secretary shall keep minutes of all proceedings. The minutes shall contain a summary of all proceedings before the SWU board, which include the vote of all members upon every question, and its recommendations, resolutions, findings and determinations, and shall be attested to by the secretary. The minutes shall be approved by a majority of the SWU board members voting. In addition, the secretary shall maintain a public record of SWU board meetings, hearings, proceedings, and correspondence.
3. *Staff.* The public works director shall be the SWU board's professional staff.

- (b) *Quorum and voting.* Four SWU board members shall constitute a quorum of the SWU board necessary to take action and transact business. All actions shall require a simple majority of the number of SWU board members present.
- (c) *Removal from office.* The county council, by a simple majority vote, shall terminate the appointment of any member of the SWU board and appoint a new member for the following reasons:
1. Absent from more than one-third of the SWU board meetings per annum, whether excused or unexcused;
  2. Is no longer a resident of the county;
  3. Is convicted of a felony; or

4. Violated conflict of interest rules.

Moreover, a member shall be removed automatically for failing to attend any three consecutive regular meetings.

- (d) *Vacancy.* Whenever a vacancy occurs on the SWU board, the county council shall appoint a new member within 60 days of the vacancy, subject to the provisions of this section. A new member shall serve out the former member's term.
- (e) *Compensation.* The SWU board members shall serve without compensation, but may be reimbursed for such travel, mileage and/or per diem expenses as may be authorized by the county council-approved budget.

(5) *Responsibilities and duties.*

- (a) Review and recommend to the county council for approval, a comprehensive Beaufort County Stormwater Management Master Plan and appropriate utility rate study which is in accordance with the South Carolina Stormwater Management and Sediment Reduction Act; and
- (b) Review and comment to the county administrator on the annual stormwater management utility enterprise fund budget; and
- (c) Cooperate with the South Carolina Department of Health and Environmental Control (DHEC), Office of Coastal Resource Management (OCRM), the Oversight Committee of the Special Area Management Plan (SAMP), the Beaufort County Clean Water Task Force as well as other public and private agencies having programs directed toward stormwater management programs; and
- (d) Review and make recommendations concerning development of a multiyear stormwater management capital improvement project (CIP) plan; and
- (e) Review and advise on proposed stormwater management plans and procurement procedures; and
- (f) Provide review and recommendations on studies conducted and/or funded by the utility; and
- (g) Review and advise on actions and programs to comply with regulatory requirements, including permits issued under the State of South Carolina National Pollutant Discharge Elimination System (NPDES) general permit for stormwater discharges from regulated small municipal separate storm sewer systems (MS4).

(6) *Meetings.* Meetings of the SWU board shall be held as established by the SWU board and county staff on a quarterly and an as needed basis and a calendar will be prepared giving the date, time and location of such meetings. Additionally, meetings may be called by the chairperson or at the request of county staff. The location of all SWU board meetings shall be held in a public building in a place accessible to the public. The following shall apply to the conduct of all meetings:

- (a) *Meeting records.* The SWU board shall keep a record of meetings, resolutions, findings, and determinations. The SWU board may provide for transcription of such hearings and proceedings, or portions of hearings and proceedings, as may be deemed necessary.
- (b) *Open to public.* All meetings and public hearings of the SWU board shall be open to the public.
- (c) *Recommendations or decisions.* All recommendations shall be by show of hands of all members present. A tie vote or failure to take action shall constitute a denial recommendation. All recommendations shall be accompanied by a written summary of the action and recommendations.
- (d) *Notice and agenda.* The SWU board must give written public notice of regular meetings at the beginning of each calendar year. The SWU board must post regular meeting agendas at the meeting place 24 hours before any meeting. Notices and agenda for call, special or rescheduled meetings must

be posted at least 24 hours before such meetings. The SWU board must notify any persons, organizations and news media that request such notification of meetings.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

**Secs. 99-117—99-199. Reserved.**

### ***ARTICLE III. REGULATORY GENERAL PROVISIONS***

#### **Sec. 99-200. Authority.**

This article is adopted pursuant to the authority conferred upon the Beaufort County (county) by the South Carolina Constitution, the South Carolina General Assembly and in accordance with Federal Clean Water Act, the South Carolina Pollution Control Act, and regulations promulgated there under.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-201. Findings.**

The county council makes the following findings:

- (a) Beaufort County's waters contain some of the few remaining pristine shellfish harvesting areas in the southern coastal counties of South Carolina. Many of its waters have been designated by the State of South Carolina as Outstanding Resource Waters. This use has historical and traditional significance to the area. It is in the public interest that the condition of these areas be maintained and preserved for future generations. Uncontrolled stormwater runoff may have significant, adverse impact on the health, safety and general welfare of the county and the quality of life of its citizens by transporting pollutants into receiving waters and by causing erosion and/or flooding. Development and redevelopment may alter the hydrologic response of local watersheds and increases stormwater runoff rates and volumes, flooding, soil erosion, stream channel erosion, non-point pollution, and sediment transport and deposition, as well as reducing groundwater recharge. These changes in stormwater runoff may contribute to increased quantities of water-borne pollutants and alterations in hydrology which are harmful to public health, safety, and welfare, as well as to the natural environment.
- (b) Point source pollution may have significant, adverse impact on the health, safety and general welfare of the county and the quality of life of its citizens by transporting pollutants into receiving waters. The allowance of discharge pipes and outfalls for non-stormwater discharges, illegal dumping, and improper handling of accidental spills and intentional disposals increase the quantities of water-borne pollutants which are harmful to public health, safety, and welfare, as well as to the natural environment.
- (c) The effects of point and non-point source pollution, such as uncontrolled runoff, have shown evidence of degradation of the county's receiving waters; thereby adversely affecting the unique qualities of the county's receiving waters, its recreational opportunities and commercial, oystering, boating and fishing, the ecosystem's ability to naturally reproduce and thrive, and the general ability of the area to sustain its natural estuarine resources.
- (d) These deleterious effects can be managed and minimized by applying proper design and well-planned controls to manage stormwater runoff from development and redevelopment sites, manage existing natural features that maintain hydrology and provide water quality control, and eliminate potential sources of pollution to receiving waters. Public education regarding the cause and effect of these types

of pollutions and the implementation of the controls and management policies is key to fundamentally changing public behavior.

- (e) This article is not in conflict with any development agreements to which the county is a party and does not prevent the development set forth in any development agreement unless impairments to the county's receiving waters is linked to this development.
- (f) This article is essential to the public health, safety or welfare and shall apply to any development that is subject to a development agreement.
- (g) Laws of general application throughout the county necessary to protect health, safety and welfare are anticipated and are provided for in development agreements.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-202. Purpose.**

- (a) It is the purpose of this article to guide development in Beaufort County to protect, maintain, and enhance the environment of the county and the short- and long-term public health, safety, and general welfare of the citizens of the county by establishing requirements and procedures to control the potential adverse effects of increased stormwater runoff associated with both future development, re-development, and existing developed land. Proper management of stormwater runoff will minimize damage to public and private property, ensure a functional drainage system, reduce the effects of development on land and stream channel erosion, attain and maintain water quality standards, enhance the local environment associated with the drainage system, reduce local flooding, reduce pollutant loading to the maximum extent practicable and maintain to the extent practicable the pre-developed runoff characteristics of the area, and facilitate economic development while minimizing associated pollutant, flooding, and drainage impacts.
  - (b) This article specifically authorizes and enables the county to:
    - (1) Prohibit illicit discharges to the stormwater system and receiving waters.
    - (2) Define procedures for site plan design, review, inspection, and enforcement relative to stormwater management. Establish decision-making processes surrounding land development or redevelopment activities that protect the integrity of local aquatic resources.
    - (3) Control the discharge of spills, dumping or disposal of materials other than stormwater to the stormwater system and receiving waters.
    - (4) Address specific categories of non-stormwater discharges and similar other incidental non-stormwater discharges.
    - (5) Control importation of water that adversely impacts our receiving waters.
    - (6) Require temporary erosion and sediment controls to protect water quality to the maximum extent practicable during construction activities, in accordance with current state regulations.
    - (7) Define procedures for receipt and consideration of information submitted by the public.
    - (8) Address runoff, particularly volume, rate, and quality through the control and treatment of stormwater with stormwater management facilities and/or best management practices (BMPs).
    - (9) Develop post-construction stormwater quality performance standards, through enforcement of minimum design standards for BMPs.
    - (10) Ensure effective long-term operation and maintenance of BMPs.

- (11) Carry out all inspection, surveillance, monitoring, and enforcement procedures necessary to determine compliance and noncompliance with this article and stormwater permit conditions including the prohibition of illicit discharges to the county's stormwater system and the protection of water quality of the receiving waters.
  - (12) Development, implement, and enforce regulations any and all other programs or policies to comply with the Municipal Separate Stormsewer System (MS4) permit issued by South Carolina Department of Health and Environmental Control (DHEC).
  - (13) Establish design criteria in the most current version of the Southern Lowcountry Stormwater Design Manual for structural and nonstructural stormwater management practices that can be used to meet the minimum post-development stormwater management standards and design criteria;
  - (14) Establish that Better Site Design (BSD) and site planning has been incorporated, documented, and presented in the development/redevelopment design process.
  - (15) Maintain structural and nonstructural stormwater management practices to ensure that they continue to function as designed and pose no threat to public safety.
  - (16) Streamline administrative procedures for the submission, review, approval and disapproval of stormwater management plans and for the inspection of approved land development projects.
  - (17) If any of the stormwater management standards, as defined in this chapter and in the most current version of the Southern Lowcountry Stormwater Design Manual cannot be attained on the site (due to impractical site characteristics or constraints), a maximum extent practicable analysis shall be prepared and submitted by the applicant for review, discussion, and ultimate approval or rejection of the jurisdiction. Any uncontrolled post-development stormwater quantity or quality volume shall be intercepted and treated in one or more off-site stormwater management practices or a fee-in-lieu shall be required.
  - (18) The stormwater management practices of approved plans shall provide volume control and at least an 80 percent reduction in total suspended solids loads, 30 percent reduction of total nitrogen load, and 60 percent reduction in bacteria load.
  - (c) The article requires prudent site planning, including special considerations for the purposes of preserving natural drainage ways incorporating on-site stormwater detention and infiltration to minimize runoff from individual sites to receiving waters by use of effective runoff management, structural and non-structural BMPs, drainage structures, and stormwater facilities. Establish that better site design (BSD) and site planning has been incorporated, documented, and presented in the development/redevelopment design process.
- ( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

## Sec. 99-203. Definitions.

The following definitions shall apply in articles III, IV, V, and VI this chapter. Any term not herein defined shall be given the definition, if any, as is found elsewhere in the Code of Ordinances of Beaufort County, including the community development code (CDC) ordinance.

*Administrators.* The public works director, the stormwater manager and other individuals designated by the county administrator, from time to time, to administer interpret and enforce this article.

*Best management practices ("BMP").* Stormwater management practices, either structural, non-structural or natural that has been demonstrated to effectively control movement of stormwater, pollutants, prevent degradation of soil and water resources, and that are compatible with the planned land use.

*Clean Water Act.* The Federal Water Pollution Control Act, as amended, codified at 33 U.S.C § 1251 et seq.

*Community development code ("CDC").* A form based code to regulate zoning and development in Beaufort County.

*County.* The Beaufort County, South Carolina.

*County council.* The publicly elected official of Beaufort County, South Carolina.

*Department.* The stormwater department, or any duly authorized representatives thereof as designated by the county administrator.

*Development.* All project construction, modification, or use of any lot, parcel, building, or structure on land and on water. Existing dirt roads which are improved and/or paved as part of Beaufort County's Dirt Road Paving Program as set forth in Beaufort County Policy Statement 15 and Policy Statement 17 and existing private dirt roads which are improved or paved and where the project is not related to a pending or proposed development of adjacent land are deemed not to constitute "development".

*Disconnected impervious areas or disconnected impervious surfaces.* Those non-contiguous impervious areas or impervious surfaces which produce stormwater runoff that discharges through or across a pervious area or surface (i.e. vegetated cover), of sufficient width to reduce or eliminate pollutants associated with stormwater runoff, prior to discharge to the stormwater system.

*Environment.* The complex of physical, chemical, and biotic factors that act upon an ecological community and ultimately determine its form and survival.

*Evapotranspiration.* The sum of evaporation and plant transpiration from the earth's land surface to atmosphere.

*Excess stormwater volume.* The additional volume of stormwater runoff leaving the site over and above the runoff volume which existed pre-development.

*Illicit connection.* A connection to the county's stormwater system or receiving water which results in a discharge that is not composed entirely of stormwater runoff and has a detrimental effect on the stormwater system or receiving water except, those granted coverage by an active NPDES permit.

*Illicit discharge.* Any activity, which results in a discharge to the county's stormwater system or receiving waters that is not composed entirely of stormwater except:

- (a) Discharge pursuant to an NPDES permit; and
- (b) Other allowable discharges as defined and exempted in this article.

*Impervious surface.* As defined in the county's best management practices (BMP) manual.

*Improper disposal.* Any disposal through an illicit discharge, including, but not limited to, the disposal of used oil and toxic materials resulting from the improper management of such substances.

*Land disturbance or land disturbing activity.* The use of land by any person that results in a change in the natural vegetated cover or topography, including clearing that may contribute to or alters the quantity and/or quality of stormwater runoff.

*Maintenance.* Any action necessary to preserve stormwater management facilities in proper working condition, in order to serve the intended purposes set forth in this article and to prevent structural failure of such facilities.

*MS4.* Municipal separate storm sewer system.

*NPDES.* National Pollutant Discharge Elimination System (see "Clean Water Act.")

*Natural resources.* Land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources.

*Outfall.* The point where county's stormwater system discharges to waters of the United States or the State of South Carolina.

*Person.* Any and all persons, natural or artificial and includes any individual, association, firm, corporation, business trust, estate, trust, partnership, two or more persons having a joint or common interest, or an agent or employee thereof, or any other legal entity.

*Pollutant.* Those manmade or naturally occurring constituents that when introduced to a specific environment creates a deleterious effect. Typical pollutants found in stormwater include, but are not limited to, sediment (suspended and dissolved), nutrients (nitrogen and phosphorus, etc.), oxygen demanding organic matter, heavy metals (iron, lead, manganese, etc.), bacteria and other pathogens, oil and grease, household hazardous waste (insecticide, pesticide, solvents, paints, etc.) and polycyclic aromatic hydrocarbons (PAHs).

*Property owner or owner.* The legal or equitable owner of land.

*Receiving waters.* All natural water bodies, including oceans, salt and freshwater marsh areas, lakes, rivers, streams, ponds, wetlands, and groundwater which are located within the jurisdictional boundaries of the county. Stormwater management ponds, manmade wetlands, ditches, and swales constructed for the sole purpose of controlling and treating stormwater are not considered receiving waters.

*Record drawings.* A set of drawings prepared by and certified by a South Carolina registered professional engineer or landscape architect that accurately represents the actual final configuration of the stormwater and other related infrastructure constructed in a development.

*Redevelopment.* As defined in the county's best management practices (BMP) manual.

*Regulation.* Any regulation, rule or requirement and promulgated by the county pursuant to this article.

*Southern Lowcountry Stormwater Design Manual.* "The Manual for Stormwater Best Management and Design Practices (BMP)" establishes technical standards as referenced and incorporated into the community development code (CDC).

*Stormwater.* Stormwater runoff, precipitation runoff, and surface runoff.

*Stormwater management.* The collection, conveyance, storage, treatment and disposal of stormwater in a manner to meet the objectives of this article and its terms, including, but not limited to, measures that control the increased volume and rate of stormwater runoff and water quality impacts caused by manmade changes to the land.

*Stormwater management program, services, systems facilities.* Those administrative, engineering, operational, regulatory, and capital improvement activities and functions performed in the course of managing the stormwater systems of the county, plus all services. Stormwater management systems and facilities are those natural and manmade channels, swales, ditches, swamps, rivers, streams, creeks, branches, reservoirs, ponds, drainage ways, inlets, catch basins, pipes, head walls, storm sewers, lakes, and other physical works, properties, and improvements which transfer, control, convey or otherwise influence the movement of stormwater runoff and its discharge to and impact upon receiving waters.

*Stormwater management plan or SWMP.* The set of drawings and other documents that comprise all of the information and specifications for the programs, drainage systems, structures, BMPs, concepts, and techniques for the control of stormwater.

*Stormwater pollution prevention plan or SWPPP.* Erosion prevention and sediment control (EPSC). Also see "stormwater management plan".

*Stormwater system.* The conveyance or system of conveyances (including roads with drainage systems, highways, right-of-way, private streets, catch basins, curbs, gutters, ditches, manmade channels, storm drains, detention ponds, and other stormwater facilities) which is designed or used for collecting or conveying stormwater.



*Structural best management practices ("BMP").* A device designed and constructed to trap and filter pollutants from runoff.

*Total impervious surface.* All impervious surfaces on a site regardless if they are directly connected to another and that is not constructed using permeable pavement technology.

*Utility.* Beaufort County Stormwater Utility as established by county article chapter 99, article II.

*Waiver.* The modification of the minimum stormwater management requirements contained in these articles and the [most current version of the](#) Southern Lowcountry Stormwater Design Manual for specific circumstances where strict adherence of the requirements would result in unnecessary hardship and not fulfill the intent of this article.

*Water quality.* Those characteristics of stormwater runoff that relate to the physical, chemical, biological, or radiological integrity of water.

*Water quantity.* Those characteristics of stormwater runoff that relate to the rate and volume of the stormwater runoff.

*Wetlands.* As defined by the Army Corps of Engineers and generally means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar type areas.

*Working day.* Monday through Friday, excluding all county-observed holidays.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2018/6 , 3-12-2018; Ord. No. 2020/18 , 5-26-2020; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-204. Applicability.**

Beginning with and subsequent to its effective date, this article shall be applicable to:

- (a) All development and redevelopment.
- (b) Any illicit discharges.
- (c) The provisions of this article shall apply throughout the unincorporated areas of the county.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-205. Regulations.**

The county council, may, in its discretion, amend or change this article, or adopt additional regulations to implement this article in order to comply with the state regulations, administer the stormwater management department, or to otherwise further the goal of protecting the quality of the receiving waters into which the stormwater system discharges.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-206. County stormwater management administration.**

Stormwater management will be administered by the public works department and the stormwater department to administer and implement the regulations of this article as set forth in the [most current version of the](#) Southern Lowcountry Stormwater Design Manual. The manual may include design standards, procedures and

criteria for conducting hydrologic, hydraulic, pollutant load evaluations, and downstream impact for all components of the stormwater management system. It is the intention of the manual to establish uniform design practices; however, it neither replaces the need for engineering judgment nor precludes the use of information not submitted. Other accepted engineering procedures may be used to conduct hydrologic, hydraulic and pollutant load studies if approved by the public works director.

The manual will contain at a minimum the following components:

- (a) Construction activity application contents and approval procedures;
- (b) Construction completion and closeout processes;
- (c) Hydrologic, hydraulic, and water quality design criteria (i.e., design standards) for the purposes of controlling the runoff rate, volume, and pollutant load. Suggested reference material shall be included for guidance in computations needed to meet the design standards;
- (d) Information and requirements for new and re-development projects in special protection areas necessary to address TMDLs, known problem areas and other areas necessary to protect, maintain, and enhance water quality and the environment of Beaufort County and the public health, safety, and general welfare of the citizens of Beaufort County.
- (e) Construction document requirements;
- (f) Long-term maintenance and maintenance plan;
- (g) Minimum easement requirements;
- (h) Required and recommended inspection schedules and activities for all components of the stormwater management system, including construction related BMPs.

The manual will be updated periodically to reflect the advances in technology and experience.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2020/18 , 5-26-2020; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-207. Administrators of operations, power and duties.**

- (a) The administrators, or designee, shall administer, implement, and enforce provisions of this article on behalf of the county.
- (b) In addition to the powers and duties that may be conferred by other provisions of the county and other laws, the administrators shall have the following powers and duties under this article:
  - (1) To create the Southern Lowcountry Stormwater Design Manual. The manual may be used to convey design and engineering standards, construction management processes and procedures, and other aspects necessary for compliance with this chapter;
  - (2) To review and approve, approve with conditions, or disapprove applications for approval of a stormwater management plan pursuant to this article;
  - (3) To make determinations and render interpretations of this article;
  - (4) To establish application requirements, schedules and fees for submittal and review of applications, receipt of appeals, in accordance with the standards for county development permits and stormwater permits under the county's CDC ordinance and this article;
  - (5) To review and make recommendations to the applications for development or redevelopment approvals;
  - (6) To enforce the provisions of this article in accordance with its enforcement provisions;

- (7) To maintain records, maps, and official materials related enforcement, or administration of this article;
  - (8) To provide expertise and technical assistance;
  - (9) To take any other action necessary to administer the provisions of this article.
- ( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-208. Coordination with other agencies.**

The administrators will coordinate the county's activities with other federal, state, and local agencies, which manage and perform functions relating to the protection of receiving waters.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-209. Cooperation with other governments.**

The county may enter into agreements with other governmental and private entities to carry out the purposes of this article. These agreements may include, but are not limited to, enforcement, resolution of disputes, cooperative monitoring, and cooperative management of stormwater systems and cooperative implementation of stormwater management programs.

Nothing in this article or in this section shall be construed as limitation or repeal of any ordinances of these local governments or of the powers granted to these local governments by the South Carolina Constitution or statutes, including, without limitation, the power to require additional or more stringent stormwater management requirements within their jurisdictional boundaries.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-210. Stormwater management standards.**

- (a) Reference to best management practices can be found in the most current version of the Southern Lowcountry Stormwater Design Manual. The administrators shall use the policy, criteria, and information, including technical specifications and standards, in the most current version of the Southern Lowcountry Stormwater Design Manual as the basis for decisions about stormwater plans and about the design, implementation and performance of structural and non-structural stormwater systems. The stormwater management standards shall describe in detail how post-development stormwater runoff will be controlled and managed, the design of all stormwater facilities and practices, and how the proposed project will meet the requirements of this article. The most current version of the Southern Lowcountry Stormwater Design Manual includes a list of acceptable stormwater treatment practices, including the specific design criteria for each stormwater practice. These standards will be updated as technology improves.
- (b) Relationship of stormwater management standards to other laws and regulations. If the specifications or guidelines of the standards are more restrictive or apply a higher standard than other laws or regulations, that fact shall not prevent application of the specifications or guidelines in the standards.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-211. Review of stormwater management plans.**

Stormwater management plans shall be reviewed as a component of the development plan review process by the administrators. They will be reviewed for compliance with standards in this article and requirements in the

CDC and [the most current version of the](#) Southern Lowcountry Stormwater Design Manual Procedures are outlined in [the most current version of the](#) Southern Lowcountry Stormwater Design Manual. Requests for meetings and submission of plans will be submitted to stormwater department. The expected process will be in accordance with the standard procedures for applications described in the community development code.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-212. Approvals.**

- (a) *Effect of approval.* Approval authorizes the applicant to go forward with only the specific plans and activity authorized in the plan. The approval shall not be construed to exempt the applicant from obtaining other applicable approvals from local, state, and federal authorities.
- (b) *Time limit/expiration.* Time limit, expiration and extensions shall be in accordance with the county's community development code.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-213. Appeals.**

- (a) *Scope of appeal.* Any person aggrieved by a decision of the administrators may appeal the same by filing an interim written notice of appeal, with the administrators within 30 days of the issuance of said decision or notice of violation. The interim notice of appeal must specify with reasonable practicality the grounds of the appeal and relief sought. The stormwater management utility board (SWUB) will review and provide a decision within 15 days after the next scheduled board meeting following the appeal. The decision of the SWUB shall be final. Appeals to SWUB's decision shall be processed in accordance with state law.
- (b) *Standards.*
  - (1) The SWUB is limited to the following determinations for an administrative appeal:
    - a. The administrators made an error in reviewing whether a standard was met. The record must indicate that an error in judgment occurred or facts, plans, or regulations were misread in determining whether the particular standard was met.
    - b. Where conflicting evidence exists, the appeal is limited to determining what evidence or testimony bears the greatest credibility in terms of documentation and qualifications of those making the determination.
    - c. The administrators made the decision on standards not contained in this chapter or other county ordinances, regulations, or state law, or a standard more strict or broad was applied. This chapter does not permit administrators to consider or create standards not officially adopted.
    - d. An error in applying a standard or measuring a standard was made.
  - (2) The board, on an appeal, shall not hear any evidence or make any decision based on financial hardships.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Secs. 99-214—99-299. Reserved.**

## **ARTICLE IV. STORMWATER MANAGEMENT STANDARDS TO BE APPLIED**

### Sec. 99-300. General requirements.

- (a) All development and redevelopment, including highways, shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume and duration of flow.
- (b) All development shall connect impervious surfaces to vegetative surfaces to the maximum extent practicable.
- (c) Stormwater runoff shall be controlled in a manner that:
  - (1) Promotes positive drainage from structures resulting from development.
  - (2) Includes the use of vegetated conveyances, such as swales and existing natural channels to promote infiltration and evapotranspiration.
  - (3) Reduces runoff velocities and maintains sheet flow condition to prevent erosion and promote infiltration.
  - (4) Limits its interaction with potential pollutant sources that may become water-borne and create non-point source pollution.
  - (5) Promotes reuse of excess stormwater volume to increase evapotranspiration.
- (d) Natural vegetative buffers play an integral part in minimizing the volume of stormwater runoff by promoting infiltration and increasing evapotranspiration to reduce stormwater volume to receiving waters and acting as a first line of treatment of water quality pollution. Development shall observe the buffer requirements of the county's CDC ordinance or if applicable the relevant development agreement, concept plan, and/or approved master plan.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### Sec. 99-301. Stormwater design requirements for development.

Developments which incorporates engineered stormwater collection, conveyance, and storage systems shall be designed to the criteria established in the ~~latest-most current~~ version of county's Southern Lowcountry Stormwater Design Manual.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### Sec. 99-302. BMP requirements.

- (a) Effectiveness of infiltration practices is dependent on the site conditions. The most current version of the Southern Lowcountry Stormwater Design Manual outlines guidance for properly siting infiltration practices and shall be reviewed prior to the design phase.
- (b) The owners of all new developments that receive a stormwater permit from the county shall be required to perform stormwater quantity monitoring at their expense to ensure compliance with the provisions of this article and ensure that volume reduction plans are operated as intended.
- (c) All construction and implementation of erosion and sediment control BMPs shall comply with the requirements of the South Carolina Stormwater Management and Sediment Reduction Act and submit reports in accordance with the most current version of the Southern Lowcountry Stormwater Design Manual.

- (d) The county reserves the right to perform other monitoring as it deems appropriate to determine compliance with the State Sediment and Erosion Control Act.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-303. Reserved.**

( Ord. No. 2016/38 , 10-24-2016)

### **Sec. 99-304. Waiver.**

Individuals seeking a waiver in connection with a stormwater plan may submit to the public works director a request for a waiver from the requirements of this article if exceptional circumstances applicable to a site exist, such that the applicant can provide rational documentation and justification to support a waiver.

Waivers may be granted for water quantity control only and best management practices to achieve water quality goals will still be required.

- (a) *Request of waiver at staff level.* A written request for a waiver is required and shall state the specific waiver sought and the reasons, with supporting data, a waiver should be granted. The request shall include all information necessary to evaluate the proposed waiver. Requests must outline the need for such a waiver, such as site constraints, soil characteristics, or similar engineering limitations. Cost shall not be considered cause for a waiver. The applicant will address the four areas of consideration for waiver approval as follows:
  - (1) What exceptional circumstances to the site are evident?
  - (2) What unnecessary hardship is being caused?
  - (3) How will denial of the waiver be inconsistent with the intent of the ordinance?
  - (4) How will granting waiver comply with intent of ordinance?
- (b) *Review of waivers.* The administrators will conduct a review of the request and will issue a decision within 15 working days of receiving the request.
- (c) *Appeal of decision.* Any person aggrieved by the decision of the administrators concerning a waiver request may appeal such decision in accordance with section 99-213 above.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-305. Maintenance; general requirements.**

- (a) *Function of BMPs as intended.* The owner of each structural BMP installed pursuant to this article shall maintain and operate it to preserve and continue its function in controlling stormwater quality and quantity at the degree or amount of function for which the structural BMP was designed.
- (b) *Right of county to inspection.* Every structural BMP installed pursuant to this article shall be made accessible for adequate inspection by the county.
- (c) *Annual maintenance inspection and report.* The person responsible for maintenance of any structural BMP installed pursuant to this article shall submit to the administrator(s) an inspection report from a qualified inspector or registered South Carolina Professional Engineer. The inspection report, at a minimum, shall contain all of the following:

- (1) The name and address of the land owner;
- (2) The recorded book and page number of the lot of each structural BMP or a digital representation of the geographic location of each structural BMP;
- (3) A statement that an inspection was made of all structural BMPs;
- (4) The date the inspection was made;
- (5) A statement that all inspected structural BMPs are performing properly and comply with the terms and conditions of the approved maintenance agreement required by this article;
- (6) The original signature and seal of the engineer inspecting the structural BMPs; and
- (7) Digital photographs of the structural BMPs and pertinent components integral to its operation, including, but not limited to, inlet/outlet control structures, downstream receiving channel/area, embankments and spillways, safety features, and vegetation.

An original inspection report shall be provided to the administrators beginning one year from the date of final inspection of the completed structural BMP and each year thereafter on or before the date of the record drawings certification.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-306. Operation and maintenance agreement.**

- (a) Prior to the conveyance or transfer of any lot or building site requiring a structural BMP pursuant to this article, the applicant or owner of the site must execute an operation and maintenance agreement (see [the most current version of the](#) Southern Lowcountry Stormwater Design Manual for form) that shall be binding on all subsequent owners of the site, portions of the site, and lots or parcels served by the structural BMP. Until the transference of all property, sites, or lots served by the structural BMP, the original owner or applicant shall have primary responsibility for carrying out the provisions of the maintenance agreement.
- (b) The operation and maintenance agreement must be approved by the administrators prior to plan approval, and it shall be referenced on the final plat and shall be recorded with the county register of deeds upon final plat approval. If no subdivision plat is recorded for the site, then the operations and maintenance agreement shall be recorded upon the approval of a certificate of completion with the county register of deeds to appear in the chain of title of all subsequent purchasers under generally accepted searching principles. A copy of the recorded maintenance agreement shall be given to the administrators within 14 days following its recordation.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-307. Deed recordation and indications on plat.**

The applicable operations and maintenance agreement pertaining to every structural BMP shall be referenced on the final plat and in covenants and shall be recorded with the county register of deeds upon final plat approval.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-308. Records of installation and maintenance activities.**

The owner of each structural BMP shall keep records of inspections, maintenance, and repairs for at least five years from the date of the record and shall submit the same upon reasonable request to the administrator(s).  
( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-309. Nuisance.**

The owner of each stormwater BMP shall maintain it so as not to create or result in a nuisance condition, such as, but not limited to, flooding, erosion, excessive algal growth, overgrown vegetation, mosquito breeding habitat, existence of unsightly debris, or impairments to public safety and health. Maintenance practices must not lead to discharges of harmful pollutants.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Secs. 99-310—99-399. Reserved.**

## ***ARTICLE V. ILLICIT DISCHARGES AND CONNECTIONS TO THE STORMWATER SYSTEM***

### **Sec. 99-400. Illicit discharges.**

No person shall cause or allow the discharge, emission, disposal, pouring, or pumping directly or indirectly to any stormwater conveyance, receiving water, or upon the land in manner and amount that the substance is likely to reach a stormwater conveyance or the receiving waters, any liquid, solid, gas, or other substance (including animal waste), other than stormwater.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-401. Non-stormwater discharges.**

(a) Non-stormwater discharges associated with the following activities are allowed provided that acceptable BMPs are followed:

- (1) Water line and hydrant flushing;
- (2) Landscape irrigation, unless it leads to excess SW volume discharge;
- (3) Diverted stream flows;
- (4) Rising ground waters;
- (5) Uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20));
- (6) Uncontaminated pumped ground water;
- (7) Discharges from potable water sources (with dechlorination BMP utilized);
- (8) Foundation drains;
- (9) Air conditioning condensation;



- (10) Reuse water;
  - (11) Springs;
  - (12) Water from crawl space pumps;
  - (13) Footing drains;
  - (14) Individual residential car washing;
  - (15) Flows from riparian habitats and wetlands;
  - (16) Dechlorinated swimming pool discharges: typically less than one part per million;
  - (17) Street wash water;
  - (18) Other non-stormwater discharge permitted under an NPDES permit, waiver, or waste discharge order issued to the discharger and administered under EPA authority, provided that the discharger is in full compliance with all requirements of the permit, waiver, or order and other applicable laws and regulations, and provided that written approval has been granted for any discharge to the storm drain system;
  - (19) Discharges specified in writing by the authorized agency/entity, as being necessary to protect public health and safety;
  - (20) Dye testing is an allowable discharge, but requires a verbal notification to the authorized enforcement agency prior to the test; and
  - (21) Firefighting.
  - (22) The public works director may develop procedures for allowing other non-stormwater discharges.
- (b) Prohibited substances include, but are not limited to: Oil, anti-freeze, chemicals, animal waste, paints, garbage, and litter.
- ( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-402. Illicit connections.**

- (a) Connections to a receiving water and/or stormwater conveyance system that allow the discharge of non-stormwater, other than the exclusions described in subsection 99-401(a) above are unlawful. Prohibited connections include, but are not limited to, floor drains, waste water from washing machines or sanitary sewers, wash water from commercial vehicle washing or steam cleaning, and waste water from septic systems.
  - (b) Where such connections exist in violation of this section and said connections were made prior to the adoption of this article or any other article prohibiting such connections, the property owner or the person using said connection shall remove or correct the connection immediately upon notice.
- ( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-403. Spills.**

- (a) Spills or leaks of polluting substances released, discharged to, or having the potential to released or discharged to a receiving water or the stormwater conveyance system, shall be immediately contained, controlled, collected, and properly disposed. All affected areas shall be restored to their preexisting condition.

- (b) Persons in control of the polluting substances shall immediately report the release or discharge to persons owning the property on which the substances were released or discharged, shall within two hours of such an event notify the nearest fire department (which will also notify the administrators), and all required federal and state agencies of the release or discharge. Notification shall not relieve any person of any expenses related to the restoration, loss, damage, or any other liability which may be incurred as a result of said spill or leak, nor shall such notification relieve any person from other liability which may be imposed by state or other law.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-404. Nuisance.**

Illicit discharges and illicit connections which exist within the unincorporated county are hereby found, deemed, and declared to be dangerous and prejudicial to the public health, and welfare, and are found, deemed, and declared to be public nuisances. Such public nuisances shall be abated in accordance with the procedures set forth in subsection 99-503(c) and (d).

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-405. Suspension of a MS4 discharge due to an illicit discharge.**

- (a) Any person discharging to the MS4 in violation of this article may have their MS4 access terminated if such termination would abate or reduce an illicit discharge. The authorized administrators notify a violator of the proposed termination of its MS4 access. The violator may petition the authorized enforcement agency for a reconsideration and hearing.
- (b) A person commits a violation if the person reinstates MS4 access to premises terminated pursuant to this section, without the prior approval of the authorized administrators.
- (c) The Beaufort County, South Carolina administrators may, without prior notice, suspend MS4 discharge access to a person when such suspension is necessary to stop an actual or threatened discharge that presents or may present imminent and substantial danger to the environment, or to the health or welfare of persons, or to the MS4 or waters of the United States. If the violator fails to comply with a suspension order issued in an emergency, the authorized enforcement agency may take such steps as deemed necessary to prevent or minimize damage to the MS4 or waters of the United States, or to minimize danger to persons.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Secs. 99-406—99-499. Reserved.**

### ***ARTICLE VI. INSPECTION, ENFORCEMENT, AND CORRECTION***

#### **Sec. 99-500. Inspections.**

The county administrators will maintain the right to inspect any and all stormwater systems within its jurisdiction as outlined below:

- (a) An inspector designated by the administrators, bearing proper credentials and identification, may enter and inspect all properties for regular inspections, periodic investigations, monitoring, observation

measurement, enforcement, sampling and testing, to ensure compliance with the provisions of this article.

- (b) Upon refusal by any property owner to permit an inspector to enter or continue an inspection, the inspector may terminate the inspection or confine the inspection to areas concerning which no objection is raised. The inspector shall immediately report the refusal and the grounds to the administrators. The administrators will promptly seek the appropriate compulsory process.
- (c) In the event that the administrators or inspector reasonably believes that discharges from the property into the county's stormwater system or receiving waters may cause an imminent and substantial threat to human health or the environment, the inspection may take place at any time after an initial attempt to notify the owner of the property or a representative on site. The inspector shall present proper credentials upon reasonable request by the owner or representative.
- (d) The Beaufort County, South Carolina, administrators shall have the right to set up on any permitted facility such devices as are necessary in the opinion of the authorized enforcement agency to conduct monitoring and/or sampling of the facility's stormwater discharge.
- (e) The Beaufort County, South Carolina, administrators have the right to require the discharger to install monitoring equipment as necessary. The facility's sampling and monitoring equipment shall be maintained at all times in a safe and proper operating condition by the discharger at its own expense. All devices used to measure stormwater flow and quality shall be calibrated to ensure their accuracy.
- (f) Any temporary or permanent obstruction to safe and easy access to the facility to be inspected and/or sampled shall be promptly removed by the operator at the written or oral request of the authorized administrators and shall not be replaced. The costs of clearing such access shall be borne by the operator.
- (g) Unreasonable delays in allowing the Beaufort County, South Carolina, administrators access to a permitted facility is a violation of a stormwater discharge permit and of this article. A person who is the operator of a facility with a NPDES permit to discharge stormwater associated with industrial activity commits an offense if the person denies the authorized enforcement agency reasonable access to the permitted facility for the purpose of conducting any activity authorized or required by this article.
- (h) Inspection reports will be maintained in a permanent file at the offices of the administrators.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-501. Notice and warning.**

- (a) Upon the county's attention to a violation of this article, the administrators shall investigate the violation and prepare a report concerning the violation. If a violation exists, a notice of violation shall be delivered within five working days to any person occupying the property or linked to a discharge, whether the person is the owner, renter, or lessee. If the nature of the violation is not correctable, a stop work order shall be issued immediately. If no one is present or refuses to accept the notice, the administrators shall post the notice of violation on the residence or building entrance.
- (b) The notice of violation shall contain the following:
  - (1) The address and tax ID number of the property.
  - (2) The section of this chapter being violated.
  - (3) The nature and location of the violation and the date by which such violation shall be removed or abated.

- (4) A notice of the penalty for failing to remove or abate the violation, stating that if the nuisance recurs by the same apparent occupant, owner, or person in charge, a notice of violation, stop work order, or notice to appear will be issued without further notice.
  - (5) The notice shall specify the number of days in which the violation shall be removed or abated, which time shall be not less than three days nor more than ten days, except in emergency cases.
  - (c) If the violation occurs where the residence or building is unoccupied, the property may be posted as provided in this section. If the property is unimproved, the notice may be placed on a tree, a stake, or other such object as available.
  - (d) A written notice containing the same information as the notice of violation shall be sent to the owner or any other person having control of the property at the last known address of the owner, or at the address of the person having control, by U.S. mail or email.
- ( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-502. Recurring violations.**

Once a notice has been delivered pursuant to this article and the same violation recurs on the same lot or tract of land by the same person previously responsible, no further notice of violation need be given. Each day a violation continues after the expiration of the warning period to abate such a violation shall constitute a separate offence. Thereafter, the county may issue a stop work order, or such person deemed responsible may be notified to appear in court to answer to the charge against such person.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-503. Failure to act upon notice of violation.**

Upon neglect or failure to act upon the notice of violation, and/or stop work order given as provided in sections 99-501 and 99-502, the county shall issue a notice to appear and shall follow the procedures as follows:

- (a) *Service of notice to appear.* If a stop work order is given and, after the time for removal or abatement has lapsed, the property is reinspected and the administrator or designee finds and determines the violation has not been removed or abated, the administrator or designee shall fill out and sign, as the complainant, a complaint and information form or a notice to appear. The notice to appear shall include the following:

- (1) Name of the occupant, owner, or person in charge of the property.
- (2) The address or tax ID number of the property on which the violation is occurring.
- (3) This chapter section or other reference the action or condition violates.
- (4) The date on which the case will be on the court docket for hearing.
- (5) Any other information deemed pertinent by the county official.

The original copy of the notice to appear shall be forwarded to the clerk of the court for inclusion on the court's docket for the date indicated on the notice to appear.

- (b) *Notice to appear; delivery by mail.* If no one is found at the property to accept a notice to appear for failure to remove or abate a violation, the administrator or designee shall fill out and sign the notice to appear as the complainant and deliver the original plus one copy to the clerk of the court. The clerk shall verify or insert the date the case has been set for hearing before the court. The clerk shall mail the copy by certified mail to the person named in the notice to appear at that person's last known address.

- (c) *Abatement by county; costs assessed to person responsible.* If the occupant, owner, or person in charge of the property for which a warning notice has been given fails to remove or abate the violation in the time specified in the notice, whether on public or private property, the administrator or designee may, if severe conditions exist that affect health, welfare, safety or severe environmental degradation, remove the violation and thereby abate the violation. If such conditions exist, the administrator or designee may lawfully enter upon the property on which the violation remains unabated to remove or abate such violation at the cost of the person responsible for creating or maintaining the violation. The violation will be subject to civil fines reflecting the cost to the county, as prosecuted by the county attorney.
- (d) *Payment of costs; special tax bill or judgment.* All costs and expenses incurred by the county in removing or abating any violation on any private property may be assessed against the property as a lien on the property. Alternatively, the cost of removing or abating the violation may be made part of the judgment by the judge, in addition to any other penalties and costs imposed if the person charged either pleads or is found guilty of causing, creating, or maintaining a violation.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-504. Penalty for violation.**

- (a) Enforcement of this article shall fall under the jurisdiction of both the Beaufort County Public Works Department and Beaufort County Codes Enforcement. Officers and inspectors shall have the authority to exercise full discretion in deciding whether to issue a notice of violation, stop work order, or fine when investigating complaints that arise under this article.
- (b) Any person, group, firm, association, or corporation violating any section of this chapter, or the requirements of an approved Beaufort County Stormwater Permit, shall be guilty of a misdemeanor and, upon conviction thereof, shall pay such penalties as the court may decide, as prescribed by state law, not to exceed \$1000.00 or 30 days' imprisonment for each violation. Each day during which such conduct shall continue shall subject the offender to the liability prescribed in this article.
- (c) In addition to the penalties established and authorized in subsection (a) of this section, the county attorney may take other actions at law or in equity as may be required to halt, terminate, remove, or otherwise eliminate any violations of this chapter.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-505. Interpretation.**

- (a) *Meaning and intent.* All provisions, terms, phrases, and expressions contained in this article shall be construed according to the general and specific purposes set forth in section 99-202, purpose. If a different or more specific meaning is given for a term defined elsewhere in county's Code of Ordinances or in an existing development agreement, the meaning and application of the term in this article shall control for purposes of application of this article.
- (b) *Text controls in event of conflict.* In the event of a conflict or inconsistency between the text of this article and any heading, caption, figure, illustration, table, or map, the text shall control.
- (c) *Authority for interpretation.* The administrators have, after consultation with county attorney, authority to determine the interpretation of this article. Any person may request an interpretation by submitting a written request to the administrators who shall respond in writing within 30 days. The administrators shall keep on file a record of all written interpretations of this article.

- (d) *References to statutes, regulations, and documents.* Whenever reference is made to a resolution, article, statute, regulation, manual (including the most current version of the Southern Lowcountry Stormwater Design Manual), or document, it shall be construed as a reference to the most recent edition of such that has been finalized and published with due provision for notice and comment, unless otherwise specifically stated.
- (e) *Delegation of authority.* Any act authorized by this article to be carried out by the county administrator may be carried out by his or her designee.
- (f) *Usage.*
- (1) *Mandatory and discretionary terms.* The words "shall," "must," and "will" are mandatory in nature, establishing an obligation or duty to comply with the particular provision. The words "may" and "should" are permissive in nature.
  - (2) *Conjunctions.* Unless the context clearly indicates the contrary, conjunctions shall be interpreted as follows: The word "and" indicates that all connected items, conditions, provisions or events apply. The word "or" indicates that one or more of the connected items, conditions, provisions or events apply.
  - (3) *Tense, plurals, and gender words used in the present tense include the future tense.* Words used in the singular number include the plural number and the plural number includes the singular number, unless the context of the particular usage clearly indicates otherwise. Words used in the masculine gender include the feminine gender, and vice versa.
- (g) *Measurement and computation.* Lot area refers to the amount of horizontal land area contained inside the lot lines of a lot or site.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-506. Conflict of laws.**

This article is not intended to modify or repeal any other ordinance, rule, regulation or other provision of law. The requirements of this article are in addition to the requirements of any other ordinance, rule, regulation or other provision of law, and where any provision of this article imposes restrictions different from those imposed by any other ordinance, rule, regulation or other provision of law, whichever provision is more restrictive or imposes higher protective standards for human or environmental health, safety, and welfare, shall control.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-507. Severability.**

If the provisions of any section, subsection, paragraph, subdivision or clause of this article shall be adjudged invalid by a court of competent jurisdiction, such judgment shall not affect or invalidate the remainder of any section, subsection, paragraph, subdivision or clause of this article.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

## Appendix B: Infiltration Testing and Geotechnical Requirements

### Table of Contents

B.1	General Notes Pertinent to All Geotechnical Testing .....	1
B.2	Initial Feasibility Assessment .....	2
B.3	Test Pit/Boring Requirements for Infiltration Tests.....	2
B.4	Infiltration Testing Requirements .....	3
B.5	Saturated Hydraulic Conductivity Calculations.....	4
B.6	Infiltration Restrictions .....	5

### B.1 General Notes Pertinent to All Geotechnical Testing

A geotechnical report may be required for all underground stormwater best management practices (BMPs), including infiltration-based practices, filtering systems, and storage practices, as well as stormwater ponds and wetlands. The following must be taken into account when producing this report.

- Testing is to be conducted at the direction of a qualified professional. This professional shall either be a registered professional engineer, soils scientist, or geologist and must be licensed in the State.
- Soil boring or test pit information is to be obtained from at least one location on the site. Additional borings or test pits are required within the proposed BMP facility under three conditions: (1) when the soils or slopes vary appreciably from the findings in the initial boring or test pit, (2) when the groundwater level is found to be significantly higher than the initial boring or test pit indicated, and (3) when the groundwater level may adversely affect the performance of the proposed BMP facilities. However, the location, number, and depth of borings or test pits shall be determined by a qualified professional, and be sufficient to accurately characterize the site soil conditions.
- Log any indications of water saturation to include both perched and groundwater table levels; include descriptions of soils that are mottled or gleyed. Depth to the groundwater table (with 24-hour readings) must be included in the boring logs/geotechnical report.
- Laboratory testing must include grain size analysis. Additional tests such as liquid limit and plastic limit tests, consolidation tests, shear tests and permeability tests may be necessary where foundation soils or slopes are potentially unstable based on the discretion of the qualified professional.
- The geotechnical report must include soil descriptions from each boring or test pit, and the laboratory test results for grain size. Based upon the proposed development, the geotechnical report may also include evaluation of settlement, bearing capacity and slope stability of soils supporting the proposed structures.
- All soil profile descriptions should provide enough detail to identify the boundary and elevations of any problem (boundary/restrictions) conditions such as fills and seepage zones, type and depth of rock, etc.

In addition to the testing requirements described above, infiltration tests must be performed for all BMPs in which infiltration will be relied upon, including permeable pavement systems, bioretention, infiltration, and dry swales. Specific requirements for infiltration testing are discussed below.

## B.2 Initial Feasibility Assessment

The feasibility assessment is conducted to determine whether full-scale infiltration testing is necessary, screen unsuitable sites, and reduce testing costs. However, a designer or landowner may opt to skip the initial feasibility assessment at his or her discretion and begin with soil borings.

The initial feasibility assessment typically involves existing data, such as the following:

- On-site septic percolation testing, which can establish historic percolation rates, water table, and/or depth to bedrock. Percolation tests are different than tests for coefficient of permeability or infiltration rate;
- Previous geotechnical reports prepared for the site or adjacent properties; or
- Natural Resources Conservation Service (NRCS) Soil Mapping.

If the results of initial feasibility assessment show that a suitable infiltration rate (typically greater than 0.5 inches per hour) is possible or probable, then test pits must be dug or soil borings drilled to determine the saturated hydraulic conductivity ( $K_{sat}$ ).

## B.3 Test Pit/Boring Requirements for Infiltration Tests

- Excavate a test pit or drill a standard soil boring to a depth of 2 feet below the proposed BMP bottom.
- Do not construct, maintain or abandon a well in a manner that may create a point source or non-point source of pollutants to waters of the State, impair the beneficial uses of waters of the State, or pose a hazard to public health and safety or the environment.
- Determine depth to groundwater table if within 2 feet of proposed bottom.
- Determine Unified Soil Classification System (USCS) and/or United States Department of Agriculture (USDA) textures at the proposed bottom to 2 feet below the bottom of the BMP.
- Determine depth to bedrock (if within 2 feet of proposed bottom).
- Include the soil description in all soil horizons. Perform the infiltration test at the proposed bottom of the practice. If any of the soil horizons below the proposed bottom of the infiltration practice (within 2 feet) appear to be a confining layer, additional infiltration tests must be performed on this layer (or layers), following the procedure described below.
- The location of the test pits or borings shall correspond to the BMP locations; a map or plan that clearly and accurately indicates the locations(s) of the test pits or soil borings must be provided with the geotechnical report.

Table 1 indicates the number of test pits or soil borings and subsequent infiltration tests that must be performed per BMP. In cases where multiple BMPs are proposed in 1 area with generally uniform conditions, a circular shape that fully encompasses all of the BMPs may be substituted for the “area of practice” that determines the number of required infiltration tests.



Table 1. Number of Infiltration Tests Required per BMP.

Area of Practice (ft <sup>2</sup> )	Minimum Number of Test Pits/Soil Borings
< 1,000	1
1,000–1,999	2
2,000–9,999	3
≥ 10,000	Add 1 test pit/soil boring for each additional 10,000 ft <sup>2</sup> of BMP.

When one test pit or boring is required, it must be located as near to the testing area as possible. When more than one test pit or boring is necessary for a single BMP or area, the pit or boring locations must be equally spaced throughout the proposed area, as directed by the qualified professional. The reported saturated hydraulic conductivity for a BMP shall be the median or geometric mean (area-weighted average) of the observed results from the soil boring/test pit locations.

## B.4 Infiltration Testing Requirements

The following tests are acceptable for use in determining soil infiltration rates. The geotechnical report shall include a detailed description of the test method and published source references:

- 1) Constant Head Bore-Hole Infiltration Tests (also referred to as bore-hole permeameter tests and constant-head well permeameter tests). These types of tests determine saturated hydraulic conductivity (coefficient of permeability) by measuring the rate of water flow to a borehole. Analytical solutions utilize principles of Darcy's Law, borehole geometry, and head (or multiple heads) of water in determining saturated hydraulic characteristics. Where the soil characteristics meet all of the above described requirements for infiltration BMPs, the hydraulic gradient element of Darcy's Law is often estimated as 1 for determining infiltration rate.

One published standard developed by the United States Bureau of Reclamation for this method is USBR 7300-89. Some of the commercially available equipment is listed below:

- Aardvark Permeameter
  - Amoozemeter
  - Guelph Permeameter
  - Johnson Permeameter
- 2) Testing Requirements for Infiltration, Bioretention, and Sand Filter Subsoils, as modified below. The data obtained from this infiltration testing procedure shall be used to calculate the saturated hydraulic conductivity (see Section B.5 Saturated Hydraulic Conductivity Calculations).
    - a. Install solid casing in the boring or test pit to the proposed BMP bottom or other required test depth (i.e. confining layer encountered within 2 feet below the BMP bottom). When installing casing, drive the casing between 3 to 5 inches below the test surface to promote a good casing-to-soil seal.
    - b. Remove any smeared, soiled surfaces, and provide a natural soil interface into which water may infiltrate. Remove all loose material from the casing. At the tester's/registered professional's discretion, a 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scouring and sediment. Fill the casing with clean, potable water 24 inches above the test surface (24 inches of head), and allow to presoak for 24 hours.

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- c. Protect the open borehole with suitable cover such as a sanitary well cap and steel plate with surrounding sandbags to prevent the introduction of surface water runoff, trash, debris, and other pollutants.
- d. Twenty-four hours later, refill the casing with approximately 24 inches of clean water (24 inches of head), and monitor the water level for 1 hour, recording the depth of water at the beginning and end of the test.
- e. Repeat step 4 (filling the casing each time) three additional times, for a total of four observations. At the registered professional's discretion, the saturated hydraulic conductivity calculations may be performed based on the values recorded during the average of the four readings or the last observation. The testing interval can be increased at the discretion of the registered professional.

All soil borings and test pits shall be properly backfilled after conclusion of the tests. A person shall not construct, maintain or abandon a well in a manner that may create a point source or non-point source of pollutants to waters of the State, impair the beneficial uses of waters of the State, or pose a hazard to public health and safety or the environment. To prevent a soil boring from becoming a conduit for stormwater or other contaminants to enter groundwater and create a low-permeability seal against vertical fluid migration, follow these steps:

- 1) Use a positive displacement technique, inject a sodium-based bentonite slurry through a tremie pipe at least 1 inch in diameter starting at the bottom of the borehole. The slurry shall be composed of 2 pounds of sodium-based bentonite powder to 1 gallon of water.
- 2) If the borehole is too narrow to accommodate a tremie pipe or the borehole is less than 10 feet deep, slowly place uncoated, medium-sized, sodium-based bentonite chips in the borehole to create a 2-foot lift of chips measured from the bottom of the borehole.
- 3) Tamp down the bentonite chips to prevent bridging.
- 4) Using a ratio of 1 gallon of water to 12.5 pounds of bentonite chips, add potable water to the borehole and allow 15 to 30 minutes to elapse to ensure proper hydration of the bentonite chips.
- 5) Adjust these instructions as necessary in accordance with the manufacturer's instructions, providing that the resulting seal will have an effective hydraulic conductivity of no more than  $1 \times 10^{-7}$  cm/s.
- 6) The process should be repeated until the boring is filled 1 to 2 feet from the ground surface.
- 7) The remainder of the borehole should be backfilled with material to match the surrounding cover and must not include the use of a coal-tar product.

Further details are provided in SCDHEC Regulations R.61-71, Well Standards.

Note: If the infiltration testing procedure reveals smells or visual indications of soil or groundwater contamination then the boring or test hole must be filled in accordance with wellhead protection best practices, unless laboratory analysis determines groundwater or soil is not contaminated.

## **B.5 Saturated Hydraulic Conductivity Calculations**

To convert the field infiltration measurements to a saturated hydraulic conductivity value ( $K_{sat}$ ), the following calculations must be performed.

$$K_{ssss} = \frac{\pi \pi \pi \pi}{11(t_2 - t_1)} \times \ln\left(\frac{H_1}{H_2}\right)$$

where:

- $K_{sat}$  = saturated hydraulic conductivity (in/hr)
- $D$  = casing diameter (in) (minimum 4 inches)
- $t_2$  = recorded end time of test (hr)
- $t_1$  = recorded beginning time of test (hr)
- $H_1$  = head in casing measured at time  $t_1$  (ft)
- $H_2$  = head in casing measured at time  $t_2$  (ft)

This equation was adapted by the U.S. Bureau of Reclamation in 1975 from Lambe and Whitman, 1969.

## B.6 Infiltration Restrictions

If a Phase I Environmental Site Assessment identifies a Recognized Environmental Concern at a site indicating that site contamination is likely or present; or if DHEC is aware of upgradient or downgradient contaminant plumes, the presence of a brownfield or historic hotspot use, such as any of the following current or previous uses, then an impermeable liner must be used for BMPs, and infiltration is prohibited.

- Leaking underground storage tank (LUST),
- Above ground storage tanks (AST),
- Gas stations,
- Vehicle maintenance or repair facility,
- Dry cleaner,
- Transformer sub-station,
- Waste transfer or holding facility,
- Print shop,
- Chemical storage warehouse,
- Illicit hazardous wastes generator,
- Greenhouse with unlined floor,
- Septic system,
- Cement or asphalt plant, or
- Dump or landfill.

If an ASTM Phase II Environmental Site Assessment is performed based on a DHEC-approved workplan and DHEC reviews the results and determines that stormwater infiltration BMPs may impact on-site contamination by the following means, then an impermeable liner must be used for BMPs, and infiltration is prohibited.

- Spreading of contamination vertically or horizontally at the site,
- Increasing on-site groundwater contamination by leaching contaminants from the soil,

(Supp. No. 45)



- Causing or enhancing contaminant migration to go offsite,
- Interfering with contaminant remedial activities,
- Decreasing or reversing the natural degradation of contaminants, or
- Causing a pollutant discharge to a surface water body.

If DHEC concludes there is no evidence of a Recognized Environmental Concern based on ASTM Phase I and II Environmental Site, and there is no current site use that could result in the foreseeable creation of a Recognized Environmental Concern, then impermeable liners are not required, and infiltration is not restricted.

B6

## Appendix C: Soil Compost Amendment Requirements

### Table of Contents

C.1	Introduction .....	1
C.2	Physical Feasibility and Design Applications .....	1
C.3	Design Criteria.....	2
C.3.1	Performance.....	2
C.3.2	Soil Testing .....	2
C.3.3	Determining Depth of Compost Incorporation .....	2
C.3.4	Compost Specifications.....	3
C.4	Construction Sequence .....	4
C.5	Maintenance .....	4
C.5.1	First-Year Maintenance Operations.....	4
C.5.2	Ongoing Maintenance.....	4
C.5.3	Maintenance Agreement .....	5
C.6	References .....	<b>Error! Bookmark not defined.</b>

### C.1 Introduction

Soil amendment (also called soil restoration) is a technique applied after construction to deeply till compacted soils and restore their porosity by amending them with compost. These soil amendments can be used to enhance the performance of impervious cover disconnections and grass channels.

### C.2 Physical Feasibility and Design Applications

Amended soils are suitable for any pervious area where soils have been or will be compacted by the grading and construction process. They are particularly well suited when existing soils have low infiltration rates (HSG C and D) and when the pervious area will be used to filter runoff (downspout disconnections and grass channels). The area or strip of amended soils should be hydraulically connected to the stormwater conveyance system. Soil restoration is recommended for sites that will experience mass grading of more than a foot of cut and fill across the site.

Compost amendments are not recommended where any of the following exists:

- Existing soils have high infiltration rates (e.g., HSG A and B), although compost amendments may be needed at mass-graded B soils in order to maintain infiltration rates.
- The water table or bedrock is located within 1.5 feet of the soil surface.
- Slopes exceed 10% (compost can be used on slopes exceeding 10% as long as proper soil erosion and sediment control measures are included in the plan).
- Existing soils are saturated or seasonally wet.
- They would harm roots of existing trees (keep amendments outside the tree dripline).
- The downhill slope runs toward an existing or proposed building foundation.

(Supp. No. 45)

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- Areas that will be used for snow storage.

### C.3 Design Criteria

#### C.3.1 Performance

When Used in Conjunction with Other Practices. As referenced in several of the Chapter 4 Stormwater Best Management Practices (BMPs) specifications, soil compost amendments can be used to enhance the performance of allied practices by improving runoff infiltration. The specifications for each of these practices contain design criteria for how compost amendments can be incorporated into those designs:

- Impermeable Surface Disconnection – See Section 4.6 Impervious Surface Disconnection.
- Grass Channels – See Section 4.7 Open Channel Systems.

#### C.3.2 Soil Testing

Soil tests are required during two stages of the compost amendment process. The first testing is done to ascertain preconstruction soil properties at proposed amendment areas. The initial testing is used to determine soil properties to a depth 1 foot below the proposed amendment area, with respect to bulk density, pH, salts, and soil nutrients. These tests should be conducted every 5,000 square feet and are used to characterize potential drainage problems and determine what, if any, further soil amendments are needed.

The second soil test is taken at least 1 week after the compost has been incorporated into the soils. This soil analysis should be conducted by a reputable laboratory to determine whether any further nutritional requirements, pH adjustment, and organic matter adjustments are necessary for plant growth. This soil analysis must be done in conjunction with the final construction inspection to ensure tilling or subsoiling has achieved design depths.

#### C.3.3 Determining Depth of Compost Incorporation

The depth of compost amendment is based on the relationship of the surface area of the soil amendment to the contributing area of impervious cover that it receives. Table C.1 presents some general guidance derived from soil modeling by Holman-Dodds (2004) that evaluates the required depth to which compost must be incorporated. Some adjustments to the recommended incorporation depth were made to reflect alternative recommendations of Roa Espinosa (2006), Balousek (2003), Chollak and Rosenfeld (1998), and others.

Table 1 indicates the number of test pits or soil borings and subsequent infiltration tests that must be performed per BMP. In cases where multiple BMPs are proposed in 1 area with generally uniform conditions, a circular shape that fully encompasses all of the BMPs may be substituted for the “area of practice” that determines the number of required infiltration tests.

Table 1. Method to Determine Compost and Incorporation Depths.

Ratio of Area of Contributing Impervious Cover to Soil Amendment <sup>a</sup> (IC/SA)	Compost Depth <sup>b</sup> (in.)	Incorporation Depth (in.)	Incorporation Method
0.5	3 <sup>c</sup>	12 <sup>c</sup>	Tiller
0.75	4 <sup>c</sup>	18 <sup>c</sup>	Subsoiler
1.0 <sup>d</sup>	6 <sup>c</sup>	24 <sup>c</sup>	Subsoiler

<sup>a</sup>IC = contrib. impervious cover (ft<sup>2</sup>) and SA = surface area of compost amendment (ft<sup>2</sup>)

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

<sup>b</sup> Average depth of compost added

<sup>c</sup> Lower end for B soils, higher end for C/D soils

<sup>d</sup> In general, IC/SA ratios greater than 1 should be avoided

Once the area and depth of the compost amendments are known, the designer can estimate the total amount of compost needed, using an estimator developed by TCC, (1997):

$$CC = AA \times DD \times 0.0031$$

where:

- $C$  = compost needed (yd<sup>3</sup>)
- $A$  = area of soil amended (ft<sup>2</sup>)
- $D$  = depth of compost added (in)

### C.3.4 Compost Specifications

The basic material specifications for compost amendments are outlined below:

- Compost shall be derived from plant material and provided by a member of the U.S. Composting Seal of Testing Assurance (STA) program. See <https://compostingcouncil.org/> for a list of local providers.
- Alternative specifications and/or certifications, such as Clemson University or the US Department of Agriculture, may be substituted, as authorized by *<local jurisdiction>*. In all cases, compost material must meet standards for chemical contamination and pathogen limits pertaining to source materials, as well as reasonable limits on phosphorus and nitrogen content to avoid excessive leaching of nutrients.
- The compost shall be the result of the biological degradation and transformation of plant-derived materials under conditions that promote anaerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have a moisture content that has no visible free water or dust produced when handling the material. It shall meet the following criteria, as reported by the U.S. Composting Council STA Compost Technical Data Sheet provided by the vendor:
  - a. 100% of the material must pass through a half-inch screen
  - b. The pH of the material shall be between 6 and 8
  - c. Manufactured inlet material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight
  - d. The organic matter shall be between 35%–65%
  - e. Soluble salt content shall be less than 6.0 mmhos/cm
  - f. Maturity must be greater than 80%
  - g. Stability shall be 7 or less
  - h. Carbon/nitrogen ratio shall be less than 25:1
  - i. Trace metal test result must equal “pass”
  - j. The compost must have a dry bulk density ranging from 40–50 lb/ft<sup>3</sup>

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## C.4 Construction Sequence

The construction sequence for compost amendments differs depending whether the practice will be applied to a large area or a narrow filter strip, such as in a rooftop disconnection or grass channel. For larger areas, a typical construction sequence is as follows:

- 1) **Soil Erosion and Sediment Control.** When areas of compost amendments exceed 2,500 square feet install soil erosion and sediment control measures, such as silt fences, are required to secure the area until the surface is stabilized by vegetation.
- 2) **Deep Till.** Deep till to a depth of 12 to 18 inches after the final building lots have been graded prior to the addition of compost.
- 3) **Dry Conditions.** Wait for dry conditions at the site prior to incorporating compost.
- 4) **Compost.** Incorporate the required compost depth (as indicated in Table 1) into the tilled soil using the appropriate equipment. Level the site. Seeds or sod are required to establish a vigorous grass cover. To help the grass grow quickly, lime or irrigation is recommended.
- 5) **Vegetation.** Ensure surface area is stabilized with vegetation.
- 6) **Construction Inspection.** Construction inspection by a qualified professional involves digging a test pit to verify the depth of amended soil and scarification. A rod penetrometer should be used to establish the depth of uncompacted soil at a minimum of 1 location per 10,000 square feet.

## C.5 Maintenance

### C.5.1 First-Year Maintenance Operations

In order to ensure the success of soil compost amendments, the following tasks must be undertaken in the first year following soil restoration:

- **Initial inspections.** For the first 6 months following the incorporation of soil amendments, the site should be inspected by a qualified professional at least once after each storm event that exceeds 1/2-inch of rainfall.
- **Spot Reseeding.** Inspectors should look for bare or eroding areas in the contributing drainage area (CDA) or around the soil restoration area and make sure they are immediately stabilized with grass cover.
- **Fertilization.** Depending on the amended soils test, a one-time, spot fertilization may be needed in the fall after the first growing season to increase plant vigor.
- **Watering.** Water once every 3 days for the first month, and then weekly during the first year (April through October), depending on rainfall.

### C.5.2 Ongoing Maintenance

There are no major ongoing maintenance needs associated with soil compost amendments, although the owners may want to de-thatch the turf every few years to increase permeability. The owner should also be aware that there are maintenance tasks needed for filter strips, grass channels, and reforestation areas. The maintenance inspection checklist for an area of Soil Compost Amendments can be accessed in Appendix F Maintenance Inspection Forms.

### C.5.3 Maintenance Agreement

A Maintenance Agreement that includes all maintenance responsibilities to ensure the continued stormwater performance for the BMP is required. The Maintenance Agreement specifies the property owner's primary maintenance responsibilities and authorizes the Beaufort County Public Works staff to access the property for inspection or corrective action in the event the proper maintenance is not performed. The Maintenance Agreement is attached to the deed of the property as attached to the land. It is to be recorded in the Register of Deeds in the County office. Maintenance responsibilities on government properties must be defined through a partnership agreement or a memorandum of understanding.

C5

## Appendix D: Conceptual Design Checklist

### D.1 Design Checklist

This checklist serves as a guide for the consultant in the preparation and for the reviewer in the evaluation of a Stormwater Management Plan (SWMP). Any questions regarding items contained herein should be referred to the *Beaufort County Public Works Department*. Applicable page number or section in the Southern Lowcountry Stormwater Design Manual is included for reference.

**NOTE: PLANS SUBMITTED WITHOUT A COMPLETED CHECKLIST MAY BE RETURNED WITHOUT REVIEW**

Site/Project Name: _____	Date: _____
Consultant: _____	Applicant: _____
Phone Number: _____	Phone Number: _____
Email Address: _____	Email Address: _____

☐ Conceptual Plan or ☐ Final Plan

*Consultant: Please complete the checklist below. A box in the Conceptual or Final checklist columns indicates the item is required for a complete application submittal.*

	Conceptual	Final
<b>A. Narrative Information</b>		
1. Cover Sheet with Project Name, Engineer's Contact Information, Developer's Contact Information, Contractors Contact Information. Information required: Name, mailing address, telephone, email.	Δ	Δ
2. Site development plan and stormwater management narrative	Δ	Δ
3. Assess potential application of green infrastructure practices in the form of better site planning and design techniques. Low impact development practice should be used to the maximum extent practicable during the creation of a stormwater management concept plan. A demonstration of better site planning is required. The following site information and practices shall be considered: <ul style="list-style-type: none"> <li>a. Soil type (from Soil Study);</li> <li>b. Depth of ground water on site;</li> <li>c. Whether the type of development proposed is a hotspot as defined by the Ordinance and Design Manual and address how this influences the concept proposal;</li> <li>d. Protection of primary and secondary conservation areas;</li> <li>e. Reduced clearing and grading limits;</li> <li>f. Reduced roadway lengths and widths;</li> <li>g. Reduced parking lot and building footprints to minimize impervious surface;</li> <li>h. Soil restoration;</li> <li>i. Site reforestation/revegetation;</li> <li>j. Impervious area disconnection;</li> </ul>	Δ	

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(Supp. No. 45)

k. Green roof; and l. Permeable pavement		
4. Stormwater Pollution Prevention Plan (SWPPP) or Erosion and Sediment Control narrative (for projects disturbing over an acre)	Δ	Δ
5. Information regarding the mitigation of any off-site impacts anticipated as a result of the proposed development. Not applicable for all projects.		Δ
6. Construction specifications	Δ	Δ
<b>B. Site Plan</b>		
1. Standard drawing size (24 x 36 inches)	Δ	Δ
2. A plan showing property boundaries and the complete address of the property	Δ	Δ
3. Lot number or property identification number designation (if applicable)	Δ	Δ
4. Property lines (include longitude and latitude)	Δ	Δ
5. Location of easements (if applicable)		Δ
6. A legend identifying all symbols used on the plan	Δ	Δ
7. Location and size of existing and proposed utilities (including gas lines, sanitary lines, telephone lines or poles, electric utilities and water mains), structures, roads, and other paved areas		Δ
8. Existing and proposed topographic contours	Δ	Δ
9. Show drainage patterns, property ridge line(s) and building finish elevation on the grading plan.		Δ
10. Material and equipment staging areas	Δ	Δ
11. Clearly note on plans: <ul style="list-style-type: none"> <li>- A right-of-way permit shall be obtained prior to performing construction activity in the right-of-way</li> <li>- Chlorinated disinfected water shall not be discharged into the stormwater system</li> <li>- Call before you dig note and number</li> </ul>		Δ
12. Soil information for design purposes	Δ	Δ
13. Area(s) of soil disturbance	Δ	Δ
14. Site drainage area(s) (SDAs) within the limits of disturbance (LOD) and contributing to the LOD		Δ
15. Contributing drainage area (CDA) to each BMP		Δ
16. Location(s) of BMPs, marked with the BMP ID Numbers to agree with the BMP design summary list		Δ
17. Delineation of existing and proposed land covers including natural cover, compacted cover, and impervious surfaces.	Δ	Δ

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

D2

18. Site fingerprint map of the location of existing stream(s), wetlands, or other natural features within the project area; tree and vegetation survey; and preservation area(s)	△	△
19. All plans and profiles must be drawn at a scale of 1 in. = 10 ft, 1 in. = 20 ft, 1 in. = 30 ft, 1 in. = 40 ft, 1 in. = 50 ft, or 1 in. = 100 ft. Although, 1 in. = 10 ft, 1 in. = 20 ft, and 1 in. = 30 ft, are the most commonly used scales. Vertical scale for profiles must be 1 in. = 2 ft, 1 in. = 4 ft, 1 in. = 5 ft, or 1 in. = 10 ft	△	△
20. Drafting media that yield first- or second-generation, reproducible drawings with a minimum letter size of No. 4 (1/8 inch)	△	△
21. Applicable flood boundaries and FEMA map identification number for sites lying wholly or partially within the 100-year floodplain (if applicable)	△	△
<b>C. Design and As-Built Certification</b>		
1. Statement and seal by a registered professional engineer licensed in the State of South Carolina that the site design, land covers, and design of the BMPs conform to engineering principles applicable to the treatment and disposal of stormwater pollutants		△
2. Submission one set of the As-Built drawings sealed by a registered professional engineer licensed in the State of South Carolina within 21 days after completion of construction of the site, all BMPs, land covers, and stormwater conveyances. *Comes at close out*		△
3. For a project consisting entirely of work in the public right-of-way (PROW), the submission of a Record Drawing certified by an officer of the project contracting company is acceptable if it details the as-built construction of the BMP and related stormwater infrastructure.		△
<b>D. Maintenance of Stormwater BMPs</b>		
1. BMP maintenance access easements shall not be located on pipe easements.		△
2. A minimum 20' wide maintenance access easement is provided around stormwater detention ponds and from publicly accessible road has been provided.		△
3. A maintenance plan that identifies routine and long-term maintenance needs and a maintenance schedule		△
4. For regulated projects, a maintenance agreement stating the owner's specific maintenance responsibilities identified in the maintenance plan and maintenance schedule. These must be exhibits recorded with the property deed at the Recorder of Deeds.		△
5. For applicants using Rainwater Harvesting, submission of third-party testing of end-use water quality may be required at equipment commissioning.		△
<b>E. Stormwater Retention Volume Computations</b>		

1. Calculation(s) of the required SWRv for the entire site within the LOD and each SDA within the LOD		△
2. Calculation(s) for each proposed BMP demonstrating retention value towards SWRv in accordance with Chapters 2 and 4 Stormwater Best Management Practices (BMPs)		△
3. For Rainwater Harvesting BMP, calculations demonstrating the annual water balance as determined using the Rainwater Harvesting Retention Calculator		△
4. For proprietary and non-proprietary BMPs outside Chapter 4, complete documentation defined in Chapter 4.15		△
5. Document off-site stormwater volume where required.		△
6. Document the 8-steps of the MEP process in Chapter 3.8.		△
7. Compliance Calculator sheets identifying that proposed BMP(s) meet standards for water quality		△
<b>F. Pre/Post-Development Hydrologic Computations</b>		
1. A summary of soil conditions and field data		△
2. Pre- and post-project curve number summary table		△
3. Pre and post construction peak flow summary table for the 2, 10, 25, 50 and the 100-year 24-hour storm events for each SDA within the project's LOD		△
4. Flow control structure elevations		△
<b>G. Hydraulic Computations</b>		
1. Existing and proposed SDA must be delineated on separate plans with the flow paths used for calculation of the times of concentration		△
2. Hydraulic capacity and flow velocity for drainage conveyances, including ditches, swales, pipes, inlets.		△
3. Plan profiles for all open conveyances and pipelines, with energy (kinetic) and hydraulic gradients for the 25-year and 100-year, 24-hour storms		△
4. The proposed development layout including the following:		△
a) Location and design of BMP(s) on site, marked with the BMP ID Numbers		△
b) A list of design assumptions (e.g., design basis, 2 through 25-year return periods)		△
c) The boundary of the CDA to the BMP		△
d) Schedule of structures (a listing of the structures, details, or elevations including inverts)		△
e) Manhole to manhole listing of pipe size, pipe type, slope, computed velocity, and computed flow rate (i.e., a storm drain pipe schedule		△
5. Demonstrate downstream conveyance system capacity for the development.	Created: 2021-07-22 09:11:36 [EST]	△

(Supp. No. 45)

D4

<b>H. Erosion and Sediment Control Plans</b>		
1. Provide erosion and sediment control drawings and detail sheets required by the CSWPPP	Δ	Δ
2. Show dewatering setup to ensure no negative off-site impacts result from the discharge	Δ	Δ
3. Provide erosion and sediment control inspection forms required by the CSWPPP		Δ
<b>I. Supporting Documentation (written report)</b>		
1. Pre- and Post-development curve number selection		Δ
2. Time of concentration calculation		Δ
3. Travel time calculation		Δ
4. Hydrologic computations supporting peak discharges assumed for each SDA within the project's LOD for the 2-, 10-, 25-, and 50-year, 24-hour storm events		Δ
5. Provide downstream and surrounding neighborhood area analysis to identify any existing capacity shortfalls or flooding based on the 10% rule.		Δ
6. SCDHEC's Construction Stormwater Pollution Prevention Plan (C-SWPPP)		Δ

The engineering features of all stormwater best management practices (BMPs), stormwater infrastructure, and land covers (collectively the "Facility") have been designed/examined by me and found to be in conformity with the standard of care applicable to the treatment and disposal of stormwater pollutants. The Facility has been designed in accordance with the specification required under Chapter 99 of the Beaufort County Ordinance.

Seal	Signed	Date	
License Number:		Expiration Date:	

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)





**Infiltration/Filtration/Bioretention/Dry Swale Practice  
Maintenance Inspection Checklist**

Item 6.

**Party Responsible for Maintenance:** \_\_\_\_\_

**Practice ID:** \_\_\_\_\_

**Contact:** \_\_\_\_\_

**Location:** \_\_\_\_\_

**Phone Number:** \_\_\_\_\_

**GPS Coordinates:** \_\_\_\_\_

**E-mail:** \_\_\_\_\_

**Inspector(s):** \_\_\_\_\_ **Mailing Address:** \_\_\_\_\_

**Date:** \_\_\_\_\_ **Time:** \_\_\_\_\_

<b>Key Questions</b>		
<b>Item</b>	<b>X</b>	<b>Comments</b>
<b>1. Type of practice (check all that apply)</b>		
a. Bioretention	<input type="checkbox"/>	
b. Dry Swale	<input type="checkbox"/>	
d. Residential Rain Garden	<input type="checkbox"/>	
e. Infiltration Practice	<input type="checkbox"/>	
f. Filtration Practice	<input type="checkbox"/>	
<b>2. For Bioretention</b>		
a. Standard Design	<input type="checkbox"/>	
b. Enhanced Design	<input type="checkbox"/>	
<b>3. Practice Location</b>		
a. Open to Surface	<input type="checkbox"/>	
b. Underground	<input type="checkbox"/>	
<b>4. Filtration Media</b>		
a. No filtration media (e.g., stone reservoir only)	<input type="checkbox"/>	
b. Sand	<input type="checkbox"/>	
c. Bioretention Soil Mix	<input type="checkbox"/>	
d. Peat	<input type="checkbox"/>	
e. Other	<input type="checkbox"/>	
<b>5. Hydraulic configuration</b>		
a. On-line	<input type="checkbox"/>	
b. Off-line	<input type="checkbox"/>	
<b>6. Type of pretreatment</b>		
a. Separate pretreatment cell	<input type="checkbox"/>	
b. Sedimentation chamber/manhole	<input type="checkbox"/>	
c. Grass channel	<input type="checkbox"/>	
d. Grass filter strip	<input type="checkbox"/>	
e. Gravel or stone flow spreader	<input type="checkbox"/>	
f. Gravel diaphragm	<input type="checkbox"/>	
g. Other	<input type="checkbox"/>	Type of pretreatment:
<b>7. If designed for infiltration (i.e., no underdrain OR infiltration sump below underdrain):</b>		
a. Soil boring logs and infiltration testing report provided	<input type="checkbox"/>	
b. Field-measured infiltration rate of at least 0.5 in/hr (preferred 1-4 in/hr)	<input type="checkbox"/>	Field-measured rate:

**A. Contributing Drainage Area**

0 = Good condition. Well maintained, no action required.

(Supp. No. 45)



**Infiltration/Filtration/Bioretention/Dry Swale Practice  
Maintenance Inspection Checklist**

1 = Moderate condition. Adequately maintained, routine maintenance needed.  
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected									
<input type="checkbox"/>	Not Inspected									
		Item						Comments		
1.		Excessive trash/debris	0	1	2	3	N/A			
2.		Bare/exposed soil	0	1	2	3	N/A			
3.		Evidence of erosion	0	1	2	3	N/A			
4.		Excessive landscape waste/yard clippings	0	1	2	3	N/A			

**B. Pretreatment**

0 = Good condition. Well maintained, no action required.  
1 = Moderate condition. Adequately maintained, routine maintenance needed.  
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected									
<input type="checkbox"/>	Not Inspected									
		Item						Comments		
1.		Maintenance access to pretreatment facility	0	1	2	3	N/A			
2.		Excessive trash/debris/sediment	0	1	2	3	N/A			
3.		Evidence of standing water	0	1	2	3	N/A			
		a. Ponding	<input type="checkbox"/>							
		b. Noticeable odors	<input type="checkbox"/>							
		c. Water stains	<input type="checkbox"/>							
		d. Presence of algae or floating aquatic vegetation	<input type="checkbox"/>							
4.		Evidence of clogging	0	1	2	3	N/A			
5.		Dead vegetation/exposed soil	0	1	2	3	N/A			
6.		Evidence of erosion	0	1	2	3	N/A			

**C. Inlets**

0 = Good condition. Well maintained, no action required.  
1 = Moderate condition. Adequately maintained, routine maintenance needed.  
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected									
<input type="checkbox"/>	Not Inspected									
		Item						Comments		
1.		Inlets provide stable conveyance into practice	0	1	2	3	N/A			
2.		Excessive trash/debris/sediment accumulation at inlet	0	1	2	3	N/A			
3.		Evidence of erosion at/around inlet	0	1	2	3	N/A			

**D. Practice**

(Supp. No. 45)



**Infiltration/Filtration/Bioretention/Dry Swale Practice  
Maintenance Inspection Checklist**

0 = Good condition. Well maintained, no action required.  
 1 = Moderate condition. Adequately maintained, routine maintenance needed.  
 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
 3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
Item		Comments				
1.	Maintenance access	0	1	2	3	N/A
2.	Condition of structural components	0	1	2	3	N/A
3.	Condition of hydraulic control components	0	1	2	3	N/A
4.	Excessive trash/debris/sediment	0	1	2	3	N/A
5.	Evidence of erosion	0	1	2	3	N/A
6.	Evidence of oil/chemical accumulation	0	1	2	3	N/A
7.	Evidence of standing water:	0	1	2	3	N/A
	a. Ponding	<input type="checkbox"/>				
	b. Noticeable odors	<input type="checkbox"/>				
	c. Water stains	<input type="checkbox"/>				
	d. Presence of algae or floating aquatic vegetation	<input type="checkbox"/>				
8.	Underdrain system (if equipped)	0	1	2	3	N/A
	a. Broken	<input type="checkbox"/>				
	b. Clogged	<input type="checkbox"/>				
9.	Vegetation	0	1	2	3	N/A
	a. Plant composition consistent with approved plans	<input type="checkbox"/>				
	b. Presence of invasive species/weeds	<input type="checkbox"/>				
	c. Dead vegetation/exposed soil	<input type="checkbox"/>				

**E. Outlets**

0 = Good condition. Well maintained, no action required.  
 1 = Moderate condition. Adequately maintained, routine maintenance needed.  
 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
 3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
Item		Comments				
1.	Outlets provide stable conveyance out of practice	0	1	2	3	N/A
2.	Excessive trash/debris/sediment accumulation at outlet	0	1	2	3	N/A
3.	Evidence of erosion at/around outlet	0	1	2	3	N/A
<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					

**F. Miscellaneous**

(Supp. No. 45)



**Infiltration/Filtration/Bioretention/Dry Swale Practice  
Maintenance Inspection Checklist**

Item 6.

0 = Good condition. Well maintained, no action required.  
1 = Moderate condition. Adequately maintained, routine maintenance needed.  
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
3 = Serious condition. Immediate need for repair or replacement.

Item						Comments
1. Complaints from local residents	0	1	2	3	N/A	
2. Mosquito proliferation	0	1	2	3	N/A	
3. Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A	

**Inspector's Summary:**

**Photographs**

	Photo ID	Description
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

**Sketch of Practice**

(note problem areas)

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)





**Infiltration/Filtration/Bioretentention/Dry Swale Practice  
Maintenance Inspection Checklist**

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*Item 6.*



**Permeable Pavement  
Maintenance Inspection Checklist**

**Party Responsible for Maintenance:** \_\_\_\_\_

**Practice ID:** \_\_\_\_\_

**Contact:** \_\_\_\_\_

**Location:** \_\_\_\_\_

**Phone Number:** \_\_\_\_\_

**GPS Coordinates:** \_\_\_\_\_

**E-mail:** \_\_\_\_\_

**Inspector(s):** \_\_\_\_\_ **Mailing Address:** \_\_\_\_\_

**Date:** \_\_\_\_\_ **Time:** \_\_\_\_\_

**Key Questions**

Item	X	Comments
1. Type of practice (check all that apply)		
a. Standard design	<input type="checkbox"/>	
b. Infiltration design	<input type="checkbox"/>	
c. Infiltration sump design	<input type="checkbox"/>	
2. Pavement Type		
a. Pervious concrete	<input type="checkbox"/>	
b. Porous asphalt	<input type="checkbox"/>	
c. Concrete grid pavers	<input type="checkbox"/>	
d. Permeable interlocking concrete pavers	<input type="checkbox"/>	
e. Other:	<input type="checkbox"/>	
3. External drainage area?		
a. Yes	<input type="checkbox"/>	Ratio: _____
b. No	<input type="checkbox"/>	
4. Pretreatment (if landscaped/turf areas in drainage area)		
a. Yes	<input type="checkbox"/>	Type: _____
b. No	<input type="checkbox"/>	
5. If designed for infiltration (e.g., no underdrain OR infiltration sump below underdrain):		
b. Soil boring logs and infiltration testing report provided	<input type="checkbox"/>	
c. Field-measured infiltration rate indicated	<input type="checkbox"/>	Field-measured rate: _____

**A. Contributing Drainage Area**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected						
<input type="checkbox"/>	Not Inspected						
Item							Comments
1. Excessive trash/debris	0	1	2	3	N/A		
2. Bare/exposed soil	0	1	2	3	N/A		
3. Evidence of erosion	0	1	2	3	N/A		
4. Excessive landscape waste/yard clippings	0	1	2	3	N/A		

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Permeable Pavement  
Maintenance Inspection Checklist**

- |   |   |   |   |   |   |     |
|---|---|---|---|---|---|-----|
| 5 | Excessive grit, sand, or other clogging agents on upgradient pavement that drains onto permeable pavement | 0 | 1 | 2 | 3 | N/A |
|---|---|---|---|---|---|-----|

**B. Pretreatment (if applicable to landscaped/turf drainage area)**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
Item		Comments				
1.	Maintenance access to pretreatment facility	0	1	2	3	N/A
2.	Excessive trash/debris/sediment	0	1	2	3	N/A
3.	Evidence of standing water					
a.	Ponding	0	1	2	3	N/A
b.	Noticeable odors	0	1	2	3	N/A
c.	Water stains	0	1	2	3	N/A
d.	Presence of algae or floating aquatic vegetation	0	1	2	3	N/A
4.	Evidence of clogging	0	1	2	3	N/A
5.	Dead vegetation/exposed soil	0	1	2	3	N/A
6.	Evidence of erosion	0	1	2	3	N/A

**C. Evidence of Materials Storage or Resurfacing of Permeable Pavement**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
Item		Comments				
1.	Evidence of storage of sand, mulch, soil, construction staging, power washing, or other activities that can clog pavement	0	1	2	3	N/A
2.	Evidence of resealing or resurfacing of permeable pavement surface	0	1	2	3	N/A

**D. Practice**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
Item		Comments				
1.	Maintenance access to practice	0	1	2	3	N/A
2.	Condition of structural components	0	1	2	3	N/A

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Permeable Pavement  
Maintenance Inspection Checklist**

3. Condition of hydraulic control components	0	1	2	3	N/A
4. Excessive trash/debris/sediment on pavement surface	0	1	2	3	N/A
5. Evidence of damaged pavers and/or cracked/broken surface	0	1	2	3	N/A
6. Evidence of oil/chemical accumulation	0	1	2	3	N/A
7. Evidence of clogging:	<input type="checkbox"/>				
a. Ponding/water standing in observation wells	0	1	2	3	N/A
b. Noticeable odors	0	1	2	3	N/A
c. Water stains	0	1	2	3	N/A
8. Underdrain system (if equipped)	0	1	2	3	N/A
a. Broken	0	1	2	3	N/A
b. Clogged	0	1	2	3	N/A
9. Vegetation (e.g., grass in grid pavers) if present	0	1	2	3	N/A
a. Grass or vegetation needs mowing or maintenance	0	1	2	3	N/A
b. Excessive growth of weeds	0	1	2	3	N/A
c. Dead vegetation	0	1	2	3	N/A

**E. Miscellaneous**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
	Item					Comments
1.	Complaints from local residents	0	1	2	3	N/A
2.	Spring clean-up conducted?	0	1	2	3	N/A
3.	Vacuum sweeping without water spray (2 -- 4 time annually)	0	1	2	3	N/A
4.	Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A

**Inspector's Summary:**

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)





Photographs	
Photo ID	Description
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

<div> <div>Sketch of Practice</div> <div>(note problem areas)</div> </div>	



**Green Roof  
Maintenance Inspection Checklist**

Party Responsible for Maintenance:

Practice ID:

Contact:

Location:

Phone Number:

GPS Coordinates:

E-mail:

Inspector(s): Mailing Address:

Date:

Time:

**Key Questions**

Item	X	Comments
1. Type of vegetated roof (check all that apply)		
a. Extensive - shallow soil	<input type="checkbox"/>	
b. Intensive - deep soil	<input type="checkbox"/>	
c. Other	<input type="checkbox"/>	Type:
2. Type of plant cover (check all that apply)		
a. Sedums	<input type="checkbox"/>	
b. Shrubs	<input type="checkbox"/>	
c. Trees	<input type="checkbox"/>	
d. Other	<input type="checkbox"/>	Type:

**A. Practice**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected
<input type="checkbox"/>	Not Inspected
Item	Comments
1. Maintenance access to practice	0 1 2 3 N/A
2. Condition of structural components	0 1 2 3 N/A
3. Condition of hydraulic control components	0 1 2 3 N/A
4. Excessive trash/debris/sediment	0 1 2 3 N/A
5. Evidence of leaking in waterproof	0 1 2 3 N/A
6. Evidence of perforated root barrier	0 1 2 3 N/A
7. Evidence of standing water:	0 1 2 3 N/A
a. Ponding	<input type="checkbox"/>
b. Noticeable odors	<input type="checkbox"/>
c. Water stains	<input type="checkbox"/>
d. Presence of algae	<input type="checkbox"/>
8. Roof drain system	0 1 2 3 N/A
a. Broken	<input type="checkbox"/>
b. Clogged	<input type="checkbox"/>
9. Vegetation	0 1 2 3 N/A
a. Plant composition consistent with approved plans	<input type="checkbox"/>
b. Presence of invasive species/weeds	<input type="checkbox"/>
c. Plants appear nutrient deficient	<input type="checkbox"/>
d. Evidence of birds/pests removing plants	<input type="checkbox"/>
e. Dead/sparse vegetation soil	<input type="checkbox"/>

22 09:11:36 [EST]

(Supp. No. 45)



**Green Roof  
Maintenance Inspection Checklist**

**B. Outlets**

0 = Good condition. Well maintained, no action required.  
 1 = Moderate condition. Adequately maintained, routine maintenance needed.  
 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
 3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected						
<input type="checkbox"/>	Not Inspected						
	<b>Item</b>						<b>Comments</b>
1.	Roof drain conveyance is clogged	0	1	2	3	N/A	
2.	Excessive trash/debris/sediment accumulation at roof drain outlets	0	1	2	3	N/A	
3.	Evidence of erosion at/around outlet	0	1	2	3	N/A	

**C. Miscellaneous**

0 = Good condition. Well maintained, no action required.  
 1 = Moderate condition. Adequately maintained, routine maintenance needed.  
 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
 3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected						
<input type="checkbox"/>	Not Inspected						
	Item						Comments
1.	Complaints from local residents		0	1	2	3	N/A
2.	Mosquito proliferation		0	1	2	3	N/A

**Inspector's Summary:****Photographs**

		Photo ID	Description
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

**Sketch of Practice**  
 (Supp. No. 45)

6-1-1-2021-07-22 09:11:36 [EST]



**Green Roof  
Maintenance Inspection Checklist**

(note problem areas)

(Supp. No. 45)

Created: 2021-07-22 09:11:36 [EST]





## Rainwater Harvesting Maintenance Inspection Checklist

**Party Responsible for Maintenance:** \_\_\_\_\_

**Practice ID:** \_\_\_\_\_

**Contact:** \_\_\_\_\_

**Location:** \_\_\_\_\_

**Phone Number:** \_\_\_\_\_

**GPS Coordinates:** \_\_\_\_\_

**E-mail:** \_\_\_\_\_

**Inspector(s):** \_\_\_\_\_ **Mailing Address:** \_\_\_\_\_

**Date:** \_\_\_\_\_ **Time:** \_\_\_\_\_

### A. Contributing Drainage Area (Roof Area)

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected						
<input type="checkbox"/>	Not Inspected						
Item							Comments
1.	Excessive leaves and debris in gutters/downspouts	0	1	2	3	N/A	
2.	Other materials/debris on roof surface (e.g., excessive bird droppings)	0	1	2	3	N/A	
3.	Clear overhanging trees/vegetation over roof surface	0	1	2	3	N/A	

### B. Pretreatment

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected						
<input type="checkbox"/>	Not Inspected						
Item							Comments
1.	Maintenance access to pretreatment facility	0	1	2	3	N/A	
2.	Check first flush diverters/filters for proper functioning (e.g., not bypassing too much water). Clean debris from filter screens.	0	1	2	3	N/A	Sediment marker reading:

### C. Inlets

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected						
<input type="checkbox"/>	Not Inspected						
Item							Comments
1.	Check all conveyances into tank; remove debris; check for clogging	0	1	2	3	N/A	

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



## Rainwater Harvesting Maintenance Inspection Checklist

2. Patch any holes or gaps. 0 1 2 3 N/A

### D. Tank or Cistern

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected

☐ Not Inspected

Item		Comments				
1.	Maintenance access to practice	0	1	2	3	N/A
2.	Check storage tank lids	0	1	2	3	N/A
a.	Vents and screens on inflow/outflow spigots	0	1	2	3	N/A
b.	Lids in place, properly secured	0	1	2	3	N/A
3.	Overflow pipes & downstream flow path	0	1	2	3	N/A Cause:
a.	Debris/clogging in overflow pipes	0	1	2	3	N/A Cause:
b.	Erosion, excessive debris, clogging of flow path	0	1	2	3	N/A Cause:
c.	Condition of downstream secondary runoff reduction practice (see applicable checklist)	0	1	2	3	N/A Cause:
4.	Sediment build-up in tank	0	1	2	3	N/A
5.	Backflow preventer	0	1	2	3	N/A
6.	Structural integrity	0	1	2	3	N/A
a.	Tank and foundation	0	1	2	3	N/A
b.	Pump and pump housing	0	1	2	3	N/A
c.	Pipes	0	1	2	3	N/A
d.	Electrical system and housing	0	1	2	3	N/A
7.	Water Quality Devices	0	1	2	3	N/A
8.	Mosquitos	0	1	2	3	N/A
a.	Mosquito screens; check gaps and holes	0	1	2	3	N/A
b.	Evidence of mosquito larvae in tank or manholes	0	1	2	3	N/A

### E. Miscellaneous

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected

☐ Not Inspected

Item		Comments				
1.	Complaints from local residents	0	1	2	3	N/A
2.	Mosquito proliferation	0	1	2	3	N/A
3.	Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A
4.	Adequate safety signage	0	1	2	3	N/A

### Inspector's Summary:

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



Photographs	
Photo ID	Description
1.	
2.	
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**Sketch of Practice**  
(note problem areas)



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**Rainwater Harvesting**  
**Maintenance Inspection Checklist**

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*Item 6.*





## Impervious Surface Disconnection Maintenance Inspection Checklist

Party Responsible for Maintenance: \_\_\_\_\_

Practice ID: \_\_\_\_\_

Contact: \_\_\_\_\_

Location: \_\_\_\_\_

Phone Number: \_\_\_\_\_

GPS Coordinates: \_\_\_\_\_

E-mail: \_\_\_\_\_

Inspector(s): \_\_\_\_\_ Mailing Address: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

### Key Questions

Item	X	Comments
1. Type of impervious area disconnected		
a. Rooftop	<input type="checkbox"/>	
b. Parking	<input type="checkbox"/>	
c. Other	<input type="checkbox"/>	
2. Type of disconnection surface		
a. Managed turf areas	<input type="checkbox"/>	
b. Forest cover or preserved open space	<input type="checkbox"/>	
c. Soil compost amended filter path	<input type="checkbox"/>	
3. Type of forest cover or open space (if applicable)		
a. Forest	<input type="checkbox"/>	
b. Meadow/Brush	<input type="checkbox"/>	
c. Other	<input type="checkbox"/>	
4. Vegetative Cover Condition		
a. Good	<input type="checkbox"/>	
b. Average	<input type="checkbox"/>	
c. Poor	<input type="checkbox"/>	
5. Meets width/length requirement	<input type="checkbox"/>	

### A. Contributing Drainage Area

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/> Inspected									
<input type="checkbox"/> Not Inspected									
Item									Comments
1. Excessive trash/debris	0	1	2	3	N/A				
2. Excessive landscape waste/yard clippings	0	1	2	3	N/A				

### B. Inflow Points

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/> Inspected									
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(Supp. No. 45)

Created: 2021-07-22 09:11:36 [EST]



## Impervious Surface Disconnection Maintenance Inspection Checklist

<input type="checkbox"/>	Not Inspected								
	Item								Comments
1.	Inflow points (e.g. downspouts, curb cuts, edge of pavement, level spreader) provide stable conveyance into practice	0	1	2	3	N/A			
2.	Runoff enters pervious area as sheet flow	0	1	2	3	N/A			
3.	Excessive trash/debris/sediment	0	1	2	3	N/A			
4.	Evidence of erosion at/around inflow points	0	1	2	3	N/A			
5.	Level spreader functional, if applicable	0	1	2	3	N/A			

### C. Practice (Pervious Area Receiving Runoff)

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected								
<input type="checkbox"/>	Not Inspected								
	Item								Comments
1.	Maintenance access to area	0	1	2	3	N/A			
2.	Downspouts or surface impervious area drains to the receiving pervious area (doesn't bypass)	0	1	2	3	N/A			
3.	Receiving pervious areas retain dimensions as shown on plans and are in good	0	1	2	3	N/A			
4.	Excessive trash/debris/sediment	0	1	2	3	N/A			
5.	Evidence of standing water:	0	1	2	3	N/A			
	a. Ponding								
	b. Noticeable odors								
	c. Water stains								
	d. Presence of algae or floating aquatic vegetation								
6.	Evidence of erosion	0	1	2	3	N/A			
7.	Evidence of oil/chemical accumulation	0	1	2	3	N/A			
8.	Vegetation	0	1	2	3	N/A			
	a. Plant composition consistent with approved plans	0	1	2	3	N/A			
	b. Presence of invasive species/weeds	0	1	2	3	N/A			
	c. Dead vegetation/exposed soil	0	1	2	3	N/A			
	d. Disturbance to natural vegetation or excessive maintenance (e.g. mowing, tree cutting)	0	1	2	3	N/A			
	e. Restoration planting survival, if	0	1	2	3	N/A			
9.	Conservation area signs (if applicable)	0	1	2	3	N/A			
10.	Level spreader (if applicable)	0	1	2	3	N/A			

### D. Miscellaneous

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

(Supp. No. 45)



## Impervious Surface Disconnection Maintenance Inspection Checklist

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected						
<input type="checkbox"/>	Not Inspected						
Item							Comments
1.	Complaints from local residents	0	1	2	3	N/A	
2.	Mosquito proliferation	0	1	2	3	N/A	
3.	Encroachment on pervious area or easement by buildings or other structures	0	1	2	3	N/A	

### Inspector's Summary:

### Photographs

Photo ID	Description
1.	
2.	
3.	
4.	
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### Sketch of Practice (note problem areas)

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



20 of 33



## Dry Detention Practices Maintenance Inspection Checklist

<b>Party Responsible for Maintenance:</b> _____ <b>Contact:</b> _____ <b>Phone Number:</b> _____ <b>E-mail:</b> _____	<b>Practice ID:</b> _____ <b>Location:</b> _____ <b>GPS Coordinates:</b> _____ <b>Inspector(s):</b> _____ <b>Mailing Address:</b> _____ _____ <b>Date:</b> _____ <b>Time:</b> _____
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Key Questions		
Item	X	Comments
1. Type of detention practice		
a. Dry Pond	<input type="checkbox"/>	
b. Underground Detention Vault and/or Tank	<input type="checkbox"/>	
c. Other	<input type="checkbox"/>	Type: _____

<b>A. Contributing Drainage Area</b> 0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.						
<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
	Item					Comments
1.	Excessive trash/debris	0	1	2	3	N/A
2.	Bare/exposed soil	0	1	2	3	N/A
3.	Evidence of erosion	0	1	2	3	N/A
4.	Excessive landscape waste/yard clippings	0	1	2	3	N/A
5.	Oils, greases, paints and other harmful substances disposed of in drainage area.	0	1	2	3	N/A

<b>B. Forebay/Pretreatment</b> 0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.						
<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
	Item					Comments
1.	Maintenance access to pretreatment facility	0	1	2	3	N/A
2.	Excessive trash/debris accumulation	0	1	2	3	N/A
3.	Excessive sediment accumulation	0	1	2	3	N/A Sediment marker reading: _____
4.	Evidence of clogging	0	1	2	3	N/A
5.	Dead vegetation/exposed soil	0	1	2	3	N/A
6.	Evidence of erosion	0	1	2	3	N/A

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Dry Detention Practices**  
**Maintenance Inspection Checklist**

**C. Inlets**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected									
<input type="checkbox"/>	Not Inspected									
		Item					Comments			
1.	Inlets provide stable conveyance into	0	1	2	3	N/A				
2.	Excessive trash/debris/sediment accumulation at inlet	0	1	2	3	N/A				
3.	Evidence of erosion at/around inlet	0	1	2	3	N/A				
4.	Damaged pipes or components	0	1	2	3	N/A				
5.	Inflow hindered by soil height, build up of sediment and/or grass	0	1	2	3	N/A				

**D. Practice**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected									
<input type="checkbox"/>	Not Inspected									
		Item					Comments			
1.	Maintenance access to practice	0	1	2	3	N/A				
2.	Sediment accumulation	0	1	2	3	N/A				
3.	Abnormally high or low water levels	0	1	2	3	N/A Cause:				
4.	Evidence of pollution/hotspot runoff	0	1	2	3	N/A Cause:				
5.	Berm(s)/embankment(s)	0	1	2	3	N/A				
a.	Cracking, bulging, or sloughing	0	1	2	3	N/A				
b.	Soft spots or sinkholes	0	1	2	3	N/A				
c.	Evidence of erosion/bare spots	0	1	2	3	N/A				
d.	Evidence of animal burrows	0	1	2	3	N/A				
e.	Presence of woody vegetation	0	1	2	3	N/A				
6.	Riser/outlet	0	1	2	3	N/A Type of riser:				
a.	Maintenance access to riser	0	1	2	3	N/A				
b.	Structural condition of riser	0	1	2	3	N/A				
c.	Condition of joints	0	1	2	3	N/A				
d.	Trash/debris accumulation	0	1	2	3	N/A				
e.	Woody growth within 5 ft. of outlet	0	1	2	3	N/A				
f.	Emergency spillway eroding or failing	0	1	2	3	N/A				
7.	Low flow orifice	0	1	2	3	N/A				
a.	Trash/debris accumulation	0	1	2	3	N/A				
b.	Adjustable control valve accessible and operational	0	1	2	3	N/A				
9.	Vegetation	0	1	2	3	N/A				
a.	Plant composition consistent with approved plans	0	1	2	3	N/A				
b.	Presence of invasive species/weeds	0	1	2	3	N/A				
c.	Dead vegetation/exposed soil	0	1	2	3	N/A				

[EST]

(Supp. No. 45)



**Dry Detention Practices**  
**Maintenance Inspection Checklist**

d. Reinforcement planting recommended ☐

**E. Outlets**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected

☐ Not Inspected

	Item						Comments
1.	Outlets provide stable conveyance out of practice	0	1	2	3	N/A	
2.	Excessive trash/debris/sediment accumulation at outlet	0	1	2	3	N/A	
3.	Evidence of erosion at/around outlet/outfall	0	1	2	3	N/A	
4.	Evidence of leaking/clogging of trash racks or reversed slope pipes	0	1	2	3	N/A	

**F. Miscellaneous**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected

☐ Not Inspected

	Item						Comments
1.	Complaints from local residents	0	1	2	3	N/A	
2.	Mosquito proliferation	0	1	2	3	N/A	
3.	Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A	
4.	Adequate safety signage	0	1	2	3	N/A	

**Inspector's Summary:**

**Photographs**

[EST]

(Supp. No. 45)



Dry Detention Practices  
Maintenance Inspection Checklist

Photo ID	Description
1.	
2.	
3.	
4.	
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<b>Sketch of practice</b> (note problem areas)

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)





**Stormwater Wet Pond/Wetland  
Maintenance Inspection Checklist**

Item 6.

**Party Responsible for Maintenance:** \_\_\_\_\_

**Practice ID:** \_\_\_\_\_

**Contact:** \_\_\_\_\_

**Location:** \_\_\_\_\_

**Phone Number:** \_\_\_\_\_

**GPS Coordinates:** \_\_\_\_\_

**E-mail:** \_\_\_\_\_

**Inspector(s):** \_\_\_\_\_ **Mailing Address:** \_\_\_\_\_

**Date:** \_\_\_\_\_ **Time:** \_\_\_\_\_

**Key Questions**

Item	X	Comments
1. Type of stormwater practice (check all that apply)		
a. Stormwater wetland basin	<input type="checkbox"/>	
b. Stormwater multi-cell wetland or pond/wetland combination	<input type="checkbox"/>	
c. Subsurface gravel wetland	<input type="checkbox"/>	
d. Wet pond	<input type="checkbox"/>	
d. Other	<input type="checkbox"/>	Type: _____
2. Type of pretreatment facility (check all that apply)		Pretreatment must be provided
a. Sediment forebay	<input type="checkbox"/>	
b. Other	<input type="checkbox"/>	Type: _____

**A. Contributing Drainage Area**

0 = Good condition. Well maintained, no action required.  
 1 = Moderate condition. Adequately maintained, routine maintenance needed.  
 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
 3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected							
<input type="checkbox"/>	Not Inspected							
Item	0	1	2	3	N/A	Comments		
1. Excessive trash/debris	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
2. Bare/exposed soil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
3. Evidence of erosion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
4. Excessive landscape waste/yard clippings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
5. Oils, greases, paints and other harmful substances disposed of in drainage area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			

**B. Pretreatment**

0 = Good condition. Well maintained, no action required.  
 1 = Moderate condition. Adequately maintained, routine maintenance needed.  
 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
 3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
Item	0	1	2	3	N/A	Comments

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Stormwater Wet Pond/Wetland  
Maintenance Inspection Checklist**

1. Maintenance access to pretreatment facility	0	1	2	3	N/A	
2. Excessive trash/debris accumulation	0	1	2	3	N/A	
3. Excessive sediment accumulation	0	1	2	3	N/A	Sediment marker reading:
4. Evidence of clogging	0	1	2	3	N/A	
5. Dead vegetation/exposed soil	0	1	2	3	N/A	
6. Evidence of erosion	0	1	2	3	N/A	

**C. Inlets**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected									
<input type="checkbox"/>	Not Inspected									
		Item					Comments			
1.	Inlets provide stable conveyance into	0	1	2	3	N/A				
2.	Excessive trash/debris/sediment accumulation at inlet	0	1	2	3	N/A				
3.	Evidence of erosion at/around inlet	0	1	2	3	N/A				
4.	Damaged pipes or components	0	1	2	3	N/A				
5.	Inflow hindered by soil height, build up of sediment and/or grass	0	1	2	3	N/A				
6.	Asphalt/concrete crumbling at inlets	0	1	2	3	N/A				

**D. Practice**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected									
<input type="checkbox"/>	Not Inspected									
		Item					Comments			
1.	Maintenance access to practice	0	1	2	3	N/A				
2.	Sediment accumulation	0	1	2	3	N/A				
	Bathymetric study recommended									
3.	Abnormally high or low water levels	0	1	2	3	N/A	Cause:			
4.	Evidence of pollution/hotspot runoff	0	1	2	3	N/A	Cause:			
5.	Berm(s)/embankment(s)	0	1	2	3	N/A				
	a. Cracking, bulging, or sloughing	0	1	2	3	N/A				
	b. Soft spots or sinkholes	0	1	2	3	N/A				
	c. Evidence of erosion/bare spots	0	1	2	3	N/A				
	d. Evidence of animal burrows	0	1	2	3	N/A				
	e. Presence of woody vegetation	0	1	2	3	N/A				

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Stormwater Wet Pond/Wetland  
Maintenance Inspection Checklist**

6. Riser/outlet	0	1	2	3	N/A	Type of riser:
a. Maintenance access to riser	0	1	2	3	N/A	
b. Structural condition of riser	0	1	2	3	N/A	
c. Condition of joints	0	1	2	3	N/A	
d. Trash/debris accumulation	0	1	2	3	N/A	
e. Woody growth within 5 ft. of outlet	0	1	2	3	N/A	
f. Emergency spillway eroding, or failing	0	1	2	3	N/A	
7. Low flow orifice	0	1	2	3	N/A	
a. Trash/debris accumulation	0	1	2	3	N/A	
b. Adjustable control valve accessible and operational	0	1	2	3	N/A	
8. Pond drain (underdrain) system (if applicable)	0	1	2	3	N/A	
a. Broken	0	1	2	3	N/A	
b. Clogged	0	1	2	3	N/A	
c. Adjustable control valve accessible and operational	0	1	2	3	N/A	
9. Vegetation	0	1	2	3	N/A	
a. Plant composition consistent with approved plans	0	1	2	3	N/A	
b. Presence of invasive species/weeds	0	1	2	3	N/A	
c. Dead vegetation/exposed soil	0	1	2	3	N/A	
d. Reinforcement planting recommended	<input type="checkbox"/>					

**E. Outlets**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected☐ Not Inspected

Item	Comments
1. Outlets provide stable conveyance out of practice	0 1 2 3 N/A
2. Excessive trash/debris/sediment accumulation at outlet	0 1 2 3 N/A
3. Evidence of erosion at/around outlet/outfall	0 1 2 3 N/A
4. Evidence of polluted water being released – discoloration, odor, staining, etc.	0 1 2 3 N/A

**F. Miscellaneous**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

Created: 2021-07-22 09:11:50 [EST]

(Supp. No. 45)



**Stormwater Wet Pond/Wetland  
Maintenance Inspection Checklist**

Item 6.

<input type="checkbox"/>	Inspected
<input type="checkbox"/>	Not Inspected
Item	Comments
1. Complaints from local residents	0 1 2 3 N/A
2. Mosquito proliferation	0 1 2 3 N/A
3. Encroachment on practice or easement by buildings or other structures	0 1 2 3 N/A
4. Adequate safety signage	0 1 2 3 N/A

**Inspector's Summary:**

Photographs	
Photo ID	Description
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

**Sketch of practice**  
(note problem areas)

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)





**Stormwater Wet Pond/Wetland  
Maintenance Inspection Checklist**

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*Item 6.*



**Grass Swale**  
**Maintenance Inspection Checklist**

**Party Responsible for Maintenance:** \_\_\_\_\_

**Practice ID:** \_\_\_\_\_

**Contact:** \_\_\_\_\_

**Location:** \_\_\_\_\_

**Phone Number:** \_\_\_\_\_

**GPS Coordinates:** \_\_\_\_\_

**E-mail:** \_\_\_\_\_

**Inspector(s):** \_\_\_\_\_ **Mailing Address:** \_\_\_\_\_

**Date:** \_\_\_\_\_ **Time:** \_\_\_\_\_

**A. Contributing Drainage Area**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected						
<input type="checkbox"/>	Not Inspected						
Item		Comments					
1.	Excessive trash/debris	0	1	2	3	N/A	
2.	Bare/exposed soil	0	1	2	3	N/A	
3.	Evidence of erosion	0	1	2	3	N/A	
4.	Excessive landscape waste/yard clippings	0	1	2	3	N/A	
5.	Impervious area added	0	1	2	3	N/A	

**B. Inflow Points**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
Item		Comments				
1.	Inflow points (e.g. curb cuts, edge of pavement, pipes) provide stable conveyance into the channel	0	1	2	3	N/A
2.	Excessive trash/debris/sediment accumulation at inflow points	0	1	2	3	N/A
3.	Evidence of erosion at/around inflow points	0	1	2	3	N/A

**C. Practice (Grass Swale)**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected
--------------------------	-----------

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Grass Swale**  
**Maintenance Inspection Checklist**

<input type="checkbox"/> Not Inspected					
Item	Comments				
1. Swale remains vegetated; no concrete, rip-rap, or other lining has been added	0	1	2	3	N/A
2. Grade ensures positive flow	0	1	2	3	N/A
3. Evidence of erosion	0	1	2	3	N/A
4. Sediment accumulation	0	1	2	3	N/A
5. Excessive trash/debris accumulation	0	1	2	3	N/A
6. Evidence of oil/chemical accumulation	0	1	2	3	N/A
7. Vegetation condition	0	1	2	3	N/A
a. Mowing as needed to maintain 4"-6" grass height.	0	1	2	3	N/A
b. 90% turf cover in practice.	0	1	2	3	N/A
8. Check dams in place	0	1	2	3	N/A
9. Signs of erosion around or under check dams	0	1	2	3	N/A

**D. Miscellaneous**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/> Inspected					
<input type="checkbox"/> Not Inspected					
Item	Comments				
1. Complaints from local residents	0	1	2	3	N/A
2. Mosquito breeding	0	1	2	3	N/A
3. Encroachments (e.g. filling, fences, obstructions, etc.)	0	1	2	3	N/A

**Inspector's Summary:**

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Grass Swale**  
**Maintenance Inspection Checklist**

<i>Photographs</i>	
Photo ID	Description
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

<i>Sketch of Practice</i>
(note problem areas)





Grass Swale

Maintenance Inspection Checklist



## Appendix G: Compliance Calculator Spreadsheet Instructions

### Table of Contents

G.1 Introduction.....	1
G.2 Compliance Calculator Spreadsheet Guidance .....	1

### **G.1 Introduction**

The compliance calculator spreadsheet (Appendix H) was created to allow a designer to quickly analyze multiple LID options and check them against the watershed area's water quality design requirements. As is clear from the specifications, each LID BMP has different design requirements, equations, and standards that determine its effectiveness. Depending upon the site, it can become difficult to determine which BMP(s) best meets the requirements. With the compliance calculator, it is easier to examine different combinations of BMPs in order to find the best option or set of options. The compliance calculator is also to be used by the plan reviewer to quickly verify the compliance status of a plan.

It is important to note that the compliance calculator is not a model, and while it can be used as a design tool, it does not replace the needed efforts of a competent designer. The numbers in the spreadsheet don't guarantee that a BMP meets the specifications, is appropriate for its location, or is generally well-designed.

### **G.2 Compliance Calculator Spreadsheet Guidance**

The following guidance explains how to use each of the worksheets in the compliance calculator spreadsheet (Appendix H).

Note: All cells highlighted in blue are user input cells. Cells highlighted in gray are calculation cells, and cells highlighted in yellow are constant values that generally should not be changed.

#### **Site Data Sheet**

1. Enter the name of the proposed project on **line 9**.
2. Enter the pre-development land cover areas (in acres) of forest/open space cover, turf cover, impervious cover and BMP cover for the site for Natural Resource Conservation Service (NRCS) soil types A, B, C, and D in cells C24-C27, E24-E27, G24-G27, and I24-I27, respectively.
3. Verify/enter the NRCS runoff curve numbers for each land use/soil type combination in cells D24-D27, F24-F27, H24-H27, and J24-J27. Default values have already been included in these cells, but they can be changed if necessary.
4. Enter the post-development land cover areas (in acres) of forest cover/open space, turf cover, impervious cover and BMP cover on the site for Natural Resource Conservation Service (NRCS) soil types A, B, C, and D in cells C34-C37, E34-E37, G34-G37, and I34-I37, respectively.
5. Verify/enter the NRCS runoff curve numbers for each land use/soil type combination in cells D34-D37, F34-F37, H34-H37, and J34-J37. As with the pre-development entries, default values have already been included in these cells, but they can be changed if necessary.

## BMP Sheet

1. Apply BMPs to the drainage area to address the required water quality volume by indicating the area in square feet (sf) of forest cover, turf cover, and impervious cover to be treated by a given BMP in **Columns B, C, and D**. This will likely be an iterative process. The available BMPs include the following:
  - Bioretention – No Underdrain
  - Bioretention - IWS
  - Bioretention - Standard
  - Permeable Pavement - Enhanced
  - Permeable Pavement - Standard
  - Infiltration
  - Green Roof
  - Green Roof – Irrigated
  - Rainwater Harvesting
  - Impervious Surface Disconnection
  - Grass Channel
  - Grass Channel – Amended Soils
  - Dry Swale
  - Wet Swale
  - Regenerative Stormwater Conveyance (RSC)
  - Filtering Systems
  - Storage Practices
  - Stormwater Ponds
  - Stormwater Wetlands
  - Proprietary Practice
  - Planted Tree
  - Preserved Tree
2. Enter the BMP's surface area (sf) in Column E and storage volume (cf) in Column F.
3. If a Stormwater Pond is used for irrigation the contributing drainage area and storage volume (determined from the Rainwater Harvesting Calculator) are entered in the Rainwater Harvesting cells B24, C24, D24, E24 and F24, respectively. The Stormwater Pond row remains empty unless there are other ponds used that are not used for irrigation.
4. If other Rainwater Harvesting BMPs are used, the Rainwater Harvesting Calculator is used to determine the contributing drainage area and storage volume inputs to the BMP worksheet.
5. The volume from direct drainage to the BMP is calculated and reported in **Column E**. Note that the total disturbed area is reflected as the sum of impervious cover (**Column D**), turf cover (**Column C**) and forest/open space cover (**Column B**) draining to the practice.
6. If more than one BMP will be employed in series, any overflow from upstream BMPs will be accounted for in **Column M**.

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

G2

7. The total volume captured by the practice ( $V_{CAP}$ ) is reported in **Column N** and is equal to the following:

$$W_{CCCC} = \text{MMNNNNNNNNMM} (SSSS, W_{UUUU} + W_{DDDD})$$

Where:

$$\begin{aligned} WQv_{CAP} &= \text{Water Quality Volume captured by the practice (cf) (Column N)} \\ Sv &= \text{Storage Volume (cf) (Column F)} \\ V_{US} &= \text{Volume of runoff from upstream practice (cf) (Column M)} \\ V_{DD} &= \text{Volume of runoff from direct discharge (cf) (Column L)} \end{aligned}$$

8. The Runoff Reduction or Pollutant Removal Efficiency (%) for each BMP (from Table 2.3) is reported in **Columns H-K**.
9. The Water Quality Volume Credited is calculated in **Column O**, and is equal to the following:

$$WWWWSS_{CCCC} = \text{MMNNNNNNNNMM } 0000 (SSSS \times CCCC, V_{CCCC})$$

Where:

$$\begin{aligned} WQv_{CR} &= \text{Water Quality Volume Credited (cf)} \\ Sv &= \text{Storage Volume (cf) (Column F)} \\ CR &= \text{Credit (fraction)} \\ V_{CAP} &= \text{Volume Captured by the Practice (cf) (Column N)} \end{aligned}$$

10. The Remaining Water Quality Volume (**Column P**) is calculated as:

$$WWWWSS_{CC} = V_{UUUU} + V_{DDDD} - W_{CCCC}$$

Where:

$$\begin{aligned} WQv_R &= \text{Water Quality Volume Remaining (cf) (Column O)} \\ V_{US} &= \text{Volume from Upstream Practices (cf) (Column M)} \\ V_{DD} &= \text{Volume from Direct Drainage (cf) (Column L)} \end{aligned}$$

11. Any runoff volume remaining can be directed to a downstream BMP by selecting a practice from the pull-down menu in **Column G**. Selecting a BMP from the menu will automatically direct the runoff volume remaining to **Column M (volume from upstream practices)** for the appropriate BMP.
12. Planted Trees. Input the number of planted and preserved trees of each size class in cells F38-F42 (retention values correspond to Table 4.62 and 4.63 in design manual).
13. The Target Retention Volume ( $WQv_T$ ) is reported in **Cell B49**, from corresponding **Cell C42** on the **Site Data Tab**.
14. The Water Quality Volume Provided ( $WQv_P$ ), is calculated in **Cell C49** as a combination of the retention values for all BMPs and trees (Cells O17-O42)
15. The fraction of target achieved (either by practice or by the entire site as appropriate) is calculated in **Cells F31-F35**. The % of target achieved is calculated as follows:

$$TT = \text{MMMMMMMMMMMM } 0000 \frac{WWWWSS_{CC}}{WWWWSS_{TT}}, 1$$

Where:

$$T = \text{Treatment (fraction)}$$

Created: 2021-07-22 09:11:36 [EST]

WQV<sub>P</sub> = Water Quality Volume Provided (cf)  
WQV<sub>T</sub> = Water Quality Volume Target (cf)

16. Cells D49, 52, 54, 58, and 61 determine if the site target has been reached as follows:

- Overall Retention Goal
  - Target Retention Volume
- General Stormwater Management Watershed Area Minimum Requirements
  - Target Retention Volume (1.16 in storm)
  - Target TSS Removal
  - Target Nitrogen Removal
  - Target Bacteria Removal
- Savannah River Special Watershed Protection Area Minimum Requirements
  - Target Retention Volume (1.16 in storm)
  - Target TSS Removal
  - Target Nitrogen Removal
  - Target Bacteria Removal

### Channel and Flood Protection

This sheet assists with calculation of Adjusted Curve Numbers that can be used to calculate peak flows associated with the 2- to 100-year storm events.

17. Enter the appropriate depths for the 2-year, 10-year, 25-year and 100-year 24-hour storms (as provided in Table 2.4) on **Line 5**.

18. The Total Site Area (from the **Site Data** Tab), is reported in **Cell C7**.

19. Detention Storage Volume (cf) is calculated in **Cell C8**, and refers to the total storage provided in all LID practices using the following equation:

$$V_{DDUV} = \frac{SSSS_{BBBBCC} \cdot IICCI_{BBBBCC}}{LLLLDD \cdot BBBBCCBB}$$

Where:

V<sub>DS</sub> = Volume in Site Detention Storage (cf)  
S<sub>V<sub>BMP</sub></sub> = Storage Volume Provided in Each BMP (cf)  
(from **Column F** of the **BMPs** Tab)  
I<sub>R<sub>D<sub>BMP</sub></sub></sub> = Infiltration, Retention or Detention Credit for Each BMP  
(from **Column J** of the **BMPs** Tab)

Note that, while other practices such as ponds provide detention, it is assumed that design engineers will explicitly account for this detention in a Pond Routing program.

20. As indicated in the Site Data sheet, each cover type is associated with a NRCS curve number. **Cells D15–G22** show the pre-development land cover areas and curve numbers that were indicated on the Site Data Sheet. Using these curve numbers, a weighted curve number is calculated in **cell G24**.
21. **Cells D29–G36** show the post-development land cover areas and curve numbers that were indicated on the Site Data Sheet. Using these curve numbers, a weighted curve number is calculated in **cell G38**.
22. Using NRCS methodology, **Line 42** calculates the pre-development runoff volume (inches) for the various storm events.

*Potential Abstraction*

$$SS = \frac{1000}{(CCCC - 10)}$$

Where:

$S$  = potential abstraction (in.)  
 $CN$  = weighted curve number

*Runoff Volume*

$$WW = \frac{(PP - 0.2 \cdot SS)^2}{(PP + 0.8 \cdot SS)}$$

Where:

$Q$  = runoff volume (in.)  
 $P$  = precipitation depth for a given 24-hour storm (in.)  
 $S$  = potential abstraction (in.)

23. **Line 43** calculates the post-development runoff volume based solely on land cover (without regard to the BMPs selected on the BMP sheet). **Line 44** then subtracts the runoff reduction volume provided by BMPs, from **Cell C8**.
24. Based upon the reduced runoff volumes calculated in line 44, the spreadsheet then calculates corresponding reduced curve numbers for each storm event. This Adjusted Curve Number is reported on **Line 45**.
25. **Line 46** compares the pre-development runoff volume in line 42 with the post-development (with BMPs) runoff volume in line 44. If the post-development volume (with BMPs) is less than or equal to the pre-development volume for a given storm event, then it is assumed that detention will not be required. If the post-development volume (with BMPs) is greater than the pre-development volume for a given storm event, then detention will be necessary, and the Adjusted Curve Numbers from line 45 should be used to calculate the post-development peak runoff rates.





[illegible]

[illegible]

Link Channel Performance Comparison - Analytics - Q1 2024										Channel	Views	Engage	Conv	Cost	ROI
Metric: Click-Through Rate (CTR)										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Month										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Device										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Age Group										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Gender										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Location										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Referral Source										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Session Type										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Device Type										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Browser										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by OS										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Language										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Time Zone										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Day of Week										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Hour of Day										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Session Duration										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Page Type										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Content Type										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Format										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Campaign										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Placement										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Size										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Creative										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Targeting										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Frequency										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Duration										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Sound										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Animation										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Text										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Image										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Video										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Audio										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Visual										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Copy										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Design										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Layout										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Color										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Font										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Size										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Aspect Ratio										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Orientation										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Format										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Type										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Style										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Theme										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Tone										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Message										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Offer										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Incentive										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Reward										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
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Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
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Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
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Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
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Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Benefit										Channel	Views	Engage	Conv	Cost	ROI
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Metric: Video Views by Ad Feature										Channel	Views	Engage	Conv	Cost	ROI
Metric: Video Views by Ad Advantage										Channel	Views	Engage	Conv	Cost	ROI
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Watershed Protection Area	Design Storm
General Stormwater Management Watershed Area	1.16
Savannah River Special Watershed Protection Area	1.16
Bacteria and Shellfish Special Watershed Protection Area	1.95

0%  
100%

0%  
80%

## Appendix I: General Design Criteria and Guidelines

### Table of Contents

I.1	Hydrology and Runoff Determination.....	1
I.1.1	Acceptable Hydrologic Methods and Models.....	1
I.1.1.1	Urban Hydrology for Small Watersheds TR-55 .....	2
I.1.1.2	Storage-Indication Routing .....	4
I.1.1.3	HEC-1, WinTR-55, TR-20, ICPR and SWMM Computer Models .....	4
I.1.2	Stormwater Volume Peak Discharge .....	4
I.2	Storm Sewer Collection System .....	6
I.2.1	Introduction .....	6
I.2.2	Clearance with Other Utilities .....	6
I.2.3	Pipe Systems .....	6
I.2.4	Hydraulic Grade Line .....	7
I.3	Open Channels .....	7
I.4	References .....	<b>Error! Bookmark not defined.</b>

### **I.1 Hydrology and Runoff Determination**

#### **I.1.1 Acceptable Hydrologic Methods and Models**

The following are the acceptable methodologies and computer models for estimating runoff hydrographs before and after development. These methods are used to predict the runoff response from given rainfall information and site surface characteristic conditions. The design storm frequencies used in all of the hydrologic engineering calculations will be based on design storms required in this guidebook unless circumstances make consideration of another storm intensity criterion appropriate:

- ☐ Rational Method (limited to sites under 10 acres)
- ☐ Urban Hydrology for Small Watersheds TR-55 (TR-55)
- ☐ Storage-Indication Routing
- ☐ HEC-1, WinTR-55, TR-20, and SWMM Computer Models

These methods are given as valid in principle and are applicable to most stormwater management design situations in the Southern Lowcountry. Other methods may be used when the Southern Lowcountry reviewing authority approves their application.

Note: Of the above methods, TR-55 and SWMM allow for the easiest correlation of the benefits of retention BMPs used to meet the stormwater retention volume (SWRV) with peak flow detention requirements and are therefore strongly recommended.

The following conditions shall be assumed when developing predevelopment, pre-project, and post-development hydrology, as applicable:

(Supp. No. 45)

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- For new development sites the runoff conditions shall be computed independent of existing developed land uses and conditions and shall be based on “Meadow in good condition” or better, assuming good hydrologic conditions and land with grass cover (NEH, 2004).
- For infill and redevelopment sites the predeveloped condition is the condition at the time of project submittal.
- Post-development conditions shall be computed for future land use assuming good hydrologic and appropriate land use conditions. If an NRCS CN Method-based approach, such as TR-55, is used, this curve number (CN) may be reduced based upon the application of retention BMPs, as indicated in the General Retention Compliance Calculator (Appendix H). This CN reduction will reduce the required detention volume for a site, but it should not be used to reduce the size of conveyance infrastructure.
- The rainfall intensity - duration - frequency curve should be determined from the most recent version of the Hydrometeorological Design Studies Center’s Precipitation Frequency Data Server (NOAA Atlas 14, Volume 2).
- Predevelopment Time of Concentration ( $T_c$ ) shall be based on the sum total of computed or estimated overland flow time and travel in natural swales, streams, creeks and rivers, but never less than 6 minutes.
- Post-development Time of Concentration shall be based on the sum total of the inlet time and travel time in improved channels or storm drains but shall not be less than 6 minutes.
- Site drainage areas exceeding 10 acres that are heterogeneous with respect to land use, soils, RCN or Time of Concentration ( $T_c$ ) shall require a separate hydrologic analysis for each sub-area.
- Hydrologic soil groups (HSGs) approved for use in the <local jurisdiction> are contained in the US Department of Agriculture Web Soil Survey. Where the HSG is not available through the Soil Survey due to the listed soil type being “Urban Soils” or similar, an HSG of C shall be used.

#### I.1.1.1 Urban Hydrology for Small Watersheds TR-55

Chapter 6 of Urban Hydrology for Small Watersheds TR-55, Storage Volume for Detention Basins, or TR-55 shortcut procedure, is based on average storage and routing effects for many structures and can be used for multistage outflow devices. Refer to TR-55 for more detailed discussions and limitations.

##### Information Needed

To calculate the required storage volume using TR-55, the predevelopment hydrology, along with the post-development hydrology for the 2, 10 and 25-year, 24-hour storm events are needed. The predevelopment hydrology is based on natural conditions (meadow) and will determine the site’s predevelopment peak rate of discharge, or allowable release rate,  $q_0$ .

The post-development hydrology may be determined using the reduced CNs calculated in the General Retention Compliance Calculator or more detailed routing calculations. This will determine the site’s post-development peak rate of discharge, or inflow for the 2, 10 and 25-year, 24-hour storm events, and the site’s post-developed runoff in inches. Note that this method does not require a hydrograph. Once the above parameters are known, the TR-55 Manual can be used to approximate the storage volume required for each design storm.

##### Procedure

- 1) Determine the peak development inflows,  $q_i$ , and the allowable release rates,  $q_0$ , from the hydrology for the appropriate design storm.

Using the ratio of the allowable release rate ( $q_o$ ) to the peak developed inflow ( $q_i$ )—or  $q_o/q_i$ —for the design storms, use Figure 1 to obtain the ratio of storage volume ( $V_s$ ) to runoff volume ( $V_R$ )—for Type III storms.

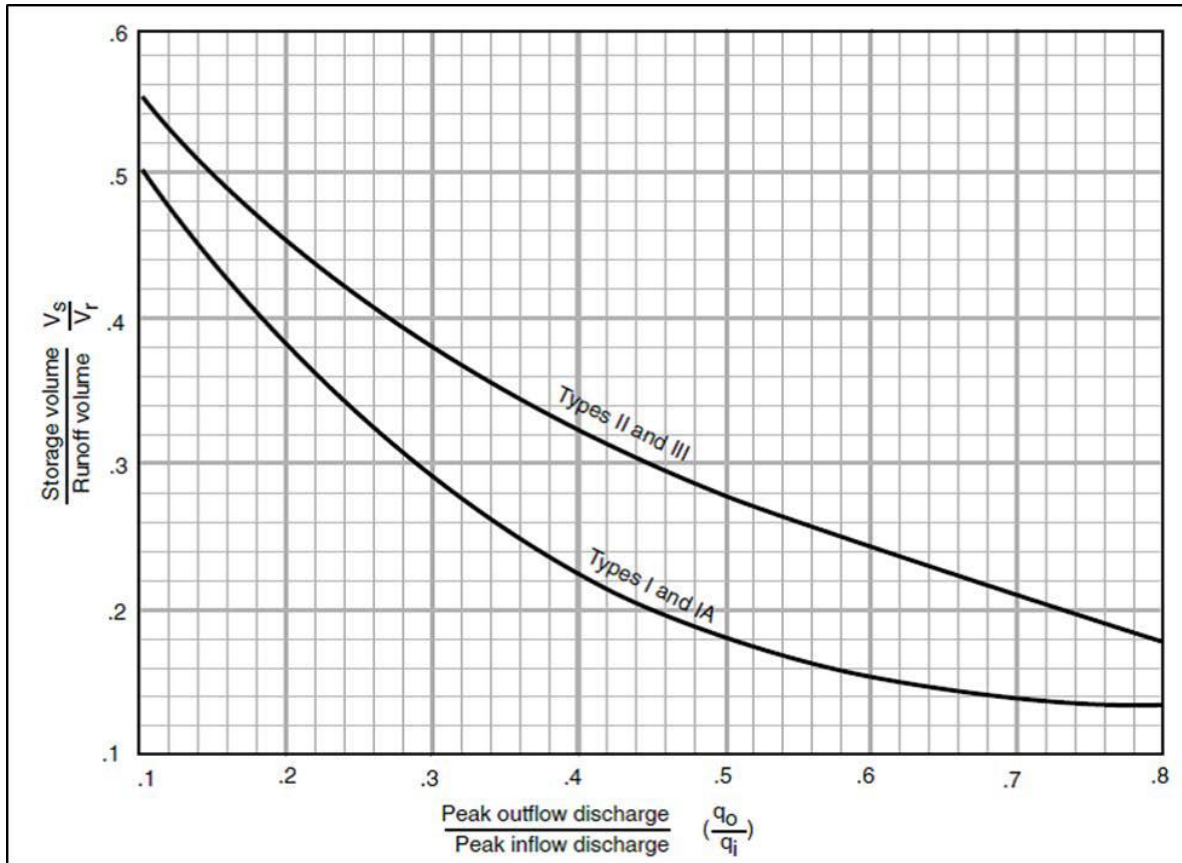


Figure 1. Approximate detention basin routing for rainfall Types I, IA, II, and III.

- 2) Determine the runoff volume  $V_R$ .

$$W_R = \frac{Q}{12} \times SDA$$

where:

- $V_R$  = post-development runoff for the design storm ( $\text{ft}^3$ )
- $Q$  = post-development runoff for the design storm (in)
- 12 = conversion factor (inches to feet)
- $SDA$  = site drainage area ( $\text{ft}^2$ )

- 3) Multiply the  $V_s/V_R$  ratios from Step 1 by the runoff volume ( $V_R$ ) from Step 2 to determine the required storage volumes ( $V_s$ ) in acre-feet.





The design procedure presented above may be used with Urban Hydrology for Small Watersheds TR-55 Worksheet 6a. The worksheet includes an area to plot the stage-storage curve, from which actual elevations corresponding to the required storage volumes can be derived. The characteristics of the stage-storage curve are dependent upon the topography of the proposed storage practice and the outlet structure, and it may be best developed using a spreadsheet or appropriate hydraulics software.

### Limitations

This routing method is less accurate as the  $q_o/q_i$  ratio approaches the limits shown in Figure 1. The curves in Figure 1 depend on the relationship between available storage, outflow device, inflow volume, and shape of the inflow hydrograph. When storage volume ( $V_s$ ) required is small, the shape of the outflow hydrograph is sensitive to the rate of the inflow hydrograph. Conversely, when  $V_s$  is large, the inflow hydrograph shape has little effect on the outflow hydrograph. In such instances, the outflow hydrograph is controlled by the hydraulics of the outflow device and the procedure therefore yields consistent results. When the peak outflow discharge ( $q_o$ ) approaches the peak inflow discharge ( $q_i$ ) parameters that affect the rate of rise of a hydrograph, such as rainfall volume, CN, and Time of Concentration, become especially significant.

The procedure should not be used to perform final design if an error in storage of 25% cannot be tolerated. Figure 1 is biased to prevent under-sizing of outflow devices, but it may significantly overestimate the required storage capacity. More detailed hydrograph development and storage indication routing will often pay for itself through reduced construction costs.

### I.1.1.2 Storage-Indication Routing

Storage-Indication Routing may be used to analyze storage detention practices. This approach requires that the inflow hydrograph be developed through one of the methods listed in this appendix (TR-55, WinTR-55, SWMM, etc.), as well as the required maximum outflow,  $q_o$ . Using the stage-discharge relationship for a given combination outlet devices, the detention volume necessary to achieve the maximum outflows can be determined.

### I.1.1.3 HEC-1, WinTR-55, TR-20, ICPR and SWMM Computer Models

If the application of the above computer models is needed, the complete input data file and print-out will be submitted with the Stormwater Management Plans (SWMPs). Submission of SWMPs shall include the following computer model documentation:

- For all computer models, supporting computations prepared for the data input file shall be submitted with the SWMPs.
- Inflow-outflow hydrographs shall be computed for each design storm presented graphically and submitted for all plans.
- Schematic (node) diagrams must be provided for all routings.

### I.1.2 Stormwater Volume Peak Discharge

The peak rate of discharge for individual design storms may be required for several different components of water quality BMP design. While the primary design and sizing factor for most stormwater retention BMPs is the design Stormwater Retention Volume (SWRV), several design elements will require a peak rate of discharge for specified design storms. The design and sizing of pretreatment cells, level spreaders, by-pass diversion structures, overflow riser structures, grass swales (Supp. No. 45)

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and water quality swale geometry, etc. all require a peak rate of discharge in order to ensure non-erosive conditions and flow capacity.

The peak rate of discharge from an SDA can be calculated from any one of several calculation methods discussed in this appendix. The two most commonly used methods of computing peak discharges for peak runoff calculations and drainage system design are NRCS TR-55 CN methods (NRCS TR-55, 1986) and the Rational Formula. The Rational Formula is limited to 10 acre drainage areas. It is highly sensitive to the Time of Concentration and rainfall intensity, and therefore should only be used with reliable Intensity-Duration-Frequency (IDF) curves or tables for the rainfall depth and region of interest (Claytor & Schueler, 1996).

The NRCS CN methods are very useful for characterizing complex sub-watersheds and SDAs and estimating the peak discharge from large storms (greater than 2 inches), but it can significantly underestimate the discharge from small storm events (Claytor and Schueler, 1996). Since the SWRV is based on smaller storm events, this underestimation of peak discharge can lead to undersized diversion and overflow structures, potentially bypassing a significant volume of the design SWRV around the retention practice. Undersized overflow structures and outlet channels can cause erosion of the BMP conveyance features that can lead to costly and frequent maintenance.

In order to maintain consistency and accuracy, the following Modified CN Method is recommended to calculate the peak discharge for the SWRV rain event. The method utilizes the Small Storm Hydrology Method (Pitt, 1994) and NRCS Graphical Peak Discharge Method (USDA, 1986) to provide an adjusted CN that is more reflective of the runoff volume from impervious areas within the SDA. The design rainfall is a NRCS Type III distribution, so the method incorporates the peak rainfall intensities common in the eastern United States, and the time of concentration is computed using the method outlined in TR-55.

The following steps describe how to calculate the SWRV peak rate of discharge ( $q_{pSWRV}$ ) for the 85<sup>th</sup> percentile rain (1.16-inch) event.

**1) Calculate the adjusted CN for the site or contributing drainage area (CDA).**

The following equation is derived from the NRCS CN Method and is described in detail in the National Engineering Handbook Part 630 Chapter 10: Estimation of Direct Runoff from Storm Rainfall and NRCS TR-55 Chapter 2: Estimating Runoff:

$$CN_{adj} = \frac{1,000}{10 + 5P + 10Q_a - 10(Q_a^2 + 1.25PQ_a)^{0.5}}$$

where:

$CN$  = adjusted curve number

$P$  = rainfall (in, 1.16 or 1.95 in)

$Q_a$  = runoff volume (watershed inches), equal to SWRV/SDA

Note: When using hydraulic/hydrologic model for sizing a retention BMP or calculating the SWRV peak discharge, designers must use this modified CN for the CDA to generate runoff equal to the SWRV for the design rainfall event.

**2) Compute the site drainage area's time of concentration ( $T_c$ ).**

(Supp. No. 45)

TR-55 Chapter 3: Time of Concentration and Travel Time provides a detailed procedure for computing the  $T_c$ .

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**3) Calculate the stormwater retention volume peak discharge ( $q_{pSWRV}$ ).**

The  $q_{pSWRV}$  is computed using the following equation and the procedures outlined in TR-55, Chapter 4: Graphical Peak Discharge Method. Designers can also use WinTR-55 or an equivalent TR-55 spreadsheet to compute  $q_{pSWRV}$ :

- Read initial abstraction ( $I_a$ ) from TR-55 Table 4.1 or calculate using  $I_a = 200/CN - 2$
- Compute  $I_a/P$  ( $P = 1.16$ )
- Read the Unit Peak Discharge ( $q_u$ ) from Exhibit 4-II using  $T_c$  and  $I_a/P$
- Compute the  $q_{pSWRV}$  peak discharge:

$$q_{pSWRV} = q_u \times SS \times Q_a$$

where:

$q_{pSWRV}$  = stormwater retention volume peak discharge (ft<sup>3</sup>/sec)

$q_u$  = unit peak discharge (ft<sup>3</sup>/sec/mi<sup>2</sup>/in)

$A$  = site drainage area (mi<sup>2</sup>)

$Q_a$  = runoff volume (watershed inches), equal to SWRV/SDA

This procedure is for computing the peak flow rate for the 85<sup>th</sup> and 95<sup>th</sup> percentile rainfall events. Calculations of peak discharge from larger storm events for the design of drainage systems, culverts, etc., should use published CNs and computational procedures.

## **I.2 Storm Sewer Collection System**

### **I.2.1 Introduction**

The focus of the *Southern Lowcountry Stormwater Design Manual* is to define standards and specifications for design, construction and maintenance of BMPs required to meet post construction stormwater performance objectives. Design of the conveyance of stormwater runoff within the public right-of-way (PROW) must follow the current requirements in SCDOT's Requirements for Hydraulic Studies, Part 2 Requirements for Roadway Drainage (SCDOT, 2009). These are incorporated by reference with the following notes pertinent to the <local jurisdiction>.

### **I.2.2 Clearance with Other Utilities**

- All proposed and existing utilities crossing or parallel to designed storm sewer systems must be shown on the plan and profile.
- Storm drain and utility crossings must not have less than a 45-degree angle between them.
- Minimum vertical and horizontal clearances, wall to wall, must be provided between storm drainage lines and other utilities as defined by the Beaufort-Jasper Water & Sewer Authority.

### **I.2.3 Pipe Systems**

- The pipe sizes used for any part of the storm drainage system within the PROW must be designed in accordance with the current requirements in SCDOT's Requirements for Hydraulic Studies, Part 2 Requirements for Roadway Drainage. (SCDOT, 2009)

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- The material and installation of the storm drain for any part of public storm sewer must be designed in accordance with the current requirements in SCDOT's Requirements for Hydraulic Studies, Part 2 Requirements for Roadway Drainage (SCDOT, 2009). An exception to the SCDOT list is spiral ribbed aluminum pipe (SRAP), which is not an acceptable pipe material for brackish waters. Materials shall be RCP, CAAP, HDPE or HP Storm per AASHTO standards for H20/H25 loading and installation per ASTM/AASHTO standards. Durability must be 100 years or greater per SCDOT standards.
- An alternative overflow path for the 100-year storm is to be shown on the plan view if the path is not directly over the pipe. Where applicable, proposed grading must ensure that overflow will be into attenuation facilities designed to control the 100-year storm.
- A pipe schedule tabulating pipe length by diameter and class is to be included on the drawings. Public and private systems must be shown separately.
- Profiles of the proposed storm drains must be shown on the drawings and indicate size, type, and class of pipe, percent grade, existing ground and proposed ground over the proposed system, and invert elevations at both ends of each pipe run. Pipe elevations and grades must be set to avoid hydrostatic surcharge during design conditions. Where hydrostatic surcharge greater than 1-foot of head cannot be avoided, a rubber gasket pipe is to be specified.

#### **I.2.4 Hydraulic Grade Line**

The existing grade line and proposed 25- and 100-year hydraulic grade lines (HGL) must be clearly indicated on the system profiles and identified with the initials HGL on the line and identified in the legend key. This grade line must take into consideration pipe and channel friction losses, computing structures losses, tailwater conditions and entrance losses. All pipe systems must be designed so that they will operate without building up a surcharged hydrostatic head under design flow conditions. It is recommended that the HGL be no more than 1 foot above the pipe crown. If pipes have a HGL more than 1 foot above the pipe crown, rubber gaskets are required. The 100-year HGL must not overtop the 6" curb of ingress/egress routes that would isolate interior parcels in the extreme flood event.

If the structural stormwater BMP discharges into a storm sewer, a detailed HGL analysis of the system including the receiving system must be submitted with the final Stormwater Management Plans (SWMPs) for 100-year storm event. Provide documentation supporting safe passage of the 100-yr post-development flow downstream and an analysis of the surrounding neighborhood area to identify any existing capacity shortfalls or drainage blockages based on the 10% rule in Section 3.8.

#### **I.3 Open Channels**

- Calculations must be provided for all channels, streams, ditches, swales, etc., including a typical section of each reach and a plan view with reach locations. In the case of existing natural streams/swales, a field survey of the stream (swale) cross sections may be required prior to the final approval.
- The final designed channel must safely pass the 100-yr storm event.
- If the base flow exists for a long period of time or velocities are more than 5 feet per second in earth and sodded channel linings, gabion or riprap protection must be provided at the intersection of the inverts and side slopes of the channels unless it can be demonstrated that the final bank and vegetation are sufficiently erosion-resistant to withstand the designed flows, and the channel will stay within the floodplain easement throughout the project life.

(Supp. No. 45)

Created: 2021-07-22 09:11:36 [EST]

- Channel inverts and tops of bank are to be shown in plan and profile views.
- For a designed channel, a cross section view of each configuration must be shown.
- For proposed channels, a final grading plan must be provided.
- The limits of a recorded 100-year floodplain easement or surface water easement sufficient to convey the 100-year flow must be shown.
- The minimum 25-foot horizontal clearance between a residential structure and 100-year floodplain must be indicated in the plan.
- For designed channels, transition at the entrance and outfall is to be clearly shown on the site



## Appendix J: Rainwater Harvesting Treatment and Management Requirements

This Appendix is provided as an example of requirements necessary for approval of use of reclaimed rainwater in non-potable water systems. It is not intended to regulate water retained by another BMP for use in irrigation and to meet stormwater retention volume requirements.

### Table of Contents

J.1	Rainwater Harvesting Treatment and Management Requirements .....	1
J.1.1	Introduction .....	1
J.1.2	Pathogen Reduction Targets .....	2
J.1.3	Filtration .....	3
J.1.4	Disinfection .....	3
J.1.5	Treatment Trains .....	5
J.1.6	Volatile Organic Compounds .....	5
J.1.7	Storage and Distribution Management Practices .....	7
J.1.8	Commissioning .....	8
J.1.9	Operational Monitoring and Reporting .....	8
J.1.10	Field Verification .....	9
J.1.11	Design Report .....	9
J.1.12	Treatment Design Examples .....	10
J.2	Rainwater Harvesting Storage Volume Calculator Instructions .....	12

### J.1 Rainwater Harvesting Treatment and Management Requirements

#### J.1.1 Introduction

The majority of the information and requirements provided herein are excerpted from the 2017 Water Environment and Reuse Foundation Report: Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems (DNWS Report), and much of the text is directly quoted. In some cases, text from this report has been modified to conform to the Stormwater Design Manual and <local jurisdiction> review and inspection procedures.

The purpose of this appendix is to provide information and guidance through a risk-based framework to help designers and <local jurisdiction> ensure that all rainwater harvesting systems are adequately protective of public health. This appendix identifies pathogen reduction targets that must be met and various treatment systems that can be used to meet the targets, as well as volatile organic compound (VOC) limits that must be achieved storage and distribution management considerations, operation and maintenance as well as long-term monitoring and reporting requirements are also discussed.

### J.1.2 Pathogen Reduction Targets

Risk-based pathogen reduction targets have been developed based on analysis of potential human health risks associated with exposure to microbial hazards, and are based on a “ $10^{-4}$  Per Person per Year Benchmark.” This means that the agreed-upon “tolerable” risk level is a probability of infection of 1 in 10,000 people per year. Pathogen reduction targets are expressed in terms of the 95th percentile Log<sub>10</sub> Reduction Target (LRT). LRTs were developed for each source water and end use addressed in this appendix based on attaining the “tolerable” infection risk. If a system can maintain this level of treatment performance at all times, then the predicted probability of infection across the population will be less than the 1 in 10,000 benchmark for each pathogen 95% of the time.

The LRT for each non-potable use scenario is presented in Table 1 for healthy adults (values are based on the DNWS Report, although additional uses have been added). A rainwater harvesting system must maintain this level of treatment performance at all times for all three pathogen types: viruses, protozoa, and bacteria. When both general runoff and roof runoff (as defined below in Table 1) are combined, the reduction targets for general runoff shall apply. Similarly, when multiple uses are proposed, the highest reduction targets shall apply.

Table 1. Ninety-fifth percentile log<sub>10</sub> pathogen reduction targets (LRT) to meet infection ppy benchmarks for healthy adults.

Water Source and Use	Log <sub>10</sub> Reduction Targets for $10^{-4}$ Per Person Per Year Benchmarks		
	Enteric Viruses	Parasitic Protozoa	Enteric Bacteria
General Runoff <sup>a</sup>			
Cooling Towers <sup>b</sup>	–	–	–
Irrigation	5.0	4.5	4.0
Indoor Use	5.5	5.5	5.0
Roof Runoff <sup>c</sup>			
Cooling Towers <sup>b</sup>	–	–	–
Irrigation	N/A	Limited data available	3.5
Indoor Use	N/A	Limited data available	3.5
a. For the purposes of this appendix, general runoff means precipitation runoff from rain or snowmelt events that flows over land and/or impervious surfaces (e.g., streets, sidewalks, and parking lots). It also includes runoff from roofs or parking garages with frequent public access.			
b. The pathogen risks associated with cooling towers and other uses in which there is no public exposure can be controlled by post-treatment management practices rather than initial treatment. The reason is that greater microbial risks from this use is likely to result from not controlling the growth of water-based pathogens (e.g., Legionella pneumophila, Pseudomonas aeruginosa, and non-tuberculous mycobacteria) that may proliferate in stagnant piped water. Management practices are discussed in Section J.1.7 Storage and Distribution Management Practices.			
c. Roof runoff means precipitation from a rain event that is collected directly from a roof surface not subject to frequent public access.			

The non-potable uses and LRTs included in Table 1 assume that human contact with the harvested water will be infrequent, and ingestion unintentional. Uses where frequent human contact with the harvested water is intended, like fountains or splash pads, will be considered similar to swimming pools, and must meet the standards defined by the *<local jurisdiction>*. The remaining sections in this appendix only cover non-potable uses with infrequent human contact. Treatment and monitoring procedures for frequent contact uses will be reviewed on a case-by-case basis.

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## Treatment Process

A well-established and accepted concept in modern drinking water and water reuse practices is to attribute the log<sub>10</sub> reduction of pathogen groups to specific technologies that are operated within defined limits, coupled with appropriate control points to demonstrate the proper performance of the technology. This is referred to as the log<sub>10</sub> reduction value (LRV) and can be compared directly to the LRTs described in Section J.1.2 above. Various treatment processes and treatment trains can be used to obtain the LRT for each pathogen for a given combination of source water and end use. Sections J.1.5 and J.1.6 discuss a range of treatment processes and provide LRVs for each process.

### J.1.3 Filtration

The removal of particulate matter, including pathogens, by size exclusion is of interest because filters can serve as a barrier to pathogens in water. Filtration is especially important because pathogens can be shielded by or embedded in particulate matter, reducing the effectiveness of subsequent disinfection processes. Typical values for pathogen group log<sub>10</sub> reduction by filtration processes are summarized in Table 2.

Table 2. Typical values for pathogen reduction using filtration processes.

Barrier	Typical Log <sub>10</sub> Reduction Values		
	Virus	Protozoa	Bacteria
Slow sand filter	2	4	2
Dual media filter with coagulant	1	2	1
Cartridge/bag filter (5-10 microns)	0	0	0
Cartridge/bag filter (3 microns or less)	0	3	0
Cartridge/bag filter (1 micron)	0	4	0
Diatomaceous earth	1	4	2
Microfilter	1	6	6
Ultrafilter or Nanofilter	6	6	6
Reverse osmosis	6	6	6

### J.1.4 Disinfection

Processes for pathogen inactivation include disinfection by chlorine, peracetic acid, ozone, ultraviolet (UV) radiation, advanced oxidation, and pasteurization. Particles in water can inhibit effective disinfection through shading (in the case of UV) and shielding embedded pathogens. Larger particles may require more time for a disinfecting agent to penetrate the particle and reach an embedded pathogen; therefore, for any disinfectant to be effective, particles larger than 10 microns must be removed.

Typical values for the inactivation of pathogens for disinfection processes in filtered water are given in Table 3, Table 4, and

Table 5. These values serve as a guide to the relative effectiveness of different disinfection technologies and are not for a specific microorganism.

Table 3. Typical values for various levels of the inactivation of enteric virus in filtered secondary effluent with selected disinfection processes.

Disinfectant	Unit <sup>b</sup>	Dose for Corresponding Log <sub>10</sub> Reduction Value			
		1 Log <sub>10</sub>	2 Log <sub>10</sub>	3 Log <sub>10</sub>	4 Log <sub>10</sub>
Free chlorine	mg•min/L	–	1.5–1.8	2.2–2.6	3.0–3.5
Chloramine <sup>a</sup>	mg•min/L	–	370–400	550–600	750–800
Peracetic acid	mg•min/L	NA	NA	NA	NA
Ozone	mg•min/L	–	0.25–0.30	0.35–0.45	0.50–0.60
Ultraviolet radiation	mJ/cm <sup>2</sup>	50–60	90–110	140–150	180–200
Advanced oxidation	mJ/cm <sup>2</sup>	10–20	50–60	70–80	110–130
Pasteurization (60°C)	Second	140	280	420	560
a. Due to interferences with chloro-organic compounds, when chloramine is used as a disinfectant, log <sub>10</sub> reductions can only be used if the actual dosage of monochloramine is known, not just the amount of combined chlorine.					
b. mg•min/L = Milligram-minutes per liter					
c. mJ/cm <sup>2</sup> = Millijoules per square centimeter.					

Table 4. Typical values for various levels of the inactivation of parasitic protozoa in filtered secondary effluent with selected disinfection processes.

Disinfectant	Unit <sup>b</sup>	Dose for Corresponding Log <sub>10</sub> Reduction Value			
		1 Log <sub>10</sub>	2 Log <sub>10</sub>	3 Log <sub>10</sub>	4 Log <sub>10</sub>
Free chlorine	mg•min/L	2,000–2,600	NA	NA	NA
Chloramine <sup>a</sup>	mg•min/L	NA	NA	NA	NA
Peracetic acid	mg•min/L	NA	NA	NA	NA
Ozone	mg•min/L	4.0–4.5	8.0–8.5	12–13	NA
Ultraviolet radiation	mJ/cm <sup>2</sup>	2–3	5–6	11–12	20–25
Advanced oxidation	mJ/cm <sup>2</sup>	2–3	5–6	10–12	20–25
Pasteurization (60°C)	Second	30	60	90	120
a. Due to interferences with chloro-organic compounds, when chloramine is used as a disinfectant, log <sub>10</sub> reductions can only be used if the actual dosage of monochloramine is known, not just the amount of combined chlorine.					
b. mg•min/L = Milligram-minutes per liter.					
c. mJ/cm <sup>2</sup> = Millijoules per square centimeter.					

Table 5. Typical values for various levels of the inactivation of enteric bacteria in filtered secondary effluent with selected disinfection processes.

Disinfectant	Unit <sup>b</sup>	Dose for Corresponding Log <sub>10</sub> Reduction Value			
		1 Log <sub>10</sub>	2 Log <sub>10</sub>	3 Log <sub>10</sub>	4 Log <sub>10</sub>
Free chlorine	mg•min/L	0.4–0.6	0.8–1.2	1.2–1.8	1.6–2.4
Chloramine <sup>a</sup>	mg•min/L	50–70	95–150	140–220	200–300
Peracetic acid	mg•min/L	10–25	40–60	75–125	150–200
Ozone	mg•min/L	0.005–0.01	0.01–0.02	0.02–0.03	0.03–0.04
Ultraviolet radiation	mJ/cm <sup>2</sup>	10–15	20–30	30–45	40–60
Advanced oxidation	mJ/cm <sup>2</sup>	4–6	6–8	8–10	10–12
Pasteurization (60°C)	Second	50	100	150	200
a. Due to interferences with chloro-organic compounds, when chloramine is used as a disinfectant, log <sub>10</sub> reductions can only be used if the actual dosage of monochloramine is known, not just the amount of combined chlorine.					
b. mg•min/L = Milligram-minutes per liter.					
c. mJ/cm <sup>2</sup> = Millijoules per square centimeter.					

### J.1.5 Treatment Trains

Most non-potable water systems use a number of unit processes in series to accomplish treatment, known commonly as the “multiple barrier” approach. Multiple barriers are used to improve the reliability of a treatment approach through process redundancy, robustness, and resiliency. When multiple treatment barriers are used to achieve the pathogen LRT, the contribution from each barrier is cumulative; therefore, a reduction in performance by one process is mitigated by other processes in the treatment train.

In addition to these treatment barriers, operational and management barriers are used to ensure that systems are in place to respond to non-routine operation. Treatment barriers can be monitored using sensors and instrumentation for continuous process monitoring. An important ability is to take the treatment train offline automatically in the event of process malfunction.

If each barrier in a treatment train is independent, the LRVs for each process in the treatment train can be added together to obtain the overall treatment train LRV.

### J.1.6 Volatile Organic Compounds

For rainwater harvesting systems that use general runoff from vehicular access areas as a source and will have some level of public exposure risk, the treated water must be tested for the presence of volatile organic compounds (VOCs); however, this does not apply when the water will be used for cooling towers or other “no public exposure” uses. The test must be performed by the system operator prior to commissioning of the system (see Commissioning) and prior to subsequent <local jurisdiction> maintenance inspections (see Operational Monitoring and Reporting). VOC levels must be below the maximums indicated in Table 6. If any VOC levels exceed these limits, the rainwater harvesting system must not be utilized until the problem is satisfactorily addressed, and a successful test has been performed. VOC limit exceedances may be addressed through source controls or through provision of additional treatment devices.

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(Supp. No. 45)

Table 6. Volatile organic compound maximum concentrations.

VOC	Maximum Concentration (mg/L) <sup>a</sup>
Benzene	0.1
Carbon Tetrachloride	0.5
1,2-Dichlorobenzene	5.4
1,4-Dichlorobenzene	5.4
1,1 Dichloroethane	14.4
1,2 Dichloroethane	0.1
1,1-Dichloroethylene	0.1
cis-1,2-Dichloroethylene	28.4
trans-1,2-Dichloroethylene	28.4
Dichloromethane	3.1
1,2-Dichloropropane	12.6
1,3-Dichloropropene	0.2
Ethylbenzene	15.6
Methyl-tert-butyl ether	5.2
Monochlorobenzene	1.7
Styrene	7.7
1,1,2,2-Tetrachloroethane	0.3
Tetrachloroethylene	6.1
Toluene	6.8
1,2,4-Trichlorobenzene	1.4
1,1,1-Trichloroethane	68.2
1,1,2-Trichloroethane	1.6
Trichloroethylene	4.8
Trichlorofluoromethane	201.1
1,1,2-Trichloro-1,2,2-Trifluoroethane	272.9
Vinyl Chloride	0.1
Xylenes	15.6
a. Values determined by the San Francisco Department of Public Health based on U.S. Occupational Safety and Health Administration Permissible Exposure Limits for 8-hour inhalation exposures to selected VOCs.	

### J.1.7 Storage and Distribution Management Practices

To achieve the desired objectives of public health protection, treated water must be properly stored and distributed to prevent compromising the quality of water after treatment. For example, opportunistic pathogens like *Legionella* could grow in the distribution system, sewage could contaminate treated water, or lead and copper (which cause toxicity) could leach from piping. Producing adequate quality non-potable water that meets all the pathogen control criteria set forth in this appendix is the first step in ensuring proper public health protection. The final step in quality control is to manage properly 1) storage and distribution systems and 2) the uses of non-potable water.

In rainwater harvesting systems, neither significant/routine ingestion nor direct contact with the treated water product is typically anticipated due to limited exposures to non-potable water. Nevertheless, the occurrence of aerosol inhalation and indirect contact requires the careful management of DNW system storage and distribution systems to control exposures to non-tuberculous mycobacterial and *Legionella* pathogens. For example, even clean drinking water may allow biofilm growth of *Legionella* (aerosol pathogen risk) if the water temperature is between 25°C and 45°C and stagnates, resulting in the presence of minimal residual chlorine.

A number of approaches are available to control microbial regrowth in distribution systems, each with varying benefits and drawbacks that depend on the characteristics and use of the system. Below are some recommended approaches for controlling microbial growth in distribution systems:

- **Producing non-potable water low in carbonaceous material and nutrient content**  
The primary energy source for pathogen regrowth is organic carbon measured as assimilable organic carbon, biodegradable dissolved organic carbon, total organic carbon, and other essential nutrients, including nitrogen (N), phosphorous (P), and iron (Fe); therefore, the primary means to reduce the regrowth potential of pathogens is to provide highly treated water. Reducing the potential for regrowth is more important in large-scale buildings or neighborhood/district-scale projects where there will be more residence time (creating more opportunities for regrowth) in distribution systems that supply non-potable water.
- **Producing highly disinfected non-potable water**  
Low concentrations of microbes resulting from filtration and advanced means of disinfection have a reduced potential for regrowth if organic carbon levels are low. Otherwise, there may be a need for a residual disinfectant to manage growth in larger community systems that produce aerosols. Post-treatment disinfection with UV radiation is a recommended means of disinfection that does not increase levels of assimilable organic carbon or biodegradable dissolved organic carbon.
- **Using non-reactive, biologically stable materials of construction**  
Avoid the use of corrosive materials or organic materials that tend to protect microorganisms from disinfection and enhance the regrowth environment by the adsorption of organic compounds.
- **Maintaining a residual disinfectant**  
Different disinfectants offer advantages and disadvantages to overall water quality and system management. In general, a higher disinfectant residual provides lower regrowth. Many design and operation considerations are available for each specific system. It is recommended that a free chlorine residual of 0.2 milligrams per liter (mg/L) or monochloramine residual of 2 to 3 mg/L be maintained at or near the point of use to control microbial growth. Chloramine provides a better residual duration as compared to chlorine. Various combinations of UV

(Supp. No. 45)

Created: 2021-07-22 09:11:36 [EST]

chlorine, chloramine, ozone, and hydrogen peroxide are beneficial for specific disinfection goals. Periodic shock treatments with disinfectants and continuous disinfection looping of reservoirs help reduce the potential for regrowth and manage issues with biofilms. Stagnation resulting from dead zones or prolonged periods of zero-flow or low flow that create long residence times and allow disinfectants to dissipate and sediments to deposit result in improved conditions for regrowth and should be avoided.

- **Cleaning storage tanks**

The required frequency of storage tank cleaning varies depending upon the quality of water stored, detention time in storage, temperature of the water, and nature of the tank. Tanks that are open to the atmosphere require more frequent cleaning.

- **Flushing the distribution system**

The required frequency of distribution system flushing varies depending upon the quality of water transmitted, detention time in the distribution system, temperature of the water, and nature of the distribution system components. Periodic flushing is a good means of both removing sediments and scouring pipe walls. System design must include means for easily flushing pipes as part of routine maintenance.

- **Controlling temperature**

Avoid the storage and distribution of non-potable water within 20°C to 45°C to reduce the potential for pathogen regrowth. Otherwise, consider a disinfection residual or point-of-use system, particularly if aerosols are generated.

The rainwater harvesting system designer and Person Responsible for Maintenance each should review published guidelines for the management of Legionella in distribution systems and implement as appropriate for each specific system. In particular, ANSI/ASHRAE Standard 188-2015 Legionellosis: Risk Management for Building Water Systems (2015) provides guidance on stormwater best management practices (BMPs) for both potable and non-potable water systems. It addresses management program responsibilities, system design, risk analysis, control mechanisms, monitoring, confirmation, and documentation. Although the ASHRAE Standard targets legionellosis, its rationales and approaches are applicable to all pathogens and health risks identified in this appendix.

#### J.1.8 Commissioning

In the process of initializing a rainwater harvesting system, the system must be evaluated for leaks in the storage unit and the performance of the components of the treatment and distribution system. A commissioning report of the evaluation is required at the initial startup of the system and anytime the system is brought back online after cleaning, flushing, and/or a hiatus of use (e.g., winter shutdown).

#### J.1.9 Operational Monitoring and Reporting

The Person Responsible for Maintenance, as identified in the Stormwater Management Plan (SWMP), must maintain the rainwater harvesting system in good working condition and assure adequate treatment of the harvested rainwater. All systems, with the exception of those installed in single-family homes, shall include continuous monitoring systems that are capable of determining if the rainwater harvesting system is operating within the design specification, and if all system components of the rainwater harvesting system are functional.



Data logs from continuous monitoring systems must be kept on file and produced upon request from *<local jurisdiction>*. In addition, annual reports must be generated that identify the following:

- Significant maintenance activities;
- Treatment modifications;
- Outages and malfunctions (including reasons and durations); and
- Steps taken to mitigate or eliminate recurrence of outages and malfunctions.

If there is a change of personnel—Person Responsible for Maintenance—it is the responsibility, within 15 business days, of the owner of the rainwater harvesting system or her/his agent to update the *<local jurisdiction>* with the name and contact information of the new personnel.

An operation and maintenance manual that includes a schematic drawing of the system, standard operating procedures for the system, and maintenance schedule(s), as well as commissioning reports, field verification reports, and annual reports must be on site and produced upon request from *<local jurisdiction>*.

#### J.1.10 Field Verification

Field verification is a performance confirmation of a rainwater harvesting system. It can be accomplished by physically observing the collection, storage, and distribution system, and the treatment process components. It can also be conducted using challenge testing, including surrogate microorganisms and/or other non-biological surrogates and typically involves manual collection of water samples for microbial analysis to check system performance in achieving LRTs. While not specifically required, *<local jurisdiction>* construction or maintenance inspections may include field verification testing to ensure that the rainwater harvesting system is achieving its LRTs, and that operational monitoring and control systems are functional.

#### J.1.11 Design Report

A design report must be submitted with each rainwater harvesting system that includes, at a minimum, the following:

- Pathogen log<sub>10</sub> reduction target
- Proposed treatment process and associated log<sub>10</sub> reduction value
- Proposed storage and distribution management practices
- Identification of the Person Responsible for Maintenance
  - Operation and Maintenance Manual
- Reliability analysis that identifies the following:
  - How the equipment used to monitor treatment, operations, and water quality enables determination of whether the system is working as planned.
  - How the monitoring and controls of the system will enable the operator or automatic controls to intervene in the event of the production of off-specification water.
  - Remedies and provisions for operation disruption (e.g., power failures, vandalism, and excessive source contamination)
  - Unauthorized access limitations for the rainwater harvesting and distribution system.

J.1.12 Treatment Design Examples**Example 1: Rooftop Runoff for Landscape Irrigation****1) Identify the log<sub>10</sub> reduction targets for the reference pathogen groups.**

Since the roof will not allow frequent public access, the water source qualifies as roof runoff rather than general runoff. No LRT is provided for enteric bacteria or parasitic protozoa, but an LRT of 3.5 is defined for enteric bacteria.

**2) Select a treatment process to achieve the log<sub>10</sub> reduction target.**

An ozone system with a CT value (the product of concentration and contact time) of 0.04 mg • min/L can achieve 4-log<sub>10</sub> reduction of enteric bacteria. However, as all disinfection processes require removal of particles 10 microns or larger, a 10-micron cartridge filter or similar device will also be necessary (see Figure 1).

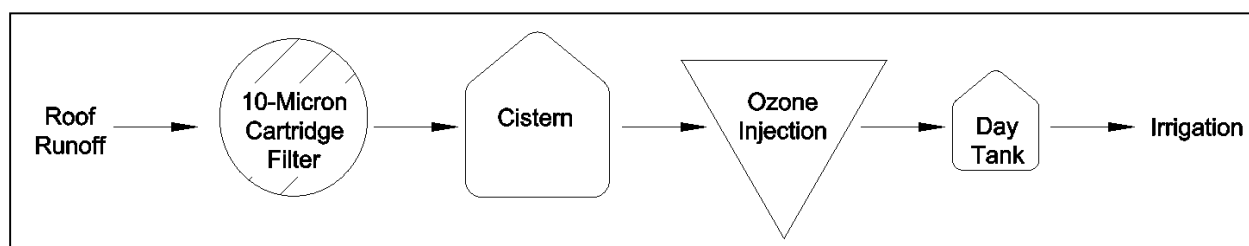


Figure 1. Example 1 treatment schematic.

Alternative treatment trains that also could meet the required LRT include the following:

- Microfiltration (i.e., 6-log<sub>10</sub> reduction of bacteria).
- Sand filter with an equivalent effluent particle size distribution of 10 microns, followed by UV radiation with a dose of 40 to 60 mJ/cm<sup>2</sup> (i.e., 4-log<sub>10</sub> inactivation of bacteria).
- Cartridge filtration (10 microns), followed by chlorination with free chlorine with a CT value of 1.6 to 2.4 mg•min/L (i.e., 4-log<sub>10</sub> inactivation of bacteria).

**3) Determine storage and distribution management practices.**

For non-potable water systems, consider the chemical characteristics of roof runoff and storage conditions, as follows:

- Due to its high purity, roof runoff may result in the corrosion of components and fixtures of the metallic distribution system. If any metallic pipe, fittings, solder, or fixtures are used that may be subject to corrosion from contact with aggressive water, then modify the water system or add a corrosion inhibitor to the non-potable water supply.
- If the temperature of water in the non-potable water distribution system exceeds 25°C (which is a condition that could promote the growth of opportunistic pathogens like *Legionella*), then maintain a free chlorine residual of 0.2 milligrams per liter (mg/L) or chloramine residual of 0.5 mg/L at or near the point of use.

**4) Identify maintenance and monitoring requirements and schedule of activities.**

These will vary based on the specific equipment and devices included in each design.

**5) Submit design report and SWMP.**

**Example 2: General Runoff for Indoor Use****1) Identify the  $\log_{10}$  reduction targets for the reference pathogen groups.**

The proposed rainwater harvesting system will capture runoff from two different areas on a rooftop. The first area will have no public access, but the second area includes a patio area that is designed for public access. The combined water from the two areas is therefore considered “general runoff,” and will need to be treated accordingly. The LRT for both enteric viruses and protozoa is 5.5, and the LRT for enteric bacteria is 5.0.

**2) Select a treatment process to achieve the  $\log_{10}$  reduction target.**

An ultrafiltration system can achieve 6- $\log_{10}$  reduction of viruses, protozoa, and bacteria (see Figure 2).

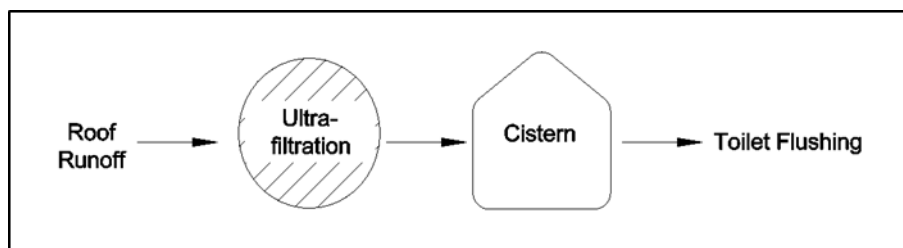


Figure 2. Example 2 treatment schematic.

The only alternative processes that can also meet the required LRTs are nanofiltration and reverse osmosis.

**3) Determine storage and distribution management practices.**

For non-potable water systems, consider the chemical characteristics of roof runoff and storage conditions, as follows:

- Due to its high purity, roof runoff may result in the corrosion of components and fixtures of the metallic distribution system. If any metallic pipe, fittings, solder, or fixtures are used that may be subject to corrosion from contact with aggressive water, then modify the water system or add a corrosion inhibitor to the non-potable water supply.
- If the temperature of water in the non-potable water distribution system exceeds 25°C (which is a condition that could promote the growth of opportunistic pathogens like Legionella), then maintain a free chlorine residual of 0.2 milligrams per liter (mg/L) or chloramine residual of 0.5 mg/L at or near the point of use.

**4) Identify maintenance and monitoring requirements and schedule of activities.**

These will vary based on the specific equipment and devices included in each design.

**5) Submit design report and SWMP.**

**Example 3: Roof Runoff for Cooling Towers****1) Identify the log<sub>10</sub> reduction targets for the reference pathogen groups.**

As there is not public exposure to the harvested rainwater, there are not initial treatment requirements. Chlorination may still be required to control the growth of opportunistic pathogens however (see Step 2).

**2) Determine storage and distribution management practices.**

For non-potable water systems, consider the chemical characteristics of roof runoff and storage conditions, as follows:

- Due to its high purity, roof runoff may result in the corrosion of components and fixtures of the metallic distribution system. If any metallic pipe, fittings, solder, or fixtures are used that may be subject to corrosion from contact with aggressive water, then modify the water system or add a corrosion inhibitor to the non-potable water supply.
- If the temperature of water in the non-potable water distribution system exceeds 25°C (which is a condition that could promote the growth of opportunistic pathogens like Legionella), then maintain a free chlorine residual of 0.2 milligrams per liter (mg/L) or chloramine residual of 0.5 mg/L at or near the point of use.

**3) Identify maintenance and monitoring requirements and schedule of activities.**

These will vary based on the specific equipment and devices included in each design.

**4) Submit design report and SWMP.****J.2 Rainwater Harvesting Storage Volume Calculator Instructions****Input Sheet**

The cells of the spreadsheet are color coded as follows:

**Color Code**

	Title/New Category
	Required Entry value
	Alternate Category Entry (if selected, do not enter value into "Required Entry value")
	Final Category Value

**Design Storm (inches)**

Cell L4 Choose either 1.16 inches or 1.95 inches depending on the Watershed Protection Area in which the project is located.

**CONTRIBUTING DRAINAGE AREA (CDA)**

Cell L7, L9, L11 Indicate the impervious CDA, the turf cover CDA, and the runoff coefficient (Rv) for the turf cover. The turf cover Rv should range between 0.15 and 0.25. The CDA is assumed to convey 95 percent of the rainfall that lands on its impervious surface and 15 - 25 percent of the rainfall that lands on its turf cover area.

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

**CONTRIBUTING BMPS**

Cell L17 Enter the retention volume as well as the overflow from the Design Storm for any BMPs that drain to the cistern. Both of these values can be found in the SoLoCo Compliance Calculator. The retention volume is in the "Volume Credited" column, and the overflow volume is in the "Remaining Volume" column.

**The following instructions identify how the collected rainwater will be used. Only fill in the sections that are applicable to the site.**

**IRRIGATION**

Cells L23, L25 Indicate the area to be irrigated in square feet and if the irrigation system as smart controls.

Row A31-L31 The spreadsheet allows for irrigation to be used in certain months. Indicate, for each month, the average weekly irrigation application rate in either inches per week or gallons per month.

The EPA WaterSense Water Budget Tool can be used to calculate Monthly Landscape Water Requirement (based on the site's peak watering month). The output for this calculation is found on the Part 2-LWA sheet, which can be found at the following link: <https://www.epa.gov/watersense/water-budget-tool>

**INDOOR DEMAND - FLUSHING TOILETS/URINALS**

Cell L35 Indicate the number of people using the building.

Cells L35, L37 The values in **lines 35 and 37** can be altered depending on how much water is used when flushing urinals or toilets. The default values are 0.80 gallons/flush and 1.60 gallons/flush for urinals and toilets, respectively.

Cell L39 If the user knows the daily toilet and urinal demand, that value can be input into **line 39** and the information in the rows above will not be used.

Cells L44, L46, L48 Indicate the first and last day of the week that the building will be in use and the number of hours each day the building will be occupied.

**INDOOR DEMAND - LAUNDRY**

Cell L54 Indicate the number of loads of laundry done each day.

Cell L54 The value in **line 54** can be altered depending on how much water is used for each load of laundry. The default value is 42 gallons per load.

Cell L56 If the user knows the daily laundry demand, the value can be input into **line 56** and the information in the rows above will not be used.

Cells L60, L62 Indicate the first and last day of the week when the water will be used.

**ADDITIONAL DAILY USE**

Row A71-L71 If there is any other additional daily use not covered in the spreadsheet, **line 69** can accommodate additional demand. Indicate, for each month, the average daily demand in gallons per day.

Cells L73, L75 Indicate the first and last day of the week when the water will be used.

Created: 2021-07-22 09:11:36 [EST]

**COOLING TOWERS**

Row A79-L79 If the rainwater collected is to be used for cooling towers, indicate in **line 79** the average daily demand in gallons per day for each month the cooling towers use the collected rainwater.

The following section allows for additional contribution to the cistern from sources other than rainwater.

**CONTRIBUTION FROM OTHER SOURCES**

Row A88-L88 If there are other sources of water that contribute to the cistern, indicate the average daily contribution in gallons per day for each month

Cells L90,  
L92 Indicate the first and last day of the week when the water will be input.

**FIRST FLUSH FILTER DIVERSION AND EFFICIENCY**

This section accounts for the filter efficiency of the cistern. It is assumed that, after the first flush diversion and loss of water due to filter inefficiencies, the remainder of the SWRv storm will be successfully captured. These minimum values can be altered if appropriate.

Cell L98 **Line 98** indicates that for the 1.16-inch storm, a minimum of 95 percent of the runoff should be conveyed into the cistern.

Cell L100 **Line 100** indicates that for the 4.19-inch storm, a minimum of 90 percent of the runoff should be conveyed.

**Storage Volume Results Sheets**

These sheets give a range of possible cistern sizes and the corresponding storage volume available. Once a cistern size is chosen, the corresponding storage volume may be used in the Stormwater Database.

The table on this sheet has the following information.

- **Cistern Volume** (gallons) – This row gives a range of cistern sizes in gallons based on the CDA size.
- **Daily Average Available Storage Volume** (gallons or cubic feet) – This row shows the average available storage capacity of a given cistern (Sv). Use the Sv that corresponds to the cistern size selected for the site for the General Retention Calculator.
- **Overflow Volume (Sv)** (gallons or cubic feet) – This row shows the average overflow created by a 1.7" storm for various cistern sizes, based on average available storage volumes.

The graph shows a trade-off curve, which allows for a comparison of the retention achieved versus cistern size. While larger cisterns yield more retention, they are more costly. The curve helps the user to choose the appropriate cistern size, based on the design objectives and site needs. The overflow volume is also plotted to illustrate the effects of cistern size on overflow volume.

## Southern Low Country -- RAINWATER HARVESTING STORAGE VOLUME CALCULATOR v1.1, August 26, 2020

## Input Sheet

The cells of the spreadsheet are color coded as follows:

## Color Code

Title/New Category

Required Entry value

Alternate Category Entry (if selected, do not enter value into "Required Entry value")

Final Category Value

## Design Storm (inches)

Choose either 1.16 inches or 1.95 inches depending on the Watershed Protection Area in which the project is located.

## CONTRIBUTING DRAINAGE AREA (CDA)

Indicate the impervious CDA, the turf cover CDA, and the runoff coefficient (Rv) for the turf cover. The turf cover Rv should range between 0.15 and 0.25. The CDA is assumed to convey 95 percent of the rainfall that lands on its impervious surface and 15 - 25 percent of the rainfall that lands on its turf cover area.

## CONTRIBUTING BMPs

Enter the retention volume as well as the overflow from the Design Storm for any BMPs that drain to the cistern. Both of these values can be found in the Soil-CO Compliance Calculator. The retention volume is in the "Volume Credited" column, and the overflow volume is in the "Remaining Volume" column.

The following instructions identify how the collected rainwater will be used. Only fill in the sections that are applicable to the site.

## IRRIGATION

Indicate the area to be irrigated in square feet and if the irrigation system is smart controls. The spreadsheet allows for irrigation to be used in certain months. Indicate, for each month, the average weekly irrigation application rate in other inches per week or gallons per month. The EPA Watersense Water Budget Tool can be used to calculate Monthly Landscape Water Requirement (based on the site's peak watering month). The output for this calculation is found on the Part 2-LWA sheet, which can be found at the following link: <https://www.epa.gov/watersense/water-budget-tool/>

## INDOOR DEMAND - FLUSHING TOILETS/URINALS

Indicate the number of people using the building. The values in lines 35 and 37 can be altered depending on how much water is used when flushing urinals or toilets. The default values are 0.80 gallons/flush and 1.60 gallons/flush for urinals and toilets, respectively. If the user knows the daily toilet and urinal demand, that value can be input into line 39 and the information in the rows above will not be used. Indicate the first and last day of the week that the building will be in use and the number of hours each day the building will be occupied.

## INDOOR DEMAND - LAUNDRY

Indicate the number of loads of laundry done each day. The value in line 54 can be altered depending on how much water is used for each load of laundry. The default value is 42 gallons per load. If the user knows the daily laundry demand, the value can be input into line 56 and the information in the rows above will not be used. Indicate the first and last day of the week when the water will be used.

## ADDITIONAL DAILY USE

If there is any other additional daily use not covered in the spreadsheet, line 69 can accommodate additional demand. Indicate, for each month, the average daily demand in gallons per day. Indicate the first and last day of the week when the water will be used.

## COOLING TOWERS

If the rainwater collected is to be used for cooling towers, indicate in line 79 the average daily demand in gallons per day for each month the cooling towers use the collected rainwater.

The following section allows for additional contribution to the cistern from sources other than rainwater.

## CONTRIBUTION FROM OTHER SOURCES

If there are other sources of water that contribute to the cistern, indicate the average daily contribution in gallons per day for each month. Indicate the first and last day of the week when the water will be input.

## FIRST FLUSH FILTER DIVERSION AND EFFICIENCY

This section accounts for the filter efficiency of the cistern. It is assumed that, after the first flush diversion and loss of water due to filter inefficiencies, the remainder of the SWR's storm will be successfully captured. These minimum values can be altered if appropriate.

Line 96 indicates that for the 1.16-inch storm, a minimum of 95 percent of the runoff should be conveyed into the cistern.

Line 98 indicates that for the 4.19-inch storm, a minimum of 90 percent of the runoff should be conveyed.

## Storage Volume Results Sheets

These sheets give a range of possible cistern sizes and the corresponding storage volume available. Once a cistern size is chosen, the corresponding storage volume may be used in the Stormwater Database.

The table on this sheet has the following information.

- Cistern Volume (gallons)** - This row gives a range of cistern sizes in gallons based on the CDA size.
- Daily Average Available Storage Volume (gallons or cubic feet)** - This row shows the average available storage capacity of a given cistern (Sv). Use the Sv that corresponds to the cistern size selected for the site for the General Retention Calculator.
- Overflow Volume (Sv) (gallons or cubic feet)** - This row shows the average overflow created by a 1.7" storm for various cistern sizes, based on average available storage volumes.

The graph shows a trade-off curve, which allows for a comparison of the retention achieved versus cistern size. While larger cisterns yield more retention, they are more costly. The curve helps the user to choose the appropriate cistern size, based on the design objectives and site needs. The overflow volume is also plotted to illustrate the effects of cistern size on overflow volume.



[illegible]

Storage Volume Summary

Average Daily Available Storage Volume by Month and Cistern Volume																			
Month\ Cistern Volume (gallons)	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500	8,000	8,500	9,000	9,500
January	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
February	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
March	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
April	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
May	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
June	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
July	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
August	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
September	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
October	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
November	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
December	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Daily Average Available Storage Volume, SV (cubic feet)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Note: Cistern Volume does not include detention for larger storm events. Detention volume that will be drawn down after each storm event should be modeled separately.																			
Overflow Volume from a 1.16-Inch Rain Event by Cistern Volume																			
Cistern Volume (Gallons)	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500	8,000	8,500	9,000	9,500
Overflow Volume (cubic feet)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

# Daily Averages of Available Storage (Sv) and Overflow Volu

1

1

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me (cubic feet)

## Appendix L: Glossary

A	
Advanced Design (AD)	<p>Detailed design for an area of a project described explicitly in the following:</p> <ul style="list-style-type: none"> <li>• Stage II planned unit development (PUD) application to the District of Columbia Zoning Commission;</li> <li>• Application for design review under the Capitol Gateway Overlay District to the District Zoning Commission; and</li> <li>• Final design submission to the National Capital Planning Commission (NCPC)</li> </ul>
Affordable housing	A single-family or two-family house that is built to be offered for rent or for sale for residential occupancy below market value and is made available to, and affordable to, a household whose income is equal to, or less than, eighty percent (80%) of the Area Median Income calculation provided by the United States Department of Housing and Urban Development
Animal confinement area	An area, including a structure, used to stable, kennel, enclose, or otherwise confine animals, not including confinement of a domestic animal on a residential property
Applicant	A person or their agent who applies for approval pursuant to this chapter
As-built plan	A set of architectural, engineering, or site drawings, sometimes including specifications that certify, describe, delineate, or present details of a completed construction project
Athletic playing fields	Compacted land cover and synthetic surfaces that are constructed primarily for use for athletic activities at public parks and schools. Compacted land cover and synthetic surfaces for which athletic activities are not the primary use are not considered athletic playing fields, unless these areas are necessary to support use of an adjacent area that is primarily used for athletic activities. Synthetic surfaces must have a minimum surface permeability of at least 10 inches per hour, in accordance with ASTM F2898 Standard Test Method for Permeability of Synthetic Turf Sports Field Base Stone and Surface System by Non-confined Area Flood Test Method
B	
Best management practice (BMP)	Structural or nonstructural practice that minimizes the impact of stormwater runoff on receiving waterbodies and other environmental resources, especially by reducing runoff volume and the pollutant loads carried in that runoff
Buffer	An area along a stream, river, or other natural feature that provides protection for that feature
Building permit	Authorization for construction activity issued by the <i>&lt;local jurisdiction&gt;</i>
C	

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(Supp. No. 45)

L1

Clearing	The removal of trees and brush from the land excluding the ordinary mowing of grass, pruning of trees or other forms of long-term landscape maintenance
Combined sewer overflow (CSO)	The discharge of untreated effluent into a water body as a result of the combined volume of stormwater and sanitary water exceeding the capacity of the combined sewer system and wastewater treatment plant
Combined sewer system (CSS)	Sewer system in which stormwater runoff is conveyed together with sanitary wastewater through sewer lines to a wastewater treatment plant
Common plan of development	Multiple, separate, and distinct land-disturbing, substantial improvement, or other construction activities taking place under, or to further, a single, larger plan, although they may be taking place at different times on different schedules
Compacted cover	An area of land that is functionally permeable, but where permeability is impeded by increased soil bulk density as compared to natural cover, such as through grading, construction, or other activity and will require regular human inputs such as periodic planting, irrigation, mowing, or fertilization. Examples include landscaped planting beds, lawns, or managed turf
Conservation area	An area with a natural cover designation set aside to receive stormwater runoff as part of an impervious surface disconnection practice
Construction	Activity conducted for the following: <ul style="list-style-type: none"> <li>• Building, renovating, modifying, or razing a structure; or</li> <li>• Moving or shaping of earth, sediment, or a natural or built feature</li> </ul>
Contributing drainage area (CDA)	Area contributing runoff to a BMP
Control measure	Technique, method, device, or material used to prevent, reduce, or limit discharge
Critical area stabilization	Stabilization of areas highly susceptible to erosion, including down-slopes and side-slopes, through the use of brick bats, straw, erosion control blanket mats, gabions, vegetation, and other control measures
Cut	An act by which soil or rock is dug into, quarried, uncovered, removed, displaced, or relocated and the conditions resulting from those actions
<b>D</b>	
Demolition	The removal of part or all of a building, structure, or built land cover
Detention	Controlling the peak discharge rate of stormwater from a site
Dewatering	Removing water from an area or the environment using an approved technology or method, such as pumping
Director	The local administrator of the stormwater construction permits.
<b>E</b>	

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(Supp. No. 45)

L2

Easement	A right acquired by a person to use another person's land for a special purpose
Electronic media	Means of communication via electronic equipment, including the internet
Energy Grade Line	The energy grade line represents the total energy at any point along the culvert (pipe) barrel.
Erosion	The process by which the ground surface, including soil and deposited material, is worn away by the action of wind, water, ice, or gravity
Excavation	An act by which soil or rock is cut into, dug, quarried, uncovered, removed, displaced or relocated and the conditions resulting from those actions
Exposed area	Land that has been disturbed or land over which unstabilized soil or other erodible material is placed
<b>F</b>	
<b>G</b>	
Grading	Causing disturbance of the earth, including excavating, filling, stockpiling of earth materials, grubbing, root mat or topsoil disturbance, or any combination of them
<b>H</b>	
Hydraulic Grade Line	The hydraulic grade line is the depth to which water would rise in vertical tubes connected to the side of the culvert (pipe) barrel.
<b>I</b>	
Impervious cover	A surface area that has been compacted or covered with a layer of material that impedes or prevents the infiltration of water into the ground, examples include conventional streets, parking lots, rooftops, sidewalks, pathways with compacted sub-base, and any concrete, asphalt, or compacted gravel surface and other similar surface
Infiltration	The passage or movement of surface water through the soil profile
<b>J</b>	
<b>K</b>	
<b>L</b>	
Land cover	Surface of land that is impervious, compacted, or natural
Land cover change	Conversion of land cover from one type to another, typically in order to comply with a requirement of this chapter.
Land-disturbing activity	Movement of earth, land, or sediment that disturbs the land surface and the related use of pervious land to support that movement. Land-disturbing activity includes stripping, grading, grubbing, trenching, excavating, transporting, and filling of land, as well as the use of pervious adjacent land for movement and storage of construction vehicles and materials. Land-disturbing activity does not include repaving or re-milling that does not expose the underlying soil

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Low impact development (LID)	A land-planning and engineering-design approach to manage stormwater runoff within a development footprint. It emphasizes conservation, the use of on-site natural features, and structural stormwater BMPs to store, infiltrate, evapotranspire, retain, and detain rainfall as close to its source as possible with the goal of mimicking the runoff characteristics of natural cover
<b>M</b>	
Maintenance agreement	See Section 5.5.2 Maintenance Agreement
Maintenance contract	See “maintenance agreement”
Maintenance responsibility	See Section 5.5.1 Maintenance Responsibility
Maintenance plan	Planned scheduled maintenance for the life of the BMP
Maintenance schedule	See “maintenance plan”
Maintenance standards	Detailed maintenance plan laid out in Exhibit C within declaration of covenants
Major land-disturbing activity	<p>A distinct project or a part of a larger common plan of development that involves the creation, addition or replacement of 5000 square feet of impervious surface, or that involves one acre or greater of land disturbing activities. New development regardless of size, that is part of a larger common plan of development, even though multiple, separate and distinct land disturbing activities, may take place at different times and on different schedules.</p> <p>Multiple distinct areas that each disturb one acre of land, that are in separate, non-adjacent sites, and that are not part of a larger common plan of development do not constitute a major land-disturbing activity.</p>
Major Substantial Improvement	a renovation or addition to a structure or existing property that meets both of the following cost and size thresholds: a) construction costs for the building renovation/addition are greater than or equal to 50% of the pre-project assessed value of the structure as developed using current Building Valuation Data of the International Code Council, and b) combined footprint of structure(s) exceeding the cost threshold and any land disturbance are greater than or equal to 5,000 square feet.
<b>N</b>	
Natural cover	Land area that is dominated by vegetation and does not require regular human inputs such as irrigation, mowing, or fertilization to persist in a healthy condition. Examples include forest, meadow, or pasture
Non-structural BMP	A land use, development, or management strategy to minimize the impact of stormwater runoff, including conservation of natural cover or disconnection of impervious surface
<b>O</b>	
Off-site retention	Use of property not within the limits of disturbance of the project to comply with the stormwater retention volumes required by this Manual

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Off-site retention volume (Off <sub>v</sub> )	A portion of a required stormwater retention volume or required water quality treatment volume that is not retained on site
On-site retention	Retention of a site's stormwater on that site or via conveyance to a shared stormwater BMP on another site
On-site stormwater management	Retention, detention, or treatment of stormwater on site or via conveyance to a shared stormwater BMP
Owner	The person who owns real estate or other property, or that person's agent
<b>P</b>	
Peak discharge	The maximum rate of flow of water at a given point and time resulting from a storm event
Permeable athletic track	A surface, including a surface made of synthetic material, located at a school or public park that is used for athletic purposes including biking, running, and walking, and that allows the infiltration of water into the ground. The track must have a minimum surface permeability of at least 10 inches per hour, in accordance with the ASTM F2898 Standard Test Method for Permeability of Synthetic Turf Sports Field Base Stone and Surface System by Non-confined Area Flood Test Method
Permeable playground surface	A surface, including a surface made of synthetic material, located under a playground area at a school or public park, that allows the infiltration of water into the ground. The playground surface must have a minimum surface permeability of at least 10 inches per hour, in accordance with ASTM F2898 Standard Test Method for Permeability of Synthetic Turf Sports Field Base Stone and Surface System by Non-confined Area Flood Test Method
Person	A legal entity, including an individual, partnership, firm, association, joint venture, public or private corporation, trust, estate, commission, board, public or private institution, cooperative, the <local authority> and its agencies, the State of South Carolina and its agencies, and the federal government and its agencies
Pervious area	Area with a compacted cover designation set aside to receive stormwater runoff as part of an impervious surface disconnection practice
Post-development	Describing conditions that may be reasonably expected to exist after completion of land development activity on a site
Practice	A system, device, material, technique, process, or procedure that is used to control, reduce, or eliminate an impact from stormwater; except where the context indicates its more typical use as a term describing a custom, application, or usual way of doing something
Preconstruction meeting	The mandatory meeting occurring prior to any construction, including the owner, the designer, the installer, and the DHEC inspector. This meeting must contain an on-site component to evaluate the SWMP against existing site conditions. This should include, at a minimum, a visual examination of land cover types, the tree preservation plan, boundaries of the CDA(s), the existing inlet elevation(s) to ensure they conform to original design

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Predevelopment	Describing conditions of meadow land and its relationship to stormwater before human disturbance of the land
Pre-project	Describing conditions, including land covers, on a site that exist before the construction described in a Stormwater Management Plan has begun
Publicly-owned or publicly-financed project	A project: <ul style="list-style-type: none"> <li>a. That is municipally-owned or municipality-instrumentality-owned;</li> <li>b. Where at least 15% of the project's total cost is municipally-financed or municipality-instrumentality-financed; or</li> <li>c. That includes a gift, lease, or sale from municipally-owned or municipality-instrumentality-owned property to a private entity</li> </ul>
Public right-of-way (PROW)	The surface, the air space above the surface (including air space immediately adjacent to a private structure located on public space or in a public right-of-way), and the area below the surface of any public street, bridge, tunnel, highway, railway track, lane, path, alley, sidewalk, or boulevard
Public space	All the publicly owned property between the property lines on a street, park, or other public property as such property lines are shown on the records of the State. This includes any roadway, tree space, sidewalk, or parking between such property lines, but it excludes adjacent parks and other public property that is not associated with the public right-of-way
<b>Q</b>	
<b>R</b>	
Raze	The complete removal of a building or other structure down to the ground or to its foundation
Responsible person	Construction personnel knowledgeable in the principles and practices of erosion and sediment control and certified by a Department-approved soil erosion and sedimentation control training program to assess conditions at the construction site that would impact the effectiveness of a soil-erosion or sediment-control measure on the site
Retention	Keeping a volume of stormwater runoff on site through infiltration, evapotranspiration, storage for non-potable use, or some combination of these
Retention capacity	The volume of stormwater that can be retained by a stormwater BMP or land cover
Retrofit	A stormwater BMP or land cover installed in a previously developed area to improve stormwater quality or reduce stormwater quantity relative to current conditions
Runoff	The portion of precipitation (including snow-melt) that travels over the land surface, and also from rooftops, either as sheetflow or as channel flow, in small trickles and streams, into the main water courses

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

S	
Savannah River Watershed Protection Area	
Sediment	Soil, including soil transported or deposited by human activity or the action of wind, water, ice, or gravity
Sedimentation	The deposition or transportation of soil or other surface materials from one place to another as a result of an erosion process
Shared BMP (S-BMP)	A stormwater BMP, or combination of BMPs, providing stormwater management for stormwater conveyed from another site or sites
Single- or two-family house	An individual house, townhouse, or rowhouse designed and used for occupancy by one or two families. An individual house, townhouse, or rowhouse that has been physically altered for use by more than one or two families is not considered a single- or two-family house
Site	A tract, lot or parcel of land, or a combination of tracts, lots, or parcels of land for which development is undertaken as part of a unit, sub-division, or project. The mere divestiture of ownership or control does not remove a property from inclusion in a site
Site drainage area (SDA)	The area that drains stormwater from the site to a single discharge point or sheet flows from a single area off the site
Soil	All earth material of whatever origin that overlies bedrock and may include the decomposed zone of bedrock that can be readily excavated by mechanical equipment
Soil erosion and sediment control plan	A set of drawings, calculations, specifications, details, and supporting documents related to minimizing or eliminating erosion and off-site sedimentation caused by stormwater on a construction site. It includes information on construction, installation, operation, and maintenance
Soils report	A geotechnical report addressing all soil erosion and sediment control-related soil attributes, including but not limited to site soil drainage and stability
Special watershed protection areas	Areas identified by US Geological Survey 12-digit Hydrologic Unit Code (HUC 12) in the Southern Low Country Stormwater Design Manual that require area-specific stormwater standards
Storm sewer	A system of pipes or other conduits that carries or stores intercepted surface runoff, street water, and other wash waters, or drainage, but excludes domestic sewage and industrial wastes
Stormwater	Flow of water that results from runoff, snow melt runoff, and surface runoff and drainage
Stormwater management	A system to control stormwater runoff with structural and non-structural stormwater BMPs, including the following: (a) quantitative control of volume and rate of surface runoff and (b) qualitative control to reduce or eliminate pollutants in runoff
Stormwater Management Plan (SWMP)	A set of drawings, calculations, specifications, details, and supporting documents related to the management of stormwater for a site. A SWMP includes information on construction, installation, operation, and maintenance

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(Supp. No. 45)

Stormwater Pollution Prevention Plan (SWPPP)	A document that identifies potential sources of stormwater pollution at a construction site, describes practices to reduce pollutants in stormwater discharge from the site, and may identify procedures to achieve compliance
Stormwater retention volume (SWRV)	Volume of stormwater from a site for which the site is required to achieve retention
Stripping	An activity that removes or significantly disturbs the vegetative surface cover including clearing, grubbing of stumps and rock mat, and top soil removal
Substantial improvement	A repair, alteration, addition, or improvement of a building or structure, the cost of which equals or exceeds 50% of the market value of the structure before the improvement or repair is started
Structural stormwater BMP	A practice engineered to minimize the impact of stormwater runoff, including a bioretention, green roof, permeable pavement, system to capture stormwater for non-potable uses, etc.
Supplemental review	A review that <i>&lt;local jurisdiction&gt;</i> conducts after the review it conducts for a first resubmission of a plan
Swale	A narrow low-lying stretch of land that gathers or carries surface water runoff
<b>T</b>	
Total suspended solids (TSS)	The entire amount of organic and inorganic particles dispersed in water. TSS is measured by several methods, which entail measuring the dry weight of sediment from a known volume of a subsample of the original
<b>U</b>	
<b>V</b>	
<b>W</b>	
Waste material	Construction debris, dredged spoils, solid waste, sewage, garbage, sludge, chemical wastes, biological materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial or municipal waste
<b>X</b>	
<b>Y</b>	
<b>Z</b>	

## Appendix M: References and Resources

### M.1 References

The following documents provide more detailed information on many aspects of BMP design than is found in this Manual. These resources may be useful for those looking to develop greater understanding of individual BMPs or stormwater design in general. Recommendations in these resources may be used to inform BMP designs; however, where conflicts occur between these resources and the Manual, the requirements of the Manual prevail.

- American Association of State Highway and Transportation Officials (AASHTO). 1993. AASHTO Guide for Design of Pavement Structures, 4th Edition with 1998 Supplement. Washington, D.C.
- Arendt, R. G. 1996. Conservation design for subdivisions. A practical guide to creating open space networks. Washington, DC: Island Press. 184 p.
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## M.2 Resources for Natural Resources Survey

Resource Group	Resource Type	Sources for Information
General Resources	<ul style="list-style-type: none"> <li>•Topography</li> <li>•Natural Drainage Divides</li> <li>•Natural Drainage Patterns</li> <li>•Natural Drainage Features (e.g., Swales, Basins, Depressional Areas)</li> <li>•Soils</li> <li>•Erodible Soils Comes with soil survey</li> <li>•Steep Slopes (e.g., Areas with Slopes Greater Than 15%) Can determine from DEM or query soil types with steep slopes. Recommend the former for accuracy.</li> <li>•Trees and Other Existing Vegetation – Can use NLCD data to get forest land cover</li> <li>•Impervious surfaces</li> <li>•Protected Lands</li> </ul>	<p>LiDAR:  <a href="https://coast.noaa.gov/dataviewer/index.html#/lidar/search/">https://coast.noaa.gov/dataviewer/index.html#/lidar/search/</a></p> <p>Major basin boundaries:  <a href="https://apps.dhec.sc.gov/GIS/ClearingHouse/">https://apps.dhec.sc.gov/GIS/ClearingHouse/</a></p> <p>Soils:  <a href="https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx">https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx</a></p> <p>Land Cover (NLCD): <a href="https://www.mrlc.gov/data">https://www.mrlc.gov/data</a></p> <p>Land Cover (NOAA C-CAP):  <a href="https://coast.noaa.gov/digitalcoast/data/ccapregional.html">https://coast.noaa.gov/digitalcoast/data/ccapregional.html</a></p> <p>County Level LIDAR  <a href="http://www.dnr.sc.gov/GIS/lidarstatus.html">http://www.dnr.sc.gov/GIS/lidarstatus.html</a></p> <p>NLCD impervious surface -  <a href="https://www.mrlc.gov/data/type/urban-imperviousness">https://www.mrlc.gov/data/type/urban-imperviousness</a></p> <p>Protected Lands (PAD-US) - LINK  <a href="#">TNC</a></p>
Freshwater Resources	<ul style="list-style-type: none"> <li>•Rivers – NHD or state level data</li> </ul>	<p>NHD: <a href="https://www.usgs.gov/core-science-systems/ngp/national-hydrography">https://www.usgs.gov/core-science-systems/ngp/national-hydrography</a></p>

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

M5



	<p>should be available</p> <ul style="list-style-type: none"> <li>•Perennial and Intermittent Streams – This distinction might not be available.</li> <li>•Freshwater Wetlands – National Wetland Inventory</li> </ul>	<p>Water classifications (view only):  <a href="https://gis.dhec.sc.gov/watersheds/">https://gis.dhec.sc.gov/watersheds/</a></p> <p>NWI: <a href="https://www.fws.gov/wetlands/index.html">https://www.fws.gov/wetlands/index.html</a></p>
Estuarine Resources	<ul style="list-style-type: none"> <li>•Tidal Rivers and Streams I think we can get all of this from NWI. Tidal influence might not be denoted.</li> <li>•Tidal Creeks</li> <li>•Coastal Marshlands</li> <li>•Tidal Flats</li> <li>•Scrub-Shrub Wetlands</li> </ul>	<p>NOAA C-CAP classification scheme includes palustrine forested wetland, palustrine scrub/shrub wetland, palustrine emergent wetland, estuarine forested wetland, estuarine scrub/shrub wetland, estuarine emergent wetland, palustrine aquatic bed, and estuarine aquatic bed</p> <p><u>County Level LIDAR Breaklines (with terrain dataset)</u>  <a href="http://www.dnr.sc.gov/GIS/lidarstatus.html">http://www.dnr.sc.gov/GIS/lidarstatus.html</a></p>
Marine Resources	<ul style="list-style-type: none"> <li>•Near Coastal Waters</li> <li>•Beaches</li> <li>•Shoreline</li> </ul>	<p>NOAA C-CAP classification scheme includes unconsolidated shore</p> <p>DHEC OCRM - <a href="https://apps.dhec.sc.gov/GIS/ClearingHouse/">https://apps.dhec.sc.gov/GIS/ClearingHouse/</a>          ←look under OCRM from drop down “List GIS Layers by DHEC...”</p>
Groundwater Resources	<ul style="list-style-type: none"> <li>•Groundwater Recharge Areas</li> <li>•Wellhead Protection Areas</li> </ul>	<p><a href="https://scdhec.gov/environment/bureau-water/groundwater-use-reporting/groundwater-management-planning/groundwater-2">https://scdhec.gov/environment/bureau-water/groundwater-use-reporting/groundwater-management-planning/groundwater-2</a></p> <p><a href="http://hydrology.dnr.sc.gov/well-database.html">http://hydrology.dnr.sc.gov/well-database.html</a></p> <p>DHEC Watershed atlas - <a href="https://gis.dhec.sc.gov/watersheds/">https://gis.dhec.sc.gov/watersheds/</a>          Check under Public Water supply tab in layer contents for protection areas</p>

Resource Group	Resource Type	Sources for Information
Terrestrial Resources	<ul style="list-style-type: none"> <li>•Dunes</li> <li>•Maritime Forests</li> <li>•Marsh Hammocks</li> <li>•Evergreen Hammocks</li> <li>•Canebrakes</li> </ul>	<ul style="list-style-type: none"> <li>• Forest inventory analysis (FIA). The SC Forestry Commission would have that data</li> <li>•Natural Communities of SC  <a href="https://dc.statelibrary.sc.gov/handle/10827/30179">https://dc.statelibrary.sc.gov/handle/10827/30179</a></li> </ul>

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

	<ul style="list-style-type: none"> <li>•Bottomland Hardwood Forests</li> <li>•Beech-Magnolia Forests</li> <li>•Pine Flatwoods</li> <li>•Longleaf Pine-Wiregrass Savannas</li> <li>•Longleaf Pine-Scrub Oak Woodlands</li> </ul>	
Other Resources	<ul style="list-style-type: none"> <li>• Shellfish Harvesting Areas</li> <li>•Floodplains – FEMA data available nationally</li> <li>•Aquatic Buffers</li> <li>•Other High Priority Habitat Areas as described by South Carolina Department of Natural Resources</li> </ul>	<ul style="list-style-type: none"> <li>•FEMA: <a href="https://msc.fema.gov/portal/home">https://msc.fema.gov/portal/home</a></li> <li>•SCDHEC: <a href="https://apps.dhec.sc.gov/GIS/ClearingHouse/">https://apps.dhec.sc.gov/GIS/ClearingHouse/</a></li> <li>•GAP/species richness/habitat/etc. data <a href="http://www.dnr.sc.gov/GIS/gap/mapping.html">http://www.dnr.sc.gov/GIS/gap/mapping.html</a></li> <li>•Intertidal Oyster Reefs - <a href="http://www.dnr.sc.gov/GIS/descoysterbed.html">http://www.dnr.sc.gov/GIS/descoysterbed.html</a></li> <li>•Shellfish harvesting areas - <a href="#">Link</a></li> </ul>

## Appendix N: Summary of Federal and State Stormwater Regulations

### Table of Contents

N.1 Summary of Federal Regulations.....	1
N.1.1 MS4 Program.....	2
N.1.2 Industrial Activity Program.....	3
N.2 Summary of State Regulations .....	4

### N.1 Summary of Federal Regulations

In general, Federal regulations and legislation have been applied at the State level to regulate stormwater runoff quality, whereas for many years local stormwater ordinances and regulations focused on regulating drainage, streets, peak stormwater runoff flow and flooding concerns.

Federal regulations that directly affect stormwater runoff control include the Coastal Zone Management Act and the National Pollutant Discharge Elimination System (NPDES) stormwater regulations of the Clean Water Act, administered by the U.S. Environmental Protection Agency (EPA). The Coastal Zone Management Act was designed to encourage and assist coastal states to develop and implement management programs. The State of South Carolina developed its own Coastal Zone Management Act in 1977, to protect coastal resources and promote responsible development in Beaufort County and seven other coastal counties. This will be discussed further in the following section on State regulations. The EPA NPDES requirements are presented below.

The 1987 amendments to the Federal Clean Water Act define specific stormwater discharges as point source discharges subject to NPDES regulations. These amendments required EPA to promulgate regulations pertaining to stormwater discharges via a phased approach.

The initial phase, promulgated by EPA on November 16, 1990, became known as the Phase I Stormwater NPDES regulations. These final regulations created two broad classes of stormwater discharges under the NPDES program:

- 1) Municipal Separate Storm Sewer System (MS4) discharges; and
- 2) Stormwater Discharges Associated with Industrial Activity.

The MS4 Program was divided into three categories (large, medium, and small populations) based on U.S. Census Bureau population estimates, with Phase I regulations including only large and medium MS4 stormwater discharges.

The Stormwater Discharges Associated with Industrial Activity program was divided into 11 categories of industrial activity. These included industrial manufacturing facilities, landfills, transportation facilities, construction (land clearing on 5 or more acres), etc., without consideration given to the type of facility owner or operator such that a publicly owned or operated facility could be included in one of the 11 categories.

On December 8, 1999, EPA adopted the Phase II stormwater regulations, which included small MS4 discharges located in an “Urbanized Area” per U.S. Census Bureau definitions and delineations. In addition, the land disturbance activity regulation with the threshold of 5 or more acres (as per the construction activity regulation) was reduced to 1 or more acres, with a provision that construction sites that disturb less than 1 acre could also be regulated if water quality concerns or problems related to the activity warrant permit coverage under the NPDES Program.

The State of South Carolina has been an EPA NPDES Program delegated authority for a number of years. The State agency that administers the Federal NPDES Program in South Carolina is the Department of Health and Environmental Control (DHEC). As such, DHEC oversees all NPDES Program related permitting, monitoring, and enforcement issues in the State of South Carolina. However, EPA does have authority over DHEC on NPDES Program issues and may, at its discretion, conduct independent audits of a DHEC-issued NPDES permit.

### **N.1.1 MS4 Program**

Phase I of the NPDES Stormwater Program required large MS4s (with populations of 250,000 people or greater) and medium MS4s (with populations of 100,000 people or greater but less than 250,000) to apply for permit coverage in two parts. All permits issued under this phase were individual permits and required the development and implementation of a stormwater management program. At a minimum, this program had to address the following key elements:

- 1) Structural control maintenance
- 2) Areas of significant development and redevelopment
- 3) Roadway runoff management
- 4) Flood control related to water quality issues
- 5) Municipally owned operations, including landfills, wastewater treatment facilities, etc.
- 6) Hazardous waste treatment, storage or disposal sites, etc.
- 7) Application of pesticides, herbicides, and fertilizers
- 8) Illicit discharge detection and elimination
- 9) Regulation of sites classified as associated with industrial activity
- 10) Construction site and post-construction site runoff control
- 11) Public education and outreach

As of July 2007, the State of South Carolina has one large MS4 (South Carolina Department of Transportation) and four medium MS4s – the City of Columbia, Greenville County, Lexington County, and Richland County.

As of July 2007, there is a list of 70 regulated small MS4s, which did not specifically include Beaufort County. In 2014 this list was increased, and additional communities were added, including Beaufort County. These small MS4s are required to begin running programs to address stormwater runoff from construction sites and post-construction activities. These activities are two of the six components of a stormwater management program as defined by the NPDES Phase II Final Rule, as listed below:

- 1) Public education and outreach.

(Supp. No. 45)

Created: 2021-07-22 09:11:36 [EST]

- 2) Public participation/involvement.
- 3) Illicit discharge detection and elimination.
- 4) Construction site runoff control.
- 5) Post-construction runoff control.
- 6) Pollution prevention/good housekeeping.

Several of these items are addressed by this document and will fulfill part of the NPDES Phase II requirements.

### **N.1.2 Industrial Activity Program**

The NPDES Phase I stormwater regulations created 11 categories of Stormwater Discharges Associated with Industrial Activity. Categories “i” through “ix” and category “xi” became part of the Industrial Program, while category “x” became part of the Construction Program. Thus, the NPDES stormwater program is made up of three distinct program components: the MS4 Program, the Industrial Program, and the Construction Program. Although the Phase I included a provision for a no-exposure permit exemption to category “xi” (light industry) only, the Phase II regulations extended this no-exposure exemption to categories “i” through “ix.”

The no-exposure exemption applied to facilities that had no stormwater runoff exposed to raw materials, byproducts, waste products, intermediate products, final products, etc. Activities within the Industrial Program and the Construction Program can have NPDES stormwater permits issued as either individual permits or general permits; however, due to the nature and number of facilities that must be issued NPDES stormwater permits, general permits are typically utilized. On rare occasions, when water quality concerns become a permit issue, DHEC may require an individual permit in lieu of granting general permit coverage. The general permit under the Industrial Program requires the preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP) for each covered facility and requires monitoring and/or inspections. Although only certain facilities require both, inspections are required of all facilities.

Under the Construction Program, the construction activity category is divided into two phases, Phase I (for large construction sites) and Phase II (for small construction sites). On a case-by-case basis, a permit may also be required when a construction activity involves the disturbance of less than 1 acre of land. Stormwater discharges from construction activities that disturb less than 5 acres of land are called “small construction activities.” A Construction Activity permit can either be issued in the form of a general permit or an individual permit. Typically, the general permit is utilized unless specific water quality issues warrant the use of an individual permit. The general permit requires that a SWPPP be prepared and implemented for each construction site, but sampling of stormwater runoff from the site is not required.

Inspections must be conducted at all construction sites covered under the general permit. In addition, a provision in the MS4 program regulations requires that all regulated MS4s implement a program for controlling construction site runoff. This provision essentially requires that the construction site must receive a permit from the regulated MS4 in addition to having to be covered under an NPDES Stormwater Construction Activity permit.

It is important to note that with the March 10, 2003 initiation of the NPDES Phase II Stormwater Program implementation, considerable overlap exists between the Federal NPDES Stormwater Program and the State of South Carolina's Sediment, Erosion, and Stormwater Management Program as discussed below.

## **N.2 Summary of State Regulations**

In addition to being an EPA NPDES Program delegated authority, the State of South Carolina also has its own relevant regulations. The South Carolina's Sediment, Erosion, and Stormwater Management Program was initiated in 1983, and required construction activities on State-owned and State-managed lands to control sediment and erosion. In 1991, via the South Carolina Stormwater Management and Sediment Reduction Act, the program was expanded to include all construction activities that disturbed more than 2 acres of land. Regulation 72-300, entitled "Standards for Stormwater Management and Sediment Reduction," describes the requirements for preparing a stormwater management and sediment and erosion control plan from land disturbance activities. Exemptions, Waivers, and Variances from the Law are explained in Section 72-302. The Bureau of Water of the Office of Environmental Quality Control (EQC) of DHEC is responsible for administering the Sediment, Erosion, and Stormwater Management Program, and by regulation the Office of Ocean and Coastal Resource management (OCRM) implements the program in the eight coastal county areas. A local government may become a State-delegated authority after submitting a request and receiving approval by the State. However, Federal, State, local government, and public school projects must be submitted to DHEC even if they are located within the jurisdiction of a State-delegated entity.

As indicated previously, the Federal NPDES Stormwater Construction Activity Program requires permit coverage for construction sites that disturb more than 1 acre of land and, on a case-by-case basis, even less than 1 acre of land. Consequently, an overlap exists currently between the State's Sediment, Erosion, and Stormwater Management Program and the NPDES Stormwater Construction Activity Program (that is, when more than 2 acres of land are disturbed due to a construction activity, permits must be secured under both programs). The State coordinates the various aspects of the two programs (i.e., permitting, compliance, monitoring, and enforcement) to minimize the overlapping responsibilities. The two programs are integrated into a comprehensive Stormwater Regulatory Program for the State of South Carolina.

The *South Carolina Stormwater Management and Sediment Control Handbook for Land Disturbance Activities* (DHEC, 2003) includes all existing South Carolina stormwater management regulations required for individuals to submit a stormwater management and sediment reduction permit application to DHEC. Elements of the Federal NPDES Stormwater Program, Coastal Zone Management Program, and the State's Stormwater Management and Sediment Reduction regulations are included in the handbook.

Table 1 summarizes the State regulatory requirements that are applicable to Southern Lowcountry, including jurisdictions in the State of South Carolina's Coastal Zone Management Program. For land disturbance of 0.5 acre or less that is within 0.5 mile of a receiving waterbody in the coastal zone, Section R.72-307H of the State Stormwater Management and Sediment Reduction Act of 1991 is applicable. Section R.72-307H is also applicable for land disturbance of less than 1 acre, at locations that are not within 0.5 mile of a coastal zone receiving water. If the land disturbance is at least 1 acre, but less than 2 acres, the NPDES General Permit and Section R.72-307H apply. Development is highly impervious or is located directly adjacent to a critical area, the more stringent R.72-307I regulations are applicable; otherwise, the less stringent R.72-307H regulations are appropriate.

Table 1. South Carolina Requirements for Land Development in Southern Lowcountry.

Extent of Land Disturbance (acres)	Applicable Regulatory Requirements
Less than 0.5 acre and within 0.5 acre of receiving waters	R.72-307H
Less than 1 acre and not within 0.5 acre of receiving waters	R.72-307H
At least 1 but less than 2 acres	R.72-307H, SCR100000
More than 2 and less than 5 acres	R.72-307I, SCR100000
5 acres or more	R.72-305, R.72-307, SCR100000

Section R.72-307I regulations are also applicable for developments of more than 2 and less than 5 acres. For developments of 5 acres or more, the applicable regulations include Sections R.72-305 and R.72-307 of the Stormwater Management and Sediment Reduction Act of 1991, plus the NPDES General Permit.

Features of the regulations highlighted in Table 1 are presented in

Table 2. The regulations under Section R.72-307H provide for a simplified stormwater management and sediment control plan that does not require approval by DHEC and does not require preparation or certification by a registered engineer, landscape architect or Tier B land surveyor (SCDHEC, 1997). However, DHEC staff does have the authority to conduct site inspections to ensure compliance with the submitted plan. Under Section R.72-307I, the stormwater management and sediment control plan must be approved by DHEC, and requires preparation and certification by a registered engineer, landscape architect or Tier B land surveyor. The plan must also include BMPs to control erosion and sediment, and measures to control peak discharge rates and peak velocities of stormwater runoff from the site.

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Table 2. South Carolina Sediment, Erosion, and Stormwater Management Program Land Development Regulatory Requirement Details Applicable to Non-Coastal Counties.

Plan Feature	Applicable Regulation(s)		
	R.72-307H	R.72-307I	R.72-305, R.72-307, SCR100000
Plan Approval by Implementing Agency	Not required	Required	Required
Plan Preparation / Certification by Registered Professional Engineers / Landscape Architects / Land Surveyors	Not required	Required	Required
BMPs to Control Erosion and Sediment	Not required	Required	Required
Measures to Control Stormwater Quantity	Not required	Required <sup>1</sup>	Required <sup>1</sup>
Measures to Control Stormwater Quality	Not required	Not required	Required <sup>2</sup>
<p>1. Stormwater quantity control requirements include:</p> <ul style="list-style-type: none"> <li>a. Post-development peak discharge rates shall not exceed pre-development discharge rates for the 2- and 10- year frequency, 24-hour duration storm events. Implementing agencies may utilize a less frequent storm event (e.g., 25-year, 24-hour storm) to address existing or future stormwater quantity or quality problems.</li> <li>b. Discharge velocities shall be reduced to provide a non-erosive velocity flow from a structure, channel, or other control measure or the velocity of the 10-year, 24-hour storm runoff in the receiving waterway prior to the land disturbance activity, whichever is greater.</li> <li>c. Watersheds other than “designated watersheds” that have well documented water quantity problems may have more stringent, or modified, design criteria determined by the local government that is responsive to the needs of that watershed.</li> </ul> <p>2. See Table A-3 for a summary of stormwater quality requirements.</p>			

The State regulation requires that post-development peak flows shall not exceed the pre- development peak flow rate for the 2-year/24-hour and 10-year/24-hour design storms. Developments of 5 acres or more must meet all of the requirements listed above and must provide measures for stormwater quality control.

The current NPDES general permit SCR100000 (effective September 1, 2006) includes requirements for inspections on construction sites. Once construction begins, these inspections must be conducted at least once every 7 calendar days, or at least once every 14 calendar days and within 24 hours of the end of a storm event of 0.5 inches or greater. The inspections must be conducted by qualified personnel (as defined in the permit) and an inspection report must be completed for each inspection. The report must be retained for at least 3 years from the date that permit coverage expires or is terminated. For construction activities disturbing 10 acres or more, a monthly report must also be submitted to DHEC. Monthly reports may also be required on a case-by- case basis.

Stormwater runoff quality control measures required for developments of 5 acres or more are presented in Table 3. In general, the water quality storage requirements depend upon the type of BMP and, in some cases, the location of the development site.

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Table 3. South Carolina Coastal Zone Management Program Stormwater Quality Bmp Requirements Beaufort County.

BMP Facility Type	Water Quality Volume Requirements		
	General	Within 0.5 Miles of a Receiving Waterbody in the Coastal Zone	Within 1,000 Ft of Shellfish Beds
Water quality facility with permanent pool of water (e.g., wet detention pond)	Permanent pool volume of 0.5 inches of runoff per acre of drainage; storage above permanent pool of 0.5 inches of runoff per acre of drainage, required to bleed down over a 24-hour period	Permanent pool volume of 0.5 inches of runoff per acre of drainage <u>or</u> 1.0 inches of runoff per impervious acre of drainage, whichever is greater; same general storage requirement above permanent pool	Permanent pool volume of 0.5 inches of runoff per acre of drainage <u>or</u> 1.5 inches of runoff per impervious acre of drainage, whichever is greater; same general storage requirement above permanent pool
Water quality facility without permanent pool of water (e.g., extended dry detention pond)	Storage of 1.0 inches of runoff from the entire drainage area, required to bleed down over a 24-hour period	General requirements apply	Not applicable
Infiltration practices	Storage of 1.0 inches of runoff per impervious acre of drainage, required to drain completely in 72 hours	General requirements apply	Storage of 1.5 inches of runoff per impervious acre of drainage, required to drain completely in 72 hours

The basic water quality volume requirements vary based on the type of BMP. A water quality facility with a permanent pool of water (e.g., a wet detention pond) has a required permanent pool volume equivalent to 0.5 inch of runoff per acre of drainage, as well as another 0.5 inch of storage above the permanent pool. The storage above the permanent pool is required to bleed down over a 24-hour period. In contrast, a water quality facility without a permanent pool of water (e.g., an extended dry detention pond) has a required water quality storage volume equivalent to 1.0 inch of runoff per acre of drainage, and this volume is required to bleed down over a 24-hour period. Infiltration facilities, which capture runoff and then release the captured runoff through evapotranspiration and infiltration into the underlying soil, are required to provide water quality storage equivalent to 1.0 inches of runoff per impervious acre of drainage.

Under existing State regulations, water quality control facilities with a permanent pool of water may have more stringent requirements if the development is within 0.5 mile of a receiving waterbody in the coastal zone. In this case, the required permanent pool volume is the greater of: (a) 0.5 inch of runoff from the entire drainage area, or (b) 1.0 inch of runoff per impervious acre of drainage. The latter condition will apply for commercial, industrial and high-density residential land uses with an imperviousness of more than 50 percent. There are no special requirements for infiltration facilities and facilities without a permanent pool of water.

Special considerations also apply when the development is within 1,000 ft of shellfish beds (determined from State mapping or by site inspection). In this case, the regulations require that 1.5 inches of runoff (Supp. No. 45)

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per impervious acre of drainage must be retained. Of the three BMP types discussed above, only infiltration facilities are designed to retain runoff (i.e., captured runoff is depleted by storage through evapotranspiration and infiltration into the underlying soil, rather than released to a drainage channel or waterbody). In contrast, facilities such as ponds are designed to detain runoff (i.e., captured runoff is detained for treatment and is then released to a drainage channel or waterbody).

Table 3 shows how the shellfish bed regulation has been interpreted for this report. The requirement for infiltration facilities is 1.5 inches per impervious acre of drainage, which is 50 percent greater than the general requirements. For facilities with a permanent pool, it was presumed that the requirement would be met by providing a permanent pool volume equivalent to 1.5 inches of runoff per impervious acre. For storms producing runoff of 1.5 inches or less, the runoff will be stored in the permanent pool and an equal volume of water will be displaced from the pool and discharged to a drainage channel or waterbody. The table provides no interpretation of the shellfish bed requirements for other facilities without a permanent pool. Such a facility would actually be operating as an infiltration facility.

As mentioned previously, DHEC administers the Federal NPDES Program on behalf of EPA; therefore, along with having jurisdiction over the NPDES Construction Program, DHEC also has jurisdiction over the NPDES Industrial Program. Under the latter program, the general permit (SCR000000) covers all categories of stormwater discharges associated with industrial activity, except the construction activity, which is covered under the Construction Program. SCR000000 requires the development of a SWPPP, which identifies potential sources of stormwater pollution and describes practices to be implemented for reducing stormwater pollutant discharges. These practices may include structural BMPs (e.g., wet detention ponds), good housekeeping practices, spill prevention procedures, and employee training. Annual or semi-annual monitoring of stormwater discharge from the site is required for certain industrial facilities. The monitoring would include measurement of specific pollutants such as nutrients and metals, and acute whole effluent toxicity tests.

Information on the South Carolina Sediment, Erosion, and Stormwater Management Program can be found at: <http://www.scdhec.net/water/html/erfmain.html>

Information on NPDES Stormwater Program Implementation in South Carolina can be found at: <http://www.scdhec.net/eqc/water/html/swnhistory.html>

## Appendix O: Maintenance Agreement Template

### O.1 Maintenance Agreement Template

#### E.3 Sample Maintenance Agreement

State of South Carolina )  
 )  
 County of Beaufort ) Permanent Stormwater Facility Maintenance  
 and Responsibility Agreement  
 Tax Map No. \_\_\_\_\_

This Agreement is entered into this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_, by and between \_\_\_\_\_, (hereinafter referred to as "Landowner") and the County of Beaufort, political subdivision of the State of South Carolina (hereinafter referred to as "County").

It is agreed as follows:

##### **Landowner Responsible for Stormwater Facility:**

The South Carolina Stormwater Management and Sediment Reduction Act of 1991 (§48-14-10, et. seq.) and Regulation 72-308 provide that a Landowner shall adequately establish and maintain stormwater management/Best Management Practices (BMP) facilities upon making certain improvements to the Landowner's property. This law applies to any individual, partnership, corporation or other entity, constructing a stormwater facility. It also applies to all subsequent owners of the property. The obligation applies to the maintenance of all pipes, equipment, and channels built to convey stormwater to a retention facility, as well as all structures, improvements, and vegetation provided to control the quantity and quality of the stormwater on the property. (All fixtures and graded or excavated improvements for controlling stormwater are herein the "Facility"). Adequate maintenance is herein defined as keeping the Facility in good working condition so that the Facility is performing all of its design functions in accordance with the purposes for which it is designed.

##### **Maintenance Required:**

The Landowner, its successors and assigns, will perform the maintenance, repair, and replacement necessary to keep the Facility in good working order. In the event a maintenance schedule for the Facility (including sediment removal) is outlined on the approved plans, the schedule must be followed.

##### **Inspection Required:**

The Landowner, its successors and assigns, shall regularly and periodically inspect the Facility in its entirety. Records shall be kept to identify the dates and maintenance performed and shall be made available to the County at the County's request. The purpose of the inspection is to assure safe and proper functioning of the Facility. The inspection shall cover all parts of the Facility including, but not limited to, berms, outlet structures, pond areas, and access roads. The Landowner's failure to inspect shall be treated as a breach of this Agreement just as much as a failure to repair if repair is needed after inspection.

##### **Access Permitted:**

The Landowner grants permission to the County, its authorized employees and agents, to enter upon the Property and to inspect the Facility whenever the County deems necessary. The purpose of inspection is to follow-up on reported or observed deficiencies, to respond to citizen complaints, or to make an inspection if a significant time has passed after the last inspection. The County shall provide the Landowner a copy of the inspection findings and a directive to commence with the repairs if necessary. In the case of multiple Landowners of a single property, notice to one shall suffice as notice to all.

Page 1 of 3

(Supp. No. 45)

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**No Duty on the County:**

This Agreement creates no affirmative duty on the County to inspect, and it imposes no liability of any kind whatsoever on the County for omissions in inspecting. The Landowner agrees to hold the County harmless from any liability in the event the Facility fails to operate properly due to the Landowner's failure to abide by the terms of this Agreement.

**Landowner Covenants:**

The Landowner accepts responsibility for ownership and proper maintenance of the stormwater system, the Facility (pond, swales, etc.) on parcel # (R \_\_\_\_\_) located at \_\_\_\_\_, (see attached Site Map) Beaufort, South Carolina, per the approved maintenance plan. The specific BMPs on the property are listed below:

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_
- 4) \_\_\_\_\_
- 5) \_\_\_\_\_

Landowner will complete any necessary repairs and/or preventive maintenance procedures in a timely manner to ensure proper functioning as a stormwater management device(s).

Landowner understands that the maintenance plan may be amended or revised at any time by the County in order to address changed conditions or to address conditions not being effectively met by the Facility. Following the County's sending notice; Landowner will abide by any prescribed changes.

This covenant to maintain the Facility shall run with the land. Landowner will continue to own and maintain the Facility until the County is notified in writing of a transfer in ownership and maintenance responsibility. The notification will include a date for the transfer of responsibility which will become effective upon the County's receipt of a letter of acceptance from the new owner. Notwithstanding the provision for a letter of acceptance, any new Landowner shall be responsible for all duties and obligations created by this Permanent Stormwater Facility and Maintenance Responsibility Agreement upon it being executed and filed in the Register of Deeds Office for Beaufort County.

Landowner understands that failure to adhere to the signed Maintenance Agreement may result in fines of up to \$1,000.00 per day, per violation and /or the institution of a court action, or such other and additional penalties, fines, or assessments as shall be enacted and provided for by the general law of the state or by local regulation lawfully enacted.

(Signatures contained on the next page)

IN WITNESS our hand and seal this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_.

\_\_\_\_\_  
WITNESS 1

Land Owner Name: \_\_\_\_\_  
(Print)

\_\_\_\_\_  
WITNESS 2

Land Owner Signature: \_\_\_\_\_

Mailing Address: \_\_\_\_\_

Phone Number: \_\_\_\_\_

County of Beaufort

\_\_\_\_\_  
WITNESS 1

BY: \_\_\_\_\_

\_\_\_\_\_  
WITNESS 2

ITS: County Administrator

STATE OF SOUTH CAROLINA )  
 )  
COUNTY OF BEAUFORT )

# ACKNOWLEDGEMENT

The foregoing instrument was acknowledged before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_  
by \_\_\_\_\_, (Landowner's name).

\_\_\_\_\_  
Notary Public for South Carolina  
My Commission Expires: \_\_\_\_\_

STATE OF SOUTH CAROLINA )  
 )  
COUNTY OF BEAUFORT )

# ACKNOWLEDGEMENT

The foregoing instrument was acknowledged before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_  
by \_\_\_\_\_, County Administrator for Beaufort County.

\_\_\_\_\_  
Notary Public for South Carolina  
My Commission Expires: \_\_\_\_\_

## Appendix R: Land Cover Designation and Maintenance

### Table of Contents

R.1	General Notes .....	1
R.1.1	Existing Natural Cover Requirements .....	1
R.1.2	Planting Requirements for the Creation of Natural Cover.....	2
R.2	Stormwater Management Plans and Natural Cover .....	3
R.3	Construction Requirements for Natural Cover Designation .....	3
R.4	Maintenance Requirements for Natural Cover Designation .....	4
R.5	Compacted Cover Designation.....	4

### R.1 General Notes

The retention standard approach taken in this guidance manual for on-site stormwater management and the run-off reduction methodology recognizes the ability of pervious land covers to manage some, or most, of the rainwater that falls on it. This is termed "land abstraction" in this appendix and is assumed to be based on SCS Hydrologic Soil Group (HSG) or soil type and whether the land cover is best represented as Forest/Open Space (RvN), Managed Turf (RvC) or Impervious Cover (RvI). As noted in Section 3.7, Equation 3.2 Stormwater Retention Volume, the designation of Forest/Open Space with these lands will generate between 2-5% stormwater runoff for a design rain event. The designation of compacted cover assumes these lands will generate 15-25% stormwater runoff for a design rain event. Impervious cover will generate 95% stormwater runoff for the design rain event. The minimum area threshold for the natural cover designation is 1,500 square feet, with a minimum length of 30 feet. Areas not meeting the natural cover threshold will be considered compacted cover RvC. To ensure no loss of land abstraction, all land cover designations must be recorded in the maintenance agreement.

#### R.1.1 Existing Natural Cover Requirements

A site claiming natural cover based on the preservation of existing conditions must ensure conditions remain undisturbed to preserve hydrologic properties equal to or better than meadow in good condition. No credit will be given for areas that are cut and then replaced with planting. The intention of preserving areas is to allow for natural succession with saplings reaching maturity after a period of time.

Preservation areas for natural cover may include the following:

- Portions of residential yards in forest cover that will not be disturbed during construction;
- Community open space areas that will not be mowed routinely, but left in a natural vegetated state, as defined below (can include areas that will be rotary mowed no more than two times per year);
- Utility rights-of-way that will be left in a natural vegetated state (can include areas that will be rotary mowed no more than two times per year); or

- Other areas of existing forest and/or open space that will be protected during construction and that will remain undisturbed.

### R.1.2 Planting Requirements for the Creation of Natural Cover

Every 1,500 square feet of created natural area shall be vegetated according to the following options of plant material quantity:

- 1 native understory tree: 1.5-inch caliper (minimum), and 2 native canopy trees: 2.5 inch caliper (minimum), or
- 6 native shrubs: 5 to 7-gallon container size (minimum), or
- 50 native perennial herbaceous or woody plants or clump-forming grasses: 1-gallon container size (minimum), or
- 1 native canopy tree: 2.5-inch caliper (minimum), and 25 native perennial herbaceous plants: 1-gallon container size (minimum), or
- 3 native shrubs: 5 to 7-gallon container size (minimum), and 25 native perennial herbaceous plants 1-gallon container size (minimum)

Plantings shall be indigenous to the immediate area and shall be arranged in a natural random pattern (e.g. not a formal composition). To ensure a resilient planting composition, diversity must be provided in the planting plan: at least 2 different species of trees, 3 different species of shrubs, and/or 5 different types of perennials/grasses shall be used in each planting.

If planting near marshes, vegetation should be elevated as much as possible to ease establishment from the saline environment and lessen the impacts of inundation from King Tide events.

Steep slopes greater than 6% grade will require additional plantings, soil stabilization, or a terracing system.

Whip and seedling stock may be used (when approved by *<local jurisdiction>*) as a site's natural cover creation if a stream bank stabilization opportunity falls within the site's footprint. In this instance, whips or seedlings must be planted at a minimum density of 700 plants per acre, and at least 55% of these plants must remain at the end of the 2-year management period.

Natural regeneration (i.e., allowing volunteer plants to propagate from surrounding natural cover as a cover creation technique) may be allowed by *<local jurisdiction>*, when 75% of the proposed planting area is located within 25 feet of adjoining forest, and the adjoining forest contains less than 20% cover of invasive exotic species (as documented by the South Carolina Exotic Pest Plant Council 2014 list here: [https://www.se-eppc.org/southcarolina/SCEPPC\\_LIST2014finalOct.pdf](https://www.se-eppc.org/southcarolina/SCEPPC_LIST2014finalOct.pdf)). In this case, supplemental planting must ensure a density of 400 seedlings per acre.

All plant materials used must be native to the southeastern region and must be installed in areas suitable for their growth. There are several websites that may be consulted to select the most appropriate plantings for the Southern Lowcountry:

- Low Impact Development in Coastal South Carolina: A Planning and Design Guide; see suggested plant lists for bioretention (4.2), open channels (4.8) and stormwater wetlands (4.12)

<http://www.northinlet.sc.edu/wp-content/uploads/2019/12/LID-in-Coastal-SC.pdf>

(Supp. No. 45)



- South Carolina Wildlife Federation: <http://www.scwf.org/native-plant-list>
- South Carolina Native Plant Society: <https://scnps.org/wp-content/uploads/2012/04/CoastalNativePlantList.pdf>
- Carolina Yards Plant Database: <https://www.clemson.edu/extension/carolinayards/plant-database/index.html>
- Clemson University Cooperative Extension Services Home & Garden Information Center factsheet for freshwater shoreline landscaping: <https://hgic.clemson.edu/factsheet/shorescaping-freshwater-shorelines/>

Plant irrigation is recommended until established.

## R.2 Stormwater Management Plans and Natural Cover

Sites using preservation of existing areas for the natural cover designation shall include on their Stormwater Management Plan (SWMP) their natural resources inventory, a tree and vegetation survey, identification of location, and extent of preservation areas. Depending on the extent of the preservation area, *<local jurisdiction>* may require the SWMP to include a more detailed schedule for retained trees, noting the tree species, size, canopy, condition, and location.

The SWMP will include the identification of material and equipment staging areas and parking areas. Material and equipment staging areas and parking areas must be sufficiently offset for preservation areas to ensure no adverse impacts.

For areas maintained as meadow in good condition, the SWMP shall document either the preservation of existing conditions or the creation of meadow conditions. A plan submission claiming meadow preservation will note the existing meadow boundaries and include a field survey of the richness and diversity of existing plant species and the existing soil conditions by a qualified individual (see Section 2.1.3). A plan submission claiming meadow creation will note the proposed meadow boundaries, the planting and/or seeding species methods, and provide a soil amendment plan as specified in Appendix C Soil Compost Amendment Requirements.

## R.3 Construction Requirements for Natural Cover Designation

The preservation of lands designated as natural cover—such as undisturbed portions of yards, community open space, and any other areas designated on a site’s SWMP as preserved natural cover—must be shown outside the limits of disturbance on the site’s Soil Erosion and Sediment Control Plan. These areas must be clearly demarcated with signage prior to commencement of construction on the site on the site and with fencing during construction.

The creation of lands designated as natural cover as part of a public right-of-way (PROW) project and on sites where soils were not protected from compaction during construction the soils must be conditioned prior to planting with soil compost amendments as prescribed in Appendix C Soil Compost Amendment Requirements.

For maximum survivability, planting of trees, shrubs, and herbaceous vegetation for the creation of natural cover should occur only during the fall and early spring (i.e., September through November and March through May). The work should be done only under the supervision of someone qualified and skilled in landscape installation (see Section 4.14 Tree Planting and Preservation for details on

qualifications). Proper maintenance of the materials after installation will be key in ensuring plants <sup>36 [EST]</sup> (Supp. No. 45)

survival. Prior to inspection, all trees and shrubs planted must be alive and in good health, and native grass and wildflower seeds must have been sown at adequate densities and at the right time of year for each species.

Once a natural cover designation has been assigned to a portion of regulated development site, that area will need to be recorded in the declaration of covenants, documented at the site prior to construction activities, protected during construction activities, and permanently protected/maintained for the life of the regulated site.

Root pruning and fertilizing are examples of preconstruction activities. These measures aim to increase the wellbeing of trees and prepare them for higher stress. Prior to beginning construction, temporary devices such as fences or sediment controls are installed and remain throughout the construction phase. Some devices, like retaining walls and root aeration systems may remain permanently. For example, if part of a root system is collapsed by a built road, permanent aeration may be necessary for the tree to remain healthy.

#### **R.4 Maintenance Requirements for Natural Cover Designation**

All areas that will be considered natural cover for stormwater purposes must have documentation that prescribes that the area will remain in a natural, vegetated state. Appropriate documentation includes subdivision covenants and restrictions; deeded operation and maintenance agreements and plans; parcels of common ownership with maintenance plans; third-party protective easements within the PROW; or other documentation approved by *<local jurisdiction>*.

While the goal is to have natural cover areas remain undisturbed, some activities may be prescribed in the appropriate documentation, as approved by *<local jurisdiction>*, such as forest management, control of invasive species, replanting and revegetation, passive recreation (e.g., trails), limited bush hogging to maintain desired vegetative community, etc.

#### **R.5 Compacted Cover Designation**

The compacted cover designation can apply to all site areas that are disturbed and/or graded for eventual use as managed turf or landscaping. Examples of compacted cover include lawns, portions of residential yards that are graded or disturbed and maintained as turf (including yard areas), residential utility connections, and PROW. Landscaping areas intended to be maintained as vegetation other than turf within residential, commercial, industrial, and institutional settings are also considered compacted cover if regular maintenance practices are employed.

## **Appendix S: Single Family On-Lot Volume Control**

### **Step 2 On-Lot Volume Control**

Beaufort County passed the On-Lot Volume Controls on June 13, 2011. This requires On-Lot Volume Control when constructing new homes in communities that do not meet current community-wide runoff volume control requirements. This section is applicable only for home lots of record platted but not yet developed. Worksheets are available in an online calculator format at <http://stormwaterworksheet.createandsolve.com/>.

#### **Purpose**

The purpose of this worksheet and web-based program is to help a homeowner or builder determine the amount of excess stormwater runoff that will come off the property after construction of the home.

It will also assist in selecting the controls necessary to control this excess runoff so that the County's water resources are not impacted. Scientists have determined that excess freshwater runoff into saltwater tidal waters can impact the area's fishery resources.

The worksheet and program will allow the user to print out a sheet that can be used to document satisfactory controls so a zoning permit can be obtained. This zoning permit is necessary for issuance of a building permit.

#### **Step 1 – Lot Information**

This information is used to compute the excess runoff after construction. If a homeowner is planning an irrigation system, (entered in Section 1), storage and reuse of stormwater from rooftop should be considered for a portion of the irrigation needs. Use of drinking water for irrigation is an expensive alternative for homeowners, and reduction of this can save money as well as reducing amount of water running off the parcel after construction. While this is recommended, storage and reuse is optional because of its initial cost.

#### **Step 2 – Post Construction Stormwater Runoff Calculations**

The amount of excess runoff in gallons can be computed using this web-based program. It will depend on whether the soil is sandy or clay (entered in Section 1). The rainfall event that is used to determine the amount of runoff to be controlled is a 1.95-inch rainfall (95<sup>th</sup> percentile of average events in a year) in a 24-hour period. Before construction, on sandy soils, generally no runoff will occur with the 1.95-inch rainfall event. For clay soils, more than 0.5 inch of a 1.95 rainfall will runoff before construction. Taking this into account, the program will determine the runoff to be controlled, in gallons, after construction.

#### **Step 3 – Application of Best Management Practices**

This section takes the gallons determined in the Step above and guides the user through three steps that will reduce these gallons until they are all being controlled. The first step is an optional (Supp. No. 45)

**storage and reuse/infiltration practice.** This practice will utilize a holding facility of some size and then the water can be utilized for reuse or infiltrated at a slow rate from the storage facility.

When storage is utilized, it will control a certain amount of rooftop impervious surface. The maximum storage allowed for credit is limited to the rooftop impervious surface (in square feet) times 1.15. Additional storage can be added but credit is limited to 1.15 gallon per square foot of rooftop surface. When storage is used, it decreases the amount of impervious surface that needs to be handled by the other practices. This is called unaddressed impervious surface.

The second practice is **disconnected impervious surface**. It can utilize the natural infiltration capacity of the lot to control water running off unaddressed impervious surfaces. It will require a determination of which way the water sheet flows across the lot. The program allows up to two directions to be selected. The user starts with an estimate of the impervious surfaces and pervious portion of the lot. If the lot flows in one direction, the estimate is easy. It would be the unaddressed impervious surface and the previous surface it flows over to the end of the lot. If the ratio of unaddressed impervious surface to pervious area is greater than 5, there will be no credit, and runoff is better controlled by the next step. Figures 5-1 and 5-2 provide examples of one- and two-direction calculations to help in determining input figures for this practice.

If after the employing the first two practices there is still excess runoff to be handled, **rain gardens and other practices** will be used to control the remaining runoff. This will be computed for the user, who will be given a square foot size of a standard rain garden.

This standard size rain garden is 3 ft deep and can have special soil or sand and rock mixture that will store runoff and allow it to infiltrate. There is some flexibility between storage and reuse and rain gardens. If less rain garden is desired, storage can be increased, and vice-versa.

There is an attached sheet at the end of this help sheet that provides examples of alternative practices under this step.

It should be remembered that impervious surface on the property causes the excess volume that needs to be controlled. The amount of controls can be reduced by decreasing the impervious surface on the property by considering pervious driveways and walks, reducing rooftop size (two story versus one story), and other practices.

#### **Step 4 – Summary of Volume Reduction Practices**

This section is computed for the user to show a summary. This program allows the user to print a one-page sheet that summarizes entry and practices being used. This sheet would be attached to zoning and building permits and will be checked at completion of the project.

#### **Definitions:**

**Impervious surface** – hard surface that allows rainfall to run off and not infiltrate the soil.

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**Rooftop impervious surface** – horizontal surface area of rooftops including overhangs and other detached buildings/sheds.

**Other impervious** – generally hard surfaces on the ground like paved driveways, patios, walkways and sidewalks.

**Pervious surface** – surface that is not hard, such as grass, garden or forest area.

**Irrigated area** is area that would be served by an installed irrigation system. **Unaddressed impervious surface** – term used to determine amount of impervious surface or runoff gallons that had not been controlled by a previous practice.

**Standard rain garden** – rain garden that has 3 ft of fill material and a 6-inch maximum ponding depth. Different sizes can be constructed but then credits must be computed from Beaufort County BMP manual.

### Conversions

#### Rainfall to gallons of runoff

Design storm is 1.95 inches, of which 1.85 inches is available to run off impervious surface. 1.85 inch on 1 sq ft of impervious surface is equivalent to 1.15 gallons of runoff

#### Preconstruction runoff

**Clayey soils** – 0.53 inches run off for a 1.95-inch storm. 0.53 inch on 1 sq ft is equivalent to 0.33 gallon of runoff.

**Sandy soils** – No runoff for a 1.95-inch storm

**Storage and reuse** – if irrigation is used on parcel then storage must be between 0.3 gallon/sq ft of rooftop impervious surface to maximum credit of 1.15 gallon/ sq ft of rooftop impervious surface. Storage can be larger but maximum credit is 1.15g/sq ft.

### Rain garden

Square foot of impervious surface per square foot of standard rain garden

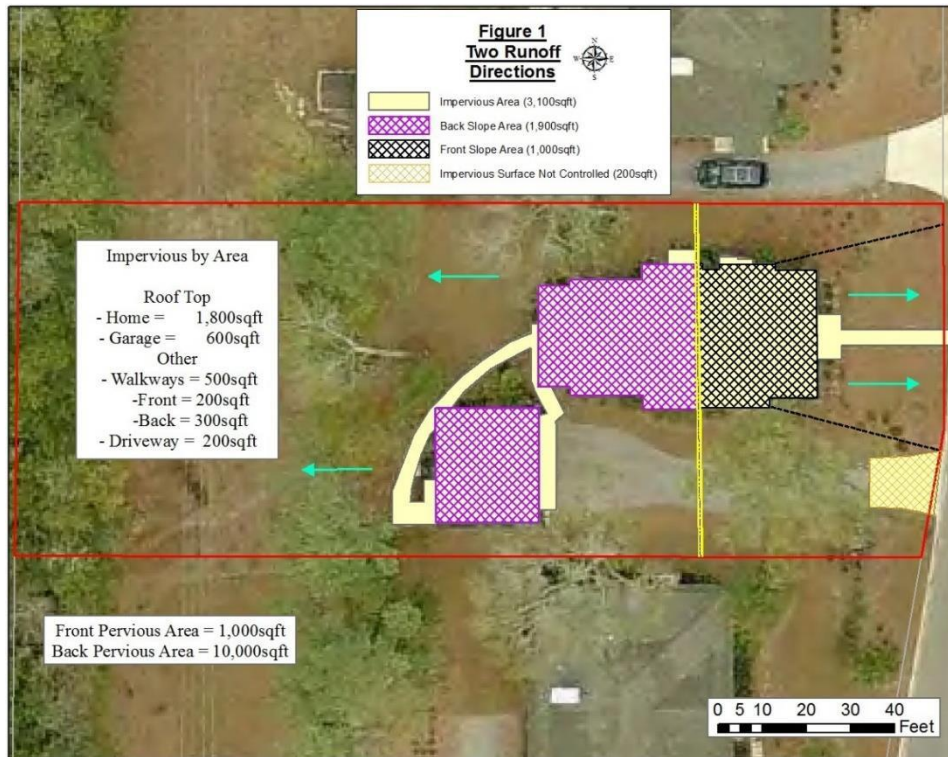
Clayey soils 4 sq ft of impervious surface to 1 sq ft of standard rain garden

Sandy soils 7 sq ft of impervious surface to 1 sq ft of standard rain garden

**Disconnected imperviousness** – is the practice of running uncontrolled stormwater flow from impervious surfaces over pervious surfaces to take advantage of natural infiltration of the soil. Credit is given in Table 5-8 based on ratio of impervious surface over pervious surface to compute a ratio.

Table 5-8 Credit Table for Disconnected Impervious Area

Disconnected Impervious Ratio	Runoff reduction (Gal/sq. ft-impervious area)	Runoff reduction (Gal/sq. ft-impervious area)
	Clayey	Sandy
0.1	.40	1.15
0.2	.40	1.12
0.4	.38	1.08
0.8	.33	1.01
1.0	.31	.98
2.0	.24	.84
3.0	.19	.74
4.0	.16	.67
5.0	.14	.60



**Figure 5-1**  
**Example of a One-Direction Calculation for Disconnected Impervious Surface**

This is a home on a 16,000 sq ft lot with about 2,500 sq ft of living space.

In this example, runoff from 1,000 sq ft of impervious surface flows towards the front of the house. It can be made to sheet flow over 1,000 sq ft of lawn (pervious surface). Therefore, on the worksheet or web program, enter 1,000 in impervious area and 1,000 in pervious area of the first direction.

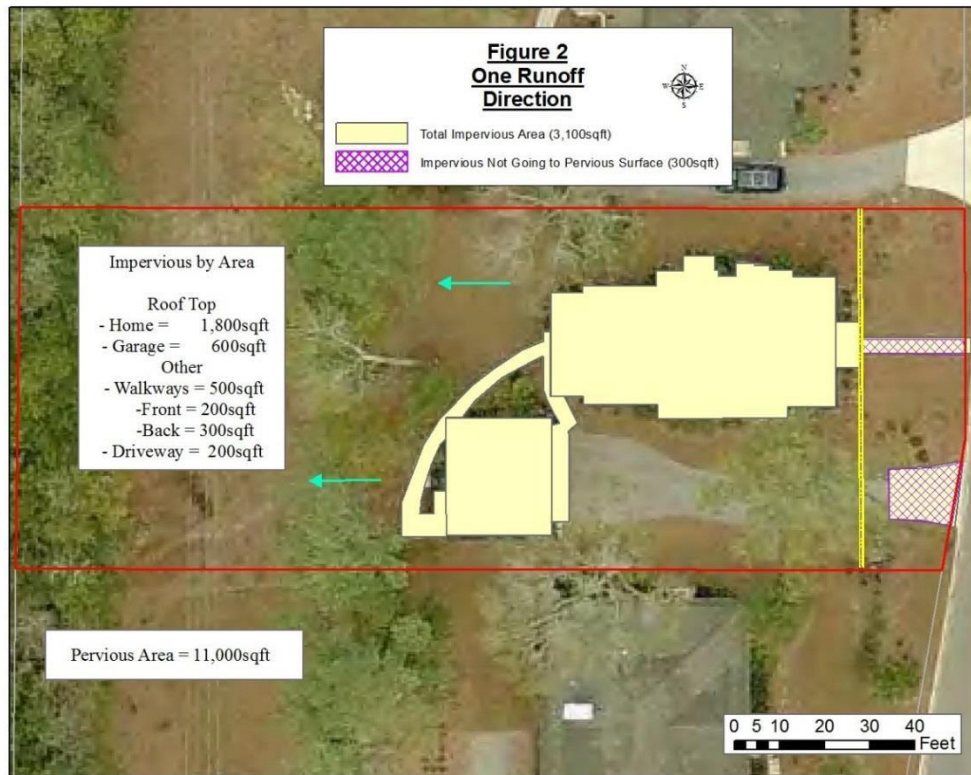
The second direction is to the back of the home, and this 1,900 sq ft of rooftop and other impervious surface flow over 10,000 sq ft of lawn and forest area.

Therefore, enter in the second direction 1,900 sq ft in impervious area and 10,000 in pervious area.

In this example, there is 200 sq ft (paved portion of driveway) that cannot sheet flow over enough pervious area to receive a credit and would not be included in calculations

If storage and reuse/infiltration was used in the first step (say two 500 cisterns/tanks in front of house) then the unaddressed impervious surface would be computed by reducing the first direction impervious surface.

Therefore, the in first direction, enter 130 in impervious surface (reduced by 870 sq ft = 1000 gal/1.15 gal/sq ft) and still 1,000 in pervious surface. See program printout for this example (with storage) in Appendix E.3



**Figure 5-2**  
**Example of a Two-Direction Calculation for Disconnected Impervious Surface**

In this example, there would be 2,800 (3,100 to 300) sq ft of impervious surface sheet flowing over 11,000 sq ft of pervious surface out the back yard.


Therefore, enter 2,800 in the first impervious area and 11,000 in the pervious area. The second direction would have zero entered in both categories.

Again, if storage and reuse/infiltration was used, the impervious surface that included in the worksheet or web program would need to be reduced.

If, for example, two 500-gallon storage devices were used, the impervious surface needs to be reduced by 870 sq ft (1000 gal/1.15 gal/sq ft).

Therefore, enter 1,930 in first impervious area and 11,000 in pervious area. The second direction would have zero in both categories.



 <div style="text-align: center;"> <b>BEAUFORT COUNTY</b>  <b>-STORMWATER PERMIT APPLICATION-</b> </div>					
DATE ACCEPTED	RECEIVED BY	FILING FEE	RECEIPT#	PERMIT#	PIN#
PROJECT NAME:			PROJECT TYPE:		
PROJECT LOCATION:					
APPLICANT/DEVELOPER NAME, ADDRESS, PHONE#			PROPERTY OWNER NAME, ADDRESS, PHONE#		
EMAIL			EMAIL		
SWPPP PREPARER NAME, ADDRESS, PHONE#			CONTRACTOR NAME, ADDRESS, PHONE#		
EMAIL			EMAIL		
QUALIFIED INSPECTOR NAME, ADDRESS, PHONE#			ADDITIONAL INFORMATION:		
EMAIL					
<b>SW01 (Single Family Home)</b>					
<input type="checkbox"/> COPY OF TIER I STORMWATER POLLUTION PREVENTION PLAN (SWPPP) – (See AppendixD) <input type="checkbox"/> PLOT PLAN SHOWING, VICINITY MAP, NORTH ARROW, GRAPHIC SCALE, PROPOSED IMPROVEMENTS <input type="checkbox"/> SITE PLAN SHOWING EXISTING GRADES/CONTOURS/ELEVATIONS AND PROPOSED GRADES/CONTOURS/ELEVATIONS, WITH OFFSITE DISCHARGE POINTS IDENTIFIED <input type="checkbox"/> NATURAL RESOURCE INVENTORY SHOWING TREES, WETLANDS, DRAINAGE COURSES, AND BUFFERS <input type="checkbox"/> GRADING AND DRAINAGE CERTIFICATION <input type="checkbox"/> STEP II VOLUME CONTROL (See Section 5.3) ( <a href="http://stormwaterworksheet.createandsolve.com">http://stormwaterworksheet.createandsolve.com</a> ) <input type="checkbox"/> APPLICATION FEE					
<b>SW02 (Non Residential and Attached Residential)</b>					
<input type="checkbox"/> COPY OF TIER II STORMWATER POLLUTION PREVENTION PLAN (SWPPP) <input type="checkbox"/> POST CONSTRUCTION STORMWATER PLAN CHECKLIST WITH LOCATION OF ALL ITEMS INDICATED. <input type="checkbox"/> SITE PLAN: VICINITY MAP, PROJECT LOCATION, NORTH ARROW, GRAPHIC SCALE, PROPOSED IMPROVEMENTS <input type="checkbox"/> CONSTRUCTION PLANS <input type="checkbox"/> DRAINAGE CALCULATIONS (See Section 5.3) <input type="checkbox"/> APPLICATION FEE					
Created: 2021-07-22 09:11:36 [EST]					

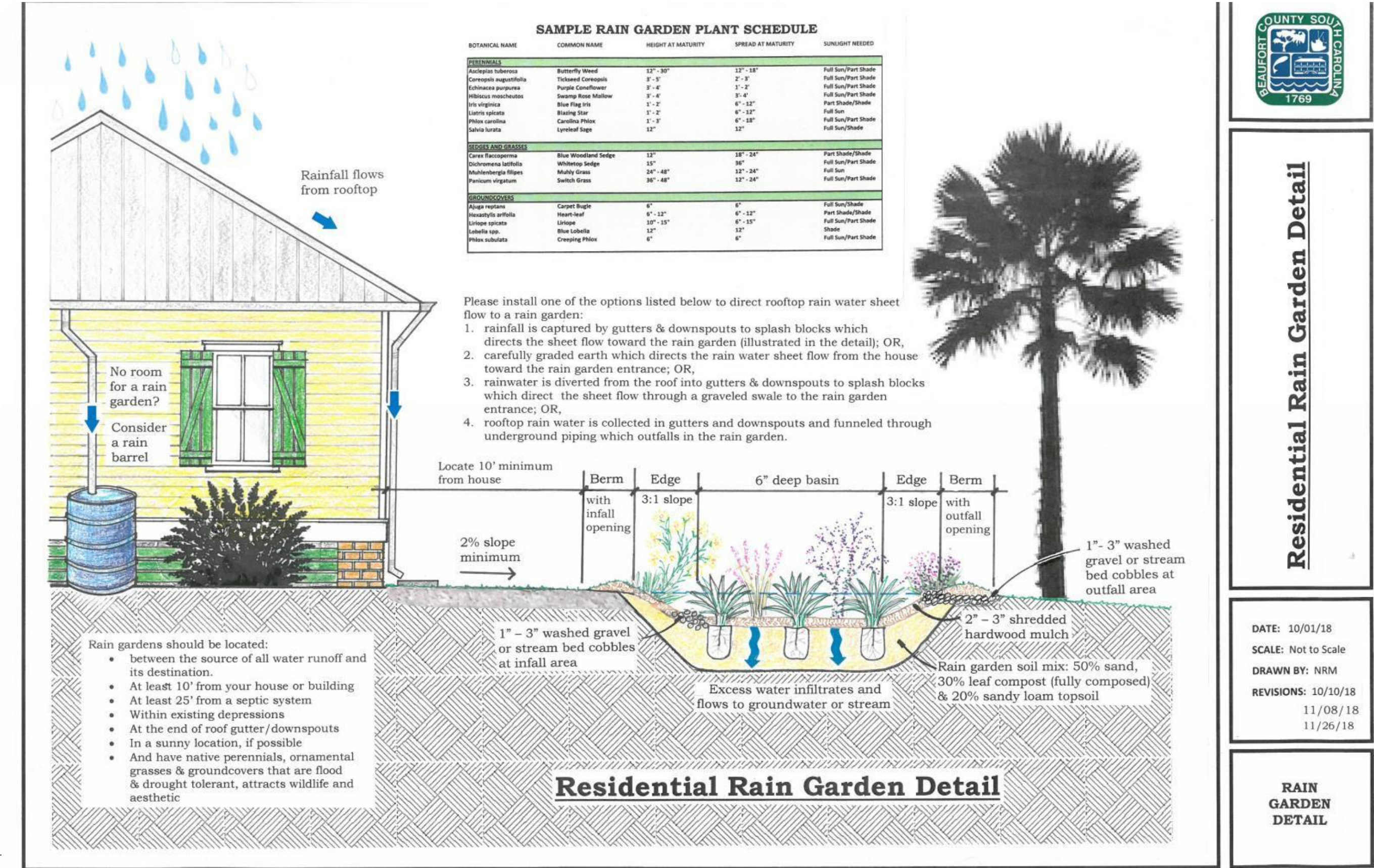
(Supp. No. 45)

**Application Affidavit**

The applicant acknowledges that application and issuance of the local Beaufort County Stormwater Permit does not preclude the need to obtain a NPDES permit from SC-DHEC per the South Carolina Erosion and Sediment Reduction act of 1983 as promulgated via 72-300, Standards for Stormwater Management and Sediment Reduction. Any change to the SWPPP associated with this permit as a result of permitting by DHEC renders this permit void until revised by the applicant to match the DHEC approved plan. The applicant further acknowledges the County may refuse to conduct inspections and may issue Notices of Violation, Stop Work Orders, and/or Civil Penalties for failure to comply with DHEC requirements.

Signature\_\_\_\_\_ Date\_\_\_\_\_





(Supp. No. 45)



# Illicit Discharge Detection and Elimination

## 1.1 Purpose

The purpose of this section is to provide for the health, safety, and general welfare of the citizens of Beaufort County, South Carolina, through regulation of non-storm-water discharges to the storm drainage system to the maximum extent practicable as required by Federal and State law. This ordinance establishes methods for controlling the introduction of pollutants into the MS4 in order to comply with requirements of the NPDES permit process. The objectives of this ordinance are:

1. To regulate the contribution of pollutants to the MS4 by stormwater discharges by any user.
2. To prohibit illicit connections and discharges to the MS4.
3. To establish legal authority to carry out all inspection, surveillance and monitoring procedures necessary to ensure compliance with this ordinance.

## 1.2 Program

The basic organization of this program is outlined below. The plan is developed around eight key components that are recommended by the U.S. Environmental Protection Agency (EPA) and the Center for Watershed Protection (CWP) for effective Illicit Discharge Detection and Elimination (IDDE) programs. These eight components are intended to help:

- Conduct an audit to understand community needs and capabilities
- Establish adequate legal authority
- Develop a tracking system to map outfalls and document reported illicit discharges
- Conduct desktop analyses to prioritize targets for illicit discharge control
- Conduct rapid reconnaissance of the stream corridor to find problem outfalls
- Apply new analytical and field methods to find and fix illicit discharges
- Educate municipal employees and the public to prevent discharges
- Estimate costs to run a program and conduct specific investigations

Technical information that addresses various aspects of the plan and references cited can be found in the following EPA sponsored publication produced by the CWP (<http://www.cwp.org/index.html>) and Robert Pitt from the University of Alabama:

Illicit Discharge Detection and Elimination:  
A Guidance Manual for Program Development and Technical Assessments  
October 2004

### **1.2.1 Ordinance**

In 2016, the County adopted a revised stormwater ordinance that will prohibit illicit discharges along with the necessary enforcement capability. The County will review other potential codes and ordinances that may have potential links to IDDE and make necessary cross-references and statements of supersede as needed to establish consistency.

### **1.2.2 Reporting and Education**

The County has a web application that will allow a person to report a suspecting IDDE to the County staff via the app. The app will allow the individual to provide the GPS location where the suspected discharge has occurred. Records are kept on each report, including the reporting mode (telephone, email, walk-in, etc.), location and nature of the problem, and any actions taken. Citizens can also call the stormwater department at 843.255.2805.

### **1.2.3 Monitoring**

The County has established a dry weather screening program to proactively detect illicit discharge and eliminate them through sampling, testing and enforcement. The County has a separate monitoring plan document that can be found in Appendix C. Inspection protocol and enforcement actions are in the stormwater ordinance found in Appendix G.

## **1.3 Definition of Illicit Discharge**

Illicit discharge is defined in Article V. of Chapter 99: Stormwater Ordinance. A copy of this ordinance is found in Appendix A.

# Southern Lowcountry Stormwater Design Manual

Stormwater Best Management Practices

Prepared by

March 2020

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# Table of Contents

<b>CHAPTER 1. INTRODUCTION, BACKGROUND, PURPOSE, AND ADMINISTRATION .....</b>	<b>1</b>
1.1 INTRODUCTION .....	1
1.2 BACKGROUND.....	1
1.3 PURPOSE.....	2
1.4 APPLICABILITY AND EXEMPTIONS.....	2
1.4.1 <i>Applicability</i> .....	2
1.4.2 <i>Exemptions</i> .....	2
1.5 ADMINISTRATION .....	3
1.5.1 <i>Approval Requirements</i> .....	3
1.5.2 <i>Fees</i> .....	3
<b>CHAPTER 2. DESIGN, REVIEW, &amp; PERMITTING PROCESS.....</b>	<b>4</b>
2.1 SATISFYING THE STORMWATER MANAGEMENT, SITE PLANNING, & DESIGN CRITERIA .....	4
2.1.1 <i>Overview</i> .....	4
2.1.2 <i>Better Site Design in the Planning Process</i> .....	4
2.1.3 <i>Natural Resources Inventory</i> .....	6
2.1.4 <i>Conservation Development</i> .....	8
2.1.5 <i>Residential Streets &amp; Parking Lots</i> .....	9
2.1.6 <i>Lot Development Principles to Meet Requirements</i> .....	10
2.1.7 <i>Site Planning &amp; Design Process</i> .....	12
2.1.8 <i>Integrating Natural Resource Protection &amp; Stormwater Management with the Site Planning &amp; Design Process</i> .....	15
2.2 SUBMITTAL & REVIEW PROCESS OF STORMWATER MANAGEMENT PLANS .....	19
2.2.1 <i>Components of a Stormwater Management Plan</i> .....	20
2.2.2 <i>Resubmission of Stormwater Management Plans</i> .....	23
2.2.3 <i>Design Certifications</i> .....	24
2.2.4 <i>Performance Bonds</i> .....	24
2.3 CONSTRUCTION INSPECTION REQUIREMENTS.....	25
2.3.1 <i>Inspection Schedule &amp; Reports</i> .....	25
2.3.2 <i>Inspection Requirements Before &amp; During Construction</i> .....	25
2.3.3 <i>Final Construction Inspection Reports</i> .....	27
2.3.4 <i>Inspection for Preventative Maintenance</i> .....	27
2.4 INSPECTIONS & MAINTENANCE .....	28
2.4.1 <i>Inspections &amp; Maintenance Responsibilities</i> .....	28
2.4.2 <i>Inspection &amp; Maintenance Agreements</i> .....	28
2.5 AS-BUILT SUBMITTALS .....	29
2.6 REFERENCES.....	30
<b>CHAPTER 3. MINIMUM CONTROL REQUIREMENTS .....</b>	<b>32</b>
3.1 INTRODUCTION .....	32
3.2 REGULATED SITE DEFINITION .....	32
3.3 INFILL & REDEVELOPMENT .....	34
3.4 STORMWATER RUNOFF QUALITY & PEAK DISCHARGE CONTROL.....	34
3.5 SOUTHERN LOWCOUNTRY STORMWATER MANAGEMENT PERFORMANCE REQUIREMENTS.....	35
3.5.1 <i>Watershed Protection Area Designations</i> .....	35
3.5.2 <i>Overall Performance Requirements</i> .....	38



3.5.3	<i>Southern Lowcountry Stormwater Precipitation &amp; Runoff</i> .....	40
3.5.4	<i>Savannah River Watershed Protection Area</i> .....	40
3.5.5	<i>Bacteria &amp; Shellfish Watershed Protection Area</i> .....	41
3.5.6	<i>General Stormwater Management Watershed Area</i> .....	41
3.5.7	<i>Runoff Reduction &amp; Pollutant Removal</i> .....	41
3.6	EROSION & SEDIMENT CONTROL (ESC) REQUIREMENTS .....	43
3.7	RETENTION STANDARD & VOLUME.....	43
3.7.1	<i>Total Suspended Solids, Nutrients, &amp; Bacteria</i> .....	45
3.7.2	<i>Hydrologic &amp; Hydraulic Analysis</i> .....	45
3.7.3	<i>Maintenance Easements</i> .....	47
3.8	EXTREME FLOOD REQUIREMENT: 10% RULE .....	48
3.9	MAXIMUM EXTENT PRACTICABLE .....	49
3.10	OFF-SITE STORMWATER MANAGEMENT.....	50
3.11	FEE-IN-LIEU .....	51
3.12	WAIVERS .....	51
3.13	REFERENCES.....	52
CHAPTER 4. STORMWATER BEST MANAGEMENT PRACTICES (BMPS) .....		54
4.1	STANDARD STORMWATER BMP DESIGN SECTIONS .....	54
4.1.1	<i>Format of Standard Stormwater BMP Design Sections</i> .....	54
4.1.2	<i>Standard Nomenclature</i> .....	54
4.2	SUMMARY OF BMP STORMWATER MANAGEMENT CAPABILITIES, SITE APPLICABILITY, & PHYSICAL FEASIBILITY.....	54
4.2.1	<i>Stormwater Retention &amp; Water Quality Treatment</i> .....	55
4.2.2	<i>Site Applicability</i> .....	55
4.2.3	<i>Site Conditions &amp; Physical Feasibility</i> .....	56
4.3	BIORETENTION .....	58
4.3.1	<i>Bioretention Feasibility Criteria</i> .....	62
4.3.2	<i>Bioretention Conveyance Criteria</i> .....	65
4.3.3	<i>Bioretention Pretreatment Criteria</i> .....	67
4.3.4	<i>Bioretention Design Criteria</i> .....	68
4.3.5	<i>Bioretention Landscaping Criteria</i> .....	82
4.3.6	<i>Bioretention Construction Sequence</i> .....	88
4.3.7	<i>Bioretention Maintenance Criteria</i> .....	90
4.3.8	<i>Bioretention Stormwater Compliance Calculations</i> .....	92
4.3.9	<i>References</i> .....	93
4.4	PERMEABLE PAVEMENT SYSTEMS .....	96
4.4.1	<i>Permeable Pavement Feasibility Criteria</i> .....	99
4.4.2	<i>Permeable Pavement Conveyance Criteria</i> .....	102
4.4.3	<i>Permeable Pavement Pretreatment Criteria</i> .....	102
4.4.4	<i>Permeable Pavement Design Criteria</i> .....	102
4.4.5	<i>Permeable Pavement Landscaping Criteria</i> .....	109
4.4.6	<i>Permeable Pavement Construction Sequence</i> .....	109
4.4.7	<i>Permeable Pavement Maintenance Criteria</i> .....	114
4.4.8	<i>Permeable Pavement Stormwater Compliance Calculations</i> .....	115
4.4.9	<i>References</i> .....	117
4.5	INFILTRATION PRACTICES .....	118
4.5.1	<i>Infiltration Feasibility Criteria</i> .....	123
4.5.2	<i>Infiltration Conveyance Criteria</i> .....	125
4.5.3	<i>Infiltration Pretreatment Criteria</i> .....	126

4.5.4	<i>Infiltration Design Criteria</i> .....	126
4.5.5	<i>Infiltration Landscaping Criteria</i> .....	130
4.5.6	<i>Infiltration Construction Sequence</i> .....	130
4.5.7	<i>Infiltration Maintenance Criteria</i> .....	132
4.5.8	<i>Infiltration Stormwater Compliance Calculations</i> .....	133
4.5.9	<i>References</i> .....	134
4.6	<b>GREEN ROOFS</b> .....	135
4.6.1	<i>Green Roof Feasibility Criteria</i> .....	137
4.6.2	<i>Green Roof Conveyance Criteria</i> .....	139
4.6.3	<i>Green Roof Pretreatment Criteria</i> .....	139
4.6.4	<i>Green Roof Design Criteria</i> .....	139
4.6.5	<i>Green Roof Landscaping Criteria</i> .....	145
4.6.6	<i>Green Roof Construction Sequence</i> .....	147
4.6.7	<i>Green Roof Maintenance Criteria</i> .....	148
4.6.8	<i>Green Roof Stormwater Compliance Calculations</i> .....	149
4.6.9	<i>References</i> .....	150
4.7	<b>RAINWATER HARVESTING</b> .....	151
4.7.1	<i>Rainwater Harvesting Feasibility Criteria</i> .....	154
4.7.2	<i>Rainwater Harvesting Conveyance Criteria</i> .....	157
4.7.3	<i>Rainwater Harvesting Pretreatment Criteria</i> .....	157
4.7.4	<i>Rainwater Harvesting Design Criteria</i> .....	159
4.7.5	<i>Rainwater Harvesting Landscaping Criteria</i> .....	170
4.7.6	<i>Rainwater Harvesting Construction Sequence</i> .....	170
4.7.7	<i>Rainwater Harvesting Maintenance Criteria</i> .....	171
4.7.8	<i>Rainwater Harvesting Stormwater Compliance Calculations</i> .....	172
4.7.9	<i>References</i> .....	173
4.8	<b>IMPERVIOUS SURFACE DISCONNECTION</b> .....	175
4.8.1	<i>Impervious Surface Disconnection Feasibility Criteria</i> .....	176
4.8.2	<i>Impervious Surface Disconnection Conveyance Criteria</i> .....	177
4.8.3	<i>Impervious Surface Disconnection Pretreatment Criteria</i> .....	177
4.8.4	<i>Impervious Surface Disconnection Design Criteria</i> .....	177
4.8.5	<i>Impervious Surface Disconnection Landscaping Criteria</i> .....	178
4.8.6	<i>Impervious Surface Disconnection Construction Sequence</i> .....	178
4.8.7	<i>Impervious Surface Disconnection Maintenance Criteria</i> .....	179
4.8.8	<i>Impervious Surface Disconnection Stormwater Compliance Calculations</i> .....	179
4.8.9	<i>References</i> .....	180
4.9	<b>OPEN CHANNEL SYSTEMS</b> .....	181
4.9.1	<i>Open Channel Feasibility Criteria</i> .....	186
4.9.2	<i>Open Channel Conveyance Criteria</i> .....	189
4.9.3	<i>Open Channel Pretreatment Criteria</i> .....	189
4.9.4	<i>Open Channel Design Criteria</i> .....	190
4.9.5	<i>Open Channel Landscaping Criteria</i> .....	203
4.9.6	<i>Open Channel Construction Sequence</i> .....	204
4.9.7	<i>Open Channel Maintenance Criteria</i> .....	206
4.9.8	<i>Open Channel Stormwater Compliance Calculations</i> .....	207
4.9.9	<i>References</i> .....	209
4.10	<b>FILTERING SYSTEMS</b> .....	211
4.10.1	<i>Filtering System Feasibility Criteria</i> .....	220
4.10.2	<i>Filtering System Conveyance Criteria</i> .....	221

4.10.3	<i>Filtering System Pretreatment Criteria</i>	222
4.10.4	<i>Filtering System Design Criteria</i>	222
4.10.5	<i>Filtering System Landscaping Criteria</i>	227
4.10.6	<i>Filtering System Construction Sequence</i>	227
4.10.7	<i>Filtering System Maintenance Criteria</i>	229
4.10.8	<i>Filtering System Stormwater Compliance Calculations</i>	230
4.10.9	<i>References</i>	230
4.11	<b>STORAGE PRACTICES</b>	232
4.11.1	<i>Storage Feasibility Criteria</i>	235
4.11.2	<i>Storage Conveyance Criteria</i>	237
4.11.3	<i>Storage Pretreatment Criteria</i>	238
4.11.4	<i>Storage Design Criteria</i>	239
4.11.5	<i>Storage Landscaping Criteria</i>	240
4.11.6	<i>Storage Construction Sequence</i>	241
4.11.7	<i>Storage Maintenance Criteria</i>	243
4.11.8	<i>Storage Stormwater Compliance Calculations</i>	244
4.11.9	<i>References</i>	244
4.12	<b>PONDS</b>	245
4.12.1	<i>Pond Feasibility Criteria</i>	249
4.12.2	<i>Pond Conveyance Criteria</i>	250
4.12.3	<i>Pond Pretreatment Criteria</i>	252
4.12.4	<i>Pond Design Criteria</i>	252
4.12.5	<i>Pond Landscaping Criteria</i>	257
4.12.6	<i>Pond Construction Sequence</i>	258
4.12.7	<i>Pond Maintenance Criteria</i>	259
4.12.8	<i>Pond Stormwater Compliance Calculations</i>	261
4.12.9	<i>References</i>	261
4.13	<b>STORMWATER WETLANDS</b>	264
4.13.1	<i>Stormwater Wetland Feasibility Criteria</i>	268
4.13.2	<i>Stormwater Wetland Conveyance Criteria</i>	270
4.13.3	<i>Stormwater Wetland Pretreatment Criteria</i>	270
4.13.4	<i>Stormwater Wetland Design Criteria</i>	271
4.13.5	<i>Stormwater Wetland Construction Sequence</i>	273
4.13.6	<i>Stormwater Wetland Landscaping Criteria</i>	276
4.13.7	<i>Stormwater Wetland Maintenance Criteria</i>	281
4.13.8	<i>Stormwater Wetland Stormwater Compliance Calculations</i>	282
4.13.9	<i>References</i>	282
4.14	<b>TREE PLANTING &amp; PRESERVATION</b>	283
4.14.1	<i>Preserving Existing Trees during Construction</i>	284
4.14.2	<i>Planting Trees</i>	287
4.14.3	<i>Tree Inspection Criteria</i>	292
4.14.4	<i>Tree Maintenance Criteria</i>	292
4.14.5	<i>Tree Stormwater Compliance Calculations</i>	293
4.14.6	<i>References</i>	293
4.15	<b>PROPRIETARY PRACTICES</b>	297
4.15.1	<i>Proprietary Practice Feasibility Criteria</i>	298
4.15.2	<i>Proprietary Practice Conveyance Criteria</i>	298
4.15.3	<i>Proprietary Practice Pretreatment Criteria</i>	298
4.15.4	<i>Proprietary Practice Design Criteria</i>	298

4.15.5	<i>Proprietary Practice Landscaping Criteria</i> .....	299
4.15.6	<i>Proprietary Practice Construction Sequence</i> .....	299
4.15.7	<i>Proprietary Practice Maintenance Criteria</i> .....	299
4.15.8	<i>Proprietary Practice Stormwater Compliance Calculations</i> .....	299
4.15.9	<i>References</i> .....	299
4.16	CONSERVATION AREA .....	301
4.16.1	<i>Scenario 1: Natural Conservation Area</i> .....	301
4.16.2	<i>Scenario 2: Reforestation/Revegetation</i> .....	301
4.16.3	<i>Scenario 3: Soil Restoration</i> .....	301
4.16.4	<i>Scenario 4: Reforestation/Revegetation &amp; Soil Restoration</i> .....	301
CHAPTER 5. EROSION & SEDIMENT CONTROL .....		302
5.1	SEDIMENTATION CYCLE .....	302
5.2	FACTORS INFLUENCING EROSION .....	302
5.3	CONCEPTS OF EROSION & SEDIMENT CONTROL .....	302
5.4	GENERAL CRITERIA .....	303
5.5	REFERENCES .....	304
CHAPTER 6. ENFORCEMENT & VIOLATIONS .....		305

## List of Figures

### Chapter 2

Figure 2.1. Conservation (i.e., cluster) development versus conventional development. ....	8
Figure 2.2. Site planning & design process (source: Center for Watershed Protection, Inc.) .....	12
Figure 2.3. Conventional Site Design (source: Merrill et al., 2006) .....	14
Figure 2.4. Conservation Site Design (source: Merrill et al., 2006) .....	14
Figure 2.5. New Urbanist Site Design (source: Merrill et al., 2006) .....	15
Figure 2.6. Integrating Natural Resource Protection & Stormwater Management with the Site Planning & Design Process (source: Center for Watershed Protection, Inc.). ....	17
Figure 2.7. Buildable Area and Primary/Secondary Conservation Areas (source: Merrill et al., 2006) .....	18

### Chapter 3

Figure 3.1. Southern Lowcountry Stormwater Design Manual applicability diagram .....	33
Figure 3.2. Watershed Protection Areas of the Southern Lowcountry. ....	37

### Chapter 4

Figure 4.1. Bioretention in parking lot (photo credit: Center for Watershed Protection, Inc.) .....	59
Figure 4.2. Example bioretention design without an underdrain .....	60
Figure 4.3. Example bioretention design with internal water storage (IWS) .....	61
Figure 4.4. Example standard bioretention design .....	61
Figure 4.5. Example streetscape bioretention. ....	62
Figure 4.6. Example design of an on-line bioretention with an overflow structure .....	67
Figure 4.7. Example design of a bioretention with an observation well/cleanout device. ....	74
Figure 4.8. Example design of a tree box .....	78
Figure 4.9. Example design of a tree box with compacted media extending below sidewalk. ....	79
Figure 4.10. Example design of a stormwater planter (B-4) .....	80

Figure 4.11. Cross-section of permeable pavement (source: ICPI).....	97
Figure 4.12. Cross-section of a standard permeable pavement design.....	98
Figure 4.13. Cross-section of an enhanced permeable pavement design with an underdrain .....	99
Figure 4.14. Cross-section of an enhanced permeable pavement design without an underdrain.....	99
Figure 4.15. Use of flow barriers to encourage infiltration on sloped sites. ....	103
Figure 4.16. Infiltration practice in median strip. ....	119
Figure 4.17. Example design of an infiltration trench.....	120
Figure 4.18. Example design of an infiltration practice with supplemental pipe storage. ....	121
Figure 4.19. Example design of an infiltration basin.....	122
Figure 4.20. Green roof (photo: Center for Watershed Protection, Inc.) .....	136
Figure 4.21. Green roof layers (note: the relative placement of various layers may vary depending on the type and design of the green roof system). ....	140
Figure 4.22. Design requirements for structures constructed above green roofs .....	144
Figure 4.23. Example cistern application (photo: Marty Morganello).....	152
Figure 4.24. Example of a rainwater harvesting system detail .....	154
Figure 4.25. Diagram of a first flush diverter (photo: Texas Water Development Board, 2005).....	158
Figure 4.26. Diagram of a roof washer (photo: Texas Water Development Board, 2005) .....	159
Figure 4.27. Cistern Design 1: Storage associated with the design storm volume only. ....	163
Figure 4.28. Cistern Design 2: Storage associated with design storm, channel protection, and flood volume. ....	164
Figure 4.29. Cistern Design 3: Constant drawdown version where storage is associated with design storm, channel protection, and flood volume. ....	165
Figure 4.30. Incremental design volumes associated with cistern sizing .....	167
Figure 4.31. Example of graph showing Average Available Storage Volume and Overflow Volume for an example cistern design. ....	169
Figure 4.32. Rooftop disconnection (photo: Center for Watershed Protection, Inc.) .....	176
Figure 4.33. Open channel (photo: Center for Watershed Protection, Inc.) .....	182
Figure 4.34. Grass channel typical plan, profile, and section views (O-1) .....	183
Figure 4.35. Example of a dry swale/bioswale (O-2) .....	184
Figure 4.36. Example of a wet swale (O-3) .....	185
Figure 4.37. Example of Regenerative Stormwater Conveyance (O-4) .....	186
Figure 4.38. Typical Width and Depth of Riffle Sections (Anne Arundel County, 2011).....	202
Figure 4.39. Typical schematic for a nonstructural or surface sand filter (note: material specifications are found in Table 4.44) .....	213
Figure 4.40. Example of a three-chamber underground sand filter (F-3) for separate sewer options. Part A. Note: material specifications are indicated in Table 4.44. ....	214
Figure 4.41. Example of a three-chamber underground sand filter (F-3) for separate sewer areas. Part B. Note: material specifications are indicated in Table 4.44. ....	215
Figure 4.42. Example of a three-chamber underground sand filter (F-3) for separate sewer areas. Part C. Note: material specifications are indicated in Table 4.44. ....	216
Figure 4.43. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part A. Note: Material specifications are indicated in Table 4.44. ....	217
Figure 4.44. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part B. Note: Material specifications are indicated in Table 4.44. ....	218

Figure 4.45. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part C. Note: Material specifications are indicated in Table 4.44. ....	219
Figure 4.46. Example of a perimeter sand filter (F-4). Note: material specifications are indicated in Table 4.44. ....	220
Figure 4.47. Dry Extended Detention Pond (Photo: Center for Watershed Protection, Inc.).....	233
Figure 4.45 Example of an underground detention vault and/or tank (S-1) .....	234
Figure 4.46 Example of a dry detention pond (S-2) .....	235
Figure 4.47 Wet Pond (photo: Denise Sanger).....	246
Figure 4. 48 Design schematics for a wet pond (C-2).....	247
Figure 4. 49 Typical extended detention pond (C-3) details. ....	248
Figure 4.50 Stormwater Wetland at Carolina Forest Recreation Center, Myrtle Beach (photo: Kathryn Ellis).....	265
Figure 4.51 Example of extended detention shallow wetland. ....	267
Figure 4.52 Cross section of a typical stormwater wetland.....	268
Figure 4.53 Interior wetland zones. Adapted from Hunt et al. (2007) .....	268
Figure 4.54 Tree Planting and Preservation in Bioretention (photo: Center for Watershed Protection, Inc.). ....	284
Figure 4.55. Tree planting guidelines. Adapted from Flott, 2004 and ISA, 2003b.....	290
Figure 4.56 Trees planted on steep slopes require a constructed level planting surface.....	291

## List of Tables

### Chapter 2

Table 2. 1. Summary of land cover changes in Southern Lowcountry from 1996 to 2010. ....	5
Table 2.2. Resources to be identified and mapped during the Natural Resources Inventory.....	7
Table 2. 3. Better Site Design principles for conservation. ....	9
Table 2.4. Better Site Design principles for streets and parking to meet <i>&lt;local jurisdiction&gt;</i> requirements. ....	10
Table 2. 5. Better Site Design principles for lot development. ....	11

### Chapter 3

Table 3.1. Watershed Protection Area HUC-12 Codes. ....	38
Table 3.2. Watershed Area Overall Performance Requirements .....	39
Table 3.3. Pollutant Removal Efficiencies of Structural BMPs.....	42
Table 3.4. Rainfall depth (inches) for the Southern Lowcountry.....	46
Table 3.5. Drainage maintenance access easements. ....	48

### Chapter 4

Table 4.1. Site applicability for BMPs.....	55
Table 4.2. Feasibility limitations for BMPs.....	57
Table 4.3. Maximum contributing drainage area (CDA) to bioretention.....	63
Table 4.4. Filter media grain size distribution.....	71
Table 4.5. Summary of filter media criteria for bioretention .....	72
Table 4.6. Bioretention material specifications. ....	76
Table 4.7. Bioretention-appropriate plants: perennial and grass.....	83

Table 4.8. Bioretention-appropriate plants: shrubs and bushes .....	86
Table 4.9. Typical maintenance tasks for bioretention practices. ....	91
Table 4.10. Retention and pollutant removal for bioretention practices without underdrains.....	92
Table 4.11. Retention and pollutant removal for bioretention practices with IWS design. ....	93
Table 4.12. Retention and pollutant removal for standard bioretention practices. ....	93
Table 4.13. Permeable pavement specifications for a variety of typical surface materials. ....	105
Table 4.14. Material specifications for typical layers beneath the surface of permeable pavements. ....	106
Table 4.15. Typical maintenance tasks for permeable pavement practices.....	115
Table 4.16. Retention and pollutant removal for enhanced permeable pavement practices.....	116
Table 4.17. Retention and pollutant removal for standard permeable pavement practices. ....	116
Table 4.18. Infiltration practice material specifications. ....	128
Table 4.19. Maximum facility depth for infiltration practices. ....	129
Table 4.20. Typical maintenance activities for infiltration practices. ....	133
Table 4.21. Retention and pollutant removal for infiltration practices. ....	133
Table 4.22. Extensive Green Roof Material Specifications .....	142
Table 4.23. Ground Covers Appropriate for Green Roofs in the State of South Carolina .....	145
Table 4.24. Typical Maintenance Activities Associated with Green Roofs .....	149
Table 4.25. Retention and pollutant removal of green roofs .....	149
Table 4.26. Advantages and Disadvantages of Typical Cistern Materials.....	161
Table 4.27. Design Specifications for Rainwater Harvesting Systems .....	162
Table 4.28. Typical Maintenance Tasks for Rainwater Harvesting Systems .....	172
Table 4.29. Rainwater Harvesting Retention and Pollutant Removal.....	173
Table 4.30. Feasibility Criteria for Disconnection .....	177
Table 4.31. Disconnection Retention and Pollutant Removal .....	180
Table 4.32. Typical Check Dam Spacing to Achieve Effective Channel Slope .....	191
Table 4.33. Grass Channel Material Specifications.....	193
Table 4.34. Dry Swale Material Specifications.....	194
Table 4.35. Regenerative Stormwater Conveyance System Material Specifications .....	196
Table 4.36. Maximum Allowable Velocity.....	203
Table 4.37. Recommended Vegetation for Open Channels.....	204
Table 4.38. Typical Maintenance Activities and Schedule for Open Channels.....	207
Table 4.39. Grass Channel Retention and Pollutant Removal .....	207
Table 4.40. Grass Channel on Amended Soils Retention and Pollutant Removal .....	208
Table 4.41. Dry Swale Retention and Pollutant Removal .....	208
Table 4.42. Wet Swale Retention and Pollutant Removal .....	208
Table 4.43. RSC Retention and Pollutant Removal .....	209
Table 4.44. Filtering Practice Material Specifications.....	225
Table 4.45. Typical Annual Maintenance Activities for Filtering Practices .....	229
Table 4.46. Filter Retention and Pollutant Removal.....	230
Table 4.47. Typical Maintenance Activities for Storage Practices. ....	243
Table 4.48. Storage Retention and Pollutant Removal.....	244
Table 4.49. Clay Liner Specifications.....	254
Table 4.50. Pond Maintenance Tasks and Frequency.....	260
Table 4.51. Ceiling Levels Governing Management of Accumulated Sediment <sup>1</sup> .....	260

Table 4.52. Pond Retention and Pollutant Removal.....	261
Table 4.53. Popular, Versatile, and Available Native Trees and Shrubs for Stormwater Wetlands.....	278
Table 4.54. Popular, Versatile, and Available Native Emergent and Submergent Vegetation for Stormwater Wetlands.....	279
Table 4.55. Stormwater Wetland Retention and Pollutant Removal .....	282
Table 4.56. Selecting Priority Trees and Forests for Preservation .....	286
Table 4.57. Methods for Addressing Urban Planting Constraints.....	288
Table 4.58. Tree Planting Techniques .....	289
Table 4.59. T-1 Preserved and Planted Tree Retention .....	293

## List of Equations

### Chapter 3

Equation 3.1. Curve number runoff equation.....	43
Equation 3.2. Stormwater retention volume (SWRv) equation.....	44

### Chapter 4

Equation 4.1. Bioretention storage volume.....	81
Equation 4.2. Bioretention infiltration rate check equation.....	81
Equation 4.3. Reservoir layer or infiltration sump depth. ....	107
Equation 4.4. Drawdown time. ....	108
Equation 4.5. Permeable pavement storage volume .....	108
Equation 4.6. Maximum surface basin depth for infiltration basins .....	128
Equation 4.7. Maximum underground reservoir depth for infiltration trenches. ....	128
Equation 4.8. Surface basin surface area for infiltration basins .....	129
Equation 4.9. Underground reservoir surface area for infiltration trenches.....	129
Equation 4.10. Storage volume for surface basin area for infiltration basins .....	130
Equation 4.11. Storage volume for underground reservoir surface area for infiltration trenches. ....	130
Equation 4.12. Storage Volume for Green Roofs.....	144
Equation 4.13 Manning's Equation .....	197
Equation 4.14 Continuity Equation .....	198
Equation 4.15 Minimum Width.....	198
Equation 4.16 Corresponding Velocity.....	198
Equation 4.17 Grass Channel Length for Hydraulic Residence Time of 9 minutes (540 seconds) .....	199
Equation 4.18 Grass Channel Storage Volume .....	199
Equation 4.19 Dry Swale Storage Volume .....	199
Equation 4.20 Wet Swale Storage Volume .....	200
Equation 4.21 Riffle Pool Length.....	202
Equation 4.22 RSC Systems Storage Volume .....	203
Equation 4.23 Minimum Filter Surface Area for Filtering Practices.....	226
Equation 4.24 Required Ponding Volume for Filtering Practices.....	226
Equation 4.25 Storage Volume for Filtering Practices .....	227
Equation 4.26 Pond Storage Volume .....	256
Equation 4.27 Water Balance Equation for Acceptable Water Depth in a Wet Pond .....	256



Equation 4.28 Baseflow Conversion .....	257
Equation 4.29 Stormwater Wetland Storage Volume .....	272
Equation 4.30 Water Balance for Acceptable Water Depth in a Stormwater Wetland.....	273
Equation 4.31 Minimum Depth of the Permanent Pool .....	273

## Acronym Definitions

Acronym/Abbreviation	Definition
ARC	Antecedent Runoff Condition
BMP	Best Management Practice
BSD	Better Site Design
CDA	Contributing Drainage Area
CN	Curve Number
C-SWPPP	Construction Stormwater Pollution Prevention Plan
EGL	Energy Grade Line
EPA	United States Environmental Protection Agency
ESC	Erosion and Sediment Control
FHWA	Federal Highway Administration
GI	Green Infrastructure
HDS	Hydraulic Design Services
HGL	Hydraulic Grade Line
HUC	Hydrologic Unit Code
IWS	Internal Water Storage
LID	Low-Impact Development
LOD	Limits of Disturbance
MEP	Maximum Extent Practicable
MS4	Municipal Separate Storm Sewer System
NC DEQ	North Carolina Department of Environmental Quality
NEH	National Engineering Handbook
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PROW	Public Right-of-Way
PUD	Planned Unit Development
SC DHEC	South Carolina Department of Health and Environmental Control
SC DOT	South Carolina Department of Transportation
SDA	Site Drainage Area
SWMP	Stormwater Management Plan
SWRv	Stormwater Retention Volume

## Chapter 1. Introduction, Background, Purpose, and Administration

### 1.1 Introduction

Upon passage of the Southern Lowcountry Stormwater Ordinance as amended and adopted by Beaufort County Public Works Department, participating municipalities/jurisdictions will follow the design and permitting requirements of the *Southern Lowcountry Stormwater Design Manual*. The Ordinance directs residents, land developers, redevelopment, and government permit applicants to submit details and plans that comply with this Manual. It is the intent of the Ordinance that all proposed development, redevelopment, and major substantial improvement shall provide stormwater quality control for the stormwater retention volume (SWRV) for Watershed Protection Areas and/or Special Watershed Protection Areas. In the following chapters, Better Site Design (BSD) practices, green infrastructure/low impact development practices (GI/LID), and stormwater best management practices (BMPs) are described in detail to support the stormwater retention requirements. Through in-line and off-line application of these practices, the cumulative impact is reduction of the runoff and the retention on site of design storms.

This Manual and the design criteria presented within represent good engineering practice and should be used in the preparation of stormwater management plans. The criteria are intended to establish requirements, minimum standards, and methods for a sound planning, design, and review process. It is intended to guide the stormwater design review of proposed work done by developers, private parties, and governmental agencies.

### 1.2 Background

The U.S. Environmental Protection Agency (EPA) recommends that the Phase II Small Municipal Separate Storm Sewer System (MS4) permit require the permittee to adopt a planning process that identifies the municipality's program goals (e.g., minimize water quality impacts resulting from post-construction runoff from new development and redevelopment), implementation strategies (e.g., adopt a combination of structural and/or non-structural BMPs), operation and maintenance policies and procedures, and enforcement procedures. In developing the program, EPA states that the permit should also require the permittee to assess existing ordinances, policies, programs and studies that address stormwater runoff quality. These policy assessments should include the following:

- Policies and ordinances that:
  - provide requirements and standards to direct growth to identified areas,
  - protect sensitive areas such as wetlands and riparian areas,
  - maintain and/or increase open space (including a dedicated funding source for open space acquisition),
  - provide buffers along sensitive water bodies,
  - minimize impervious surfaces, and
  - minimize disturbance of soils and vegetation;
- Policies or ordinances that encourage infill development in higher density urban areas and areas with existing infrastructure;
- Education programs for developers and the public about project designs that minimize water quality impacts; and
- Measures such as minimization of percent impervious area after development and minimization of directly connected impervious areas (81 Federal Register 237).

### 1.3 Purpose

This Manual's purpose is to provide a framework for designing a stormwater management system to:

- Improve water quality through runoff reduction to the maximum extent practicable (MEP);
- Prevent downstream stream bank and channel erosion;
- Reduce downstream overbank flooding; and
- Safely pass or reduce the runoff from extreme storm events.

This Manual presents a unified approach for sizing stormwater best management practices (BMPs) in the Southern Lowcountry to meet pollutant removal goals, reduce peak discharges, and pass extreme floods. Additionally, it follows a watershed approach for their size and specification. Based on the site's watershed, stormwater design criteria specific to each must be met for development permit approval.

### 1.4 Applicability and Exemptions

#### 1.4.1 Applicability

Design criteria in this Manual are applicable to any new development or redevelopment activity that meets one or more of the following criteria, or is a major substantial improvement, unless exempt pursuant to Section 1.4.2 below:

1. New development that involves the creation of 5,000 square feet of land disturbance.
2. Redevelopment that involves the creation, addition, or replacement of 5,000 square feet or more of land disturbance.
3. New development or redevelopment, regardless of size, that is part of a larger common plan of development, even though multiple, separate and distinct land disturbing activities may take place at different times and on different schedules.
4. A major substantial improvement of an existing property, which is defined as a renovation or addition to a structure that meets both of the following cost and size thresholds: a) construction costs for the building renovation/addition are greater than or equal to 50% of the pre-project assessed value of the structure as developed using current Building Valuation Data of the International Code Council, and b) project size where the combined footprint of structure(s) exceeding the cost threshold and any land disturbance is greater than or equal to 5,000 square feet.

The design criteria are applicable for infill development of platted lots, whether they are new development or redevelopment sites if the work involves creation, addition or replacement of 5,000 square feet or more of land disturbance

#### 1.4.2 Exemptions

The following activities are exempt from the permitting requirements of this Manual:

1. Any maintenance, alteration, renewal, or improvement as approved by Beaufort County Public Works Department which does not alter existing drainage pattern, does not result in change or adverse impact on adjacent property and/or downstream properties, or create adverse environmental or water quality impacts, and does not increase the temperature, rate, quality, volume, or location of stormwater runoff discharge.
2. Projects that are exclusively for agricultural or silvicultural activities within areas zoned for these agricultural and silvicultural uses. Proof of Silviculture permit required;
3. Agricultural activity not involving relocation of drainage canals;

4. Redevelopment that constitutes the replacement of the original square footage of impervious cover and original acreage of other land development activity when the original development is wholly or partially lost due to natural disaster or other acts of God occurring after January 31st, 2021,
5. Work by agencies or property owners required to mitigate emergency flooding conditions. If possible, emergency work should be approved by the duly appointed officials in charge of emergency preparedness or emergency relief. Property owners performing emergency work will be responsible for any damage or injury to persons or property caused by their unauthorized actions. Property owners will stabilize the site of the emergency work within 60 days, or as soon as reasonable, following the end of the emergency period;
6. Golf courses are required to comply with all site runoff volume and water quality and drainage planning and design requirements. However, both golf courses and private lagoons shall be exempt from the peak attenuation requirements.
7. Existing dirt roads which are improved or paves as part of Beaufort County's Dirt Road Paving Program as set forth in Beaufort County Policy Statement 15 and Policy Statement 17 are deemed not to constitute "development" under the County Code of Ordinance Chapter 99 (Stormwater Utility Ordinance), MS4 Program, or this manual and are, therefore, exempt from the provisions and requirements herein.
8. Small subdivisions may be exempt from the permitting requirements of this manual, and shall be handled on a case by case basis and to be approved by the Public Works Director.

## **1.5 Administration**

### **1.5.1 Approval Requirements**

Before the Beaufort County Public Works Department may issue a stormwater permit for any project requiring stormwater management, the Beaufort County Public Works Department must approve a Stormwater Management Plan (SWMP) meeting the requirements of the Southern Lowcountry Stormwater Ordinance and receive all fees required by the Beaufort County Public Works Department for site and building development plans.

A complete SWMP submittal includes a completed engineer's certification statement, a submittal checklist, plans and design that are signed and sealed by a registered professional engineer licensed in South Carolina. Erosion and sediment control for sites below the South Carolina Department of Health and Environmental Control (SC DHEC) National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Construction Activities (SCR100000) thresholds must obtain permit coverage under this stormwater permit. All construction stormwater permit applications above the SC DHEC thresholds are reviewed by the DHEC Office of Coastal Resources Management, or the reviews are delegated to the Beaufort County Public Works Department to determine compliance with the requirements of SCDHEC's NPDES General Permit for Stormwater Discharges from Construction Activities (SCR100000) and of the Construction Stormwater Pollution Prevention Plan (C-SWPPP). These permit applications must be approved, issued, and provided to Beaufort County Public Works Department prior to the issuance of the stormwater management plan approval.

### **1.5.2 Fees**

An applicant is responsible for paying fees that provide for the cost of review, administration, and management of the stormwater permitting process and inspection of all projects subject to the requirements of Beaufort County Public Works. These fees are posted by the Beaufort County Public Works Department.

## Chapter 2. Design, Review, & Permitting Process

### 2.1 Satisfying the Stormwater Management, Site Planning, & Design Criteria

#### 2.1.1 Overview

This chapter presents a comprehensive set of site planning and design and post-construction criteria that must be applied to new development and redevelopment activities occurring within the Southern Lowcountry region. Satisfying these criteria promotes the systematic development of acceptable stormwater management plans, and a successful integration of natural resource protection and stormwater management through the site planning and design process (Figure 2.2).

Through the use of Better Site Design, as described in detail below, the integration of natural resource protection and stormwater management can be achieved by:

- Identifying and protecting valuable natural resources;
- Limiting land disturbance, new impervious cover, and disturbed pervious cover; and
- Reducing and managing post-construction stormwater runoff rates, volumes, and pollutant loads.

This approach involves the use of two distinct but complementary groups of natural resource protection and stormwater management techniques:

- **Green Infrastructure Practices:** Natural resource protection and stormwater management practices and techniques (i.e., better site planning and design techniques, low impact development practices) that can be used to help prevent increases in post-construction stormwater runoff rates, volumes and pollutant loads.
- **Stormwater Management Practices:** Stormwater management practices (e.g., wet ponds, swales) that can be used to manage post-construction stormwater runoff rates, volumes and pollutant loads.

Natural resource protection and stormwater management techniques help control and minimize the negative impacts of the land development process while retaining and, perhaps, even enhancing a developer's vision for a development site. When applied during the site planning and design process, they can be used to create more natural and aesthetically pleasing development projects and create more cost-effective post-construction stormwater management systems (ARC, 2001). The use of these techniques, particularly the green infrastructure practices, can even reduce overall development costs while maintaining or increasing the resale value of a development project (MacMullan and Reich, 2007; US EPA, 2007; Winer-Skonovd et al., 2006).

### 2.1.2 Better Site Design in the Planning Process

Better Site Design (BSD) refers to encouraged planning land development using certain principles to minimize stormwater impacts. Integral to low impact development design, proper application of BSD principles can allow for smaller required stormwater BMP storage and retention volumes, and can help provide significant reductions in post-construction peak flows and pollutant loads. These principles include reduction/restoration of impervious cover, conservation of natural cover areas, stream restoration, and integration of both structural and non-structural stormwater management within site design. The principles of Better Site Design are referenced in the sections below. To note, any design standards in conflict with the Beaufort County Community Development Code (CDC) will be superseded by the CDC.

Fundamental to the application of Better Site Design is the correlation between impervious surface area in a watershed and negative impacts on receiving water resources. On a national level, the Impervious Cover Model (ICM) estimates stream quality based on percentage of impervious cover (Schueler and Fraley-McNeal, 2009). This model demonstrates that streams follow a continuous gradient of degradation in response to increasing impervious cover in a watershed. Local studies have supported this paradigm, and report that changes in the rate and volume of stormwater runoff were primary causes of ecological impairment in headwater tidal creeks, such as those found in Beaufort and Jasper Counties. These studies have shown that physical and chemical characteristics such as altered hydrography, increased salinity variance, increased chemical contaminants, and increased fecal coliform loadings of tidal creeks were negatively impacted with as little as 10 to 20% impervious cover. When impervious cover exceeded 30% of the watershed, measurable impacts to living resources were observed, indicating the ecological processes in the creek ecosystems were impaired (Holland et al., 2004).

Such findings are of consequence to Beaufort and Jasper Counties. Increasing pressure for development in response to population growth, and land development practices of the Lowcountry result in significant tree removal and loss of vegetative cover from land grading and storm pond construction and increases in impervious surfaces. According to the NOAA C-CAP Land Cover Analysis (<https://coast.noaa.gov/ccapatlas/>), from 1996 to 2010, the percent net increase in impervious surface area was 60% for Beaufort County and 59% for Jasper County. Table 2. 1. Summary of land cover changes in Southern Lowcountry from 1996 to 2010. below summarizes the findings of this NOAA report. Although the percentage of total wetlands lost is relatively low for both counties, the actual wetland types have been converted from palustrine forested wetlands to palustrine scrub/shrub and palustrine emergent wetlands, which may alter ecosystem processes and hydrology in these areas.

Table 2. 1. Summary of land cover changes in Southern Lowcountry from 1996 to 2010.

Land Cover %	Beaufort County <sup>1</sup>			Jasper County <sup>1</sup>		
	1996	2010	% Change	1996	2010	% Change
Development	3.87	6.16	+59.12	1.62	2.52	+55.15
Forested Area	25.28	21.5	-14.98	62.50	48.37	-22.60
Wetlands	33.85	33.20	-1.93	45.24	44.74	-1.11

<sup>1</sup> Percent of County under each land cover type.

Given the rapid growth the Southern Lowcountry experienced in the past 20 years, the goals of Better Site Design should resonate with those charged with managing stormwater and its release into the area watersheds. Succinctly, the goals of Better Site Design include the following:

- Preventing stormwater impacts rather than mitigating them;
- Managing stormwater (quantity and quality) as close to the point of origin as possible and minimizing collection and conveyance;
- Utilizing simple, nonstructural methods for stormwater management that are lower cost and lower maintenance than structural controls;
- Creating a multifunctional landscape; and
- Using hydrology as a framework for site design.

The Center for Watershed Protection's Better Site Design Handbook outlines 22 model development principles for site design that act to reduce impervious cover, conserve open space, prevent stormwater pollution, and reduce the overall cost of development (CWP, 2017). The principles can provide notable reductions in post-construction stormwater runoff rates, volumes and pollutant loads (ARC, 2001).

Better Site Design across the country is implemented through review of existing planning and development codes, and streets, parking and stormwater engineering criteria. Within the context of a stormwater management document and this Manual, the Better Site Design techniques of greatest application include protection of existing natural areas, incorporation of open space into new development, effective sediment and erosion control practices, and stormwater management that mimics natural systems. The following sections apply Better Site Design to the Southern Lowcountry Watershed Protection Areas and Special Watershed Protection Areas to help mitigate the effects of development to the watersheds. Therefore, the conservation principles below are part of an overall watershed approach to stormwater management and will complement the Watershed Protection Area approach in this Manual. Their application is subject to Beaufort County Public Works Department requirements and/or standards.

### 2.1.3 Site Planning & Design Process

Figure 2.2 depicts the site planning and design process that is captured in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al., 2014) and is applicable to the Beaufort County Public Works Department. The site planning and design checklist of the Southern Lowcountry Design Manual does not make each of the phases of the process a submittal requirement. The checklist, however, gives the Beaufort County Public Works Department the opportunity to ask whether each of these steps have been considered. Required steps for the Beaufort County Public Works Stormwater Permit submittal are the conceptual plan and final plan, with construction and final inspections occurring after final plan has been approved. The actual document submittal begins with the preliminary plan when considered in context of the planning process below:

- **Site Prospecting:** During the site prospecting phase, some basic information is used to evaluate the feasibility of completing a development or redevelopment project. A *feasibility study* is typically used to evaluate the many factors that influence a developer's decision about whether or not to move forward with a potential development project. Factors that are typically evaluated during a *feasibility study* include information about site characteristics and constraints, applicable local, state and federal stormwater management and site planning and design requirements, adjacent land uses and access to local infrastructure (e.g., water, sanitary sewer).
- **Site Assessment:** Once a potential development or redevelopment project has been deemed feasible, a more thorough assessment of the development site is completed. The site assessment, which is typically completed using acceptable site reconnaissance and surveying techniques, provides additional information about a development site's

characteristics, its natural resource inventory and constraints. Once the assessment is complete, a developer can identify and analyze the natural, man-made, economic and social aspects of a potential development project, define the actual buildable area available on the development site and begin making some preliminary decisions about the layout of the proposed development project.

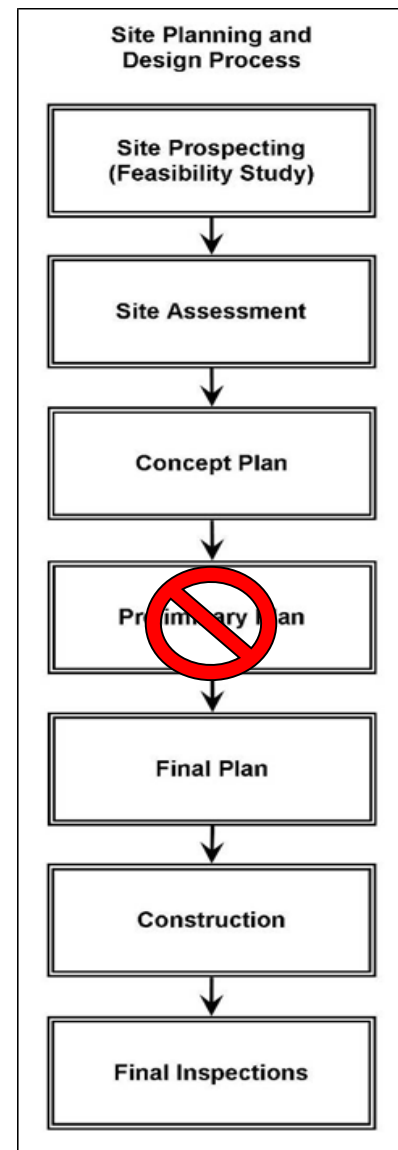


Figure 2.1. Site planning & design process



- Concept Plan: The results of the site assessment are typically used to create a concept plan for the proposed development project. A concept plan is used to illustrate the basic layout of the proposed development project, including lots and roadways, and is usually reviewed with the local development review authority before additional resources are used to create a more detailed plan of development. During this phase, several alternative concept plans can be created and compared with one another to craft a plan of development that best “fits” the character of the development site (Figure 2.3, Figure 2.4, and Figure 2.5). It is at this point in the planning and design process that a Maximum Extent Practicable demonstration described in Section 3.9 is required for development projects that will seek a waiver from requirements of this Manual.
- Final Plan: The final plan adds further detail to the preliminary plan and reflects any changes to the plan of development that were requested or required by the local development review authority. The final plan typically includes all of the information that was included in the preliminary plan, as well as information about landscaping, pollution prevention, erosion and sediment control and long-term operation and maintenance of the site’s post-construction stormwater management system. There may be several iterations of the final plan between the time that it is submitted and the time that it is approved by the local development review authority.
- ⑦ Construction: Once the final plan has been reviewed and approved, performance bonds are set and placed, contractors are retained, and construction begins. During the construction phase, a development project may be inspected on a regular basis by the local development review authority to ensure that all roadways, parking areas, buildings, utilities and other infrastructure, including the post-construction stormwater management system, are being built in accordance with the approved final plan and that all primary and secondary conservation areas have been protected from any land disturbing activities.
- ⑦ Final Inspections: Once construction is complete, final inspections take place to ensure that all roadways, parking areas, buildings, utilities and other infrastructure, including the post-construction stormwater management system, were built according to the approved final plan. As-built plans are also typically prepared and executed during this phase. If a development project passes all final inspections, an occupancy permit may be issued for the project.

#### **2.1.4 Natural Resources Inventory**

The first step to conserve natural resources is properly documenting existing assets. An up-to-date natural resources inventory map can provide geospatial information for water resources, soils, sensitive natural resource areas, critical habitats, and other unique resources (Ellis et al., 2014).

An application for new development requires a natural resources inventory prior to the start of any land disturbing activities. A natural resources inventory prepared by a qualified person shall be used to identify and map the most critical natural resources identified on the property that would be best to preserve, such as those listed in Table 2.2, as they exist predevelopment. Qualified persons include individuals with a working knowledge of hydrology, wetlands, plant taxonomy, and field survey methods. Qualified individuals include but are not limited to licensed foresters, professional wetland scientists, and geographic information professionals. A thorough assessment of the natural resources, both terrestrial and aquatic, found on a development site shall be submitted in the development application.

Table 2.2. Resources to be identified and mapped during the Natural Resources Inventory.

Resource Group	Resource Type
General Resources	<ul style="list-style-type: none"> <li>• Topography</li> <li>• Natural Drainage Divides</li> <li>• Natural Drainage Patterns</li> <li>• Natural Drainage Features (e.g., Swales, Basins, Depressional Areas)</li> <li>• Soils</li> <li>• Erodible Soils</li> <li>• Steep Slopes (e.g., Areas with Slopes Greater Than 15%)</li> <li>• Trees and Other Existing Vegetation</li> </ul>
Freshwater Resources	<ul style="list-style-type: none"> <li>• Freshwater Wetlands</li> </ul>
Estuarine Resources	<ul style="list-style-type: none"> <li>• Tidal Rivers and Streams</li> <li>• Tidal Creeks</li> <li>• Coastal Marshlands</li> <li>• Tidal Flats</li> <li>• Scrub-Shrub Wetlands</li> </ul>
Marine Resources	<ul style="list-style-type: none"> <li>• Near Coastal Waters</li> <li>•</li> </ul>
Groundwater Resources	<ul style="list-style-type: none"> <li>• Groundwater Recharge Areas</li> <li>• Wellhead Protection Areas</li> <li>•</li> </ul>
Terrestrial Resources	<ul style="list-style-type: none"> <li>• Bottomland Hardwood Forests</li> <li>• Beech-Magnolia Forests</li> </ul>

#### Other Resources

- Pine Flatwoods
- Longleaf Pine-Wiregrass Savannas
- Longleaf Pine-Scrub Oak Woodlands
- Shellfish Harvesting Areas
- Floodplains
- Aquatic Buffers
- Other High Priority Habitat Areas as described by South Carolina Department of Natural Resources

### 2.1.5 Conservation Development

Conservation development, also known as open space development or cluster development, is a site planning and design technique used to concentrate structures and impervious surfaces in a small portion of a development site, leaving room for larger conservation areas and managed open spaces elsewhere on the site (Figure 2.2). Alternative lot designs are typically used to “cluster” structures and other impervious surfaces within these conservation developments.

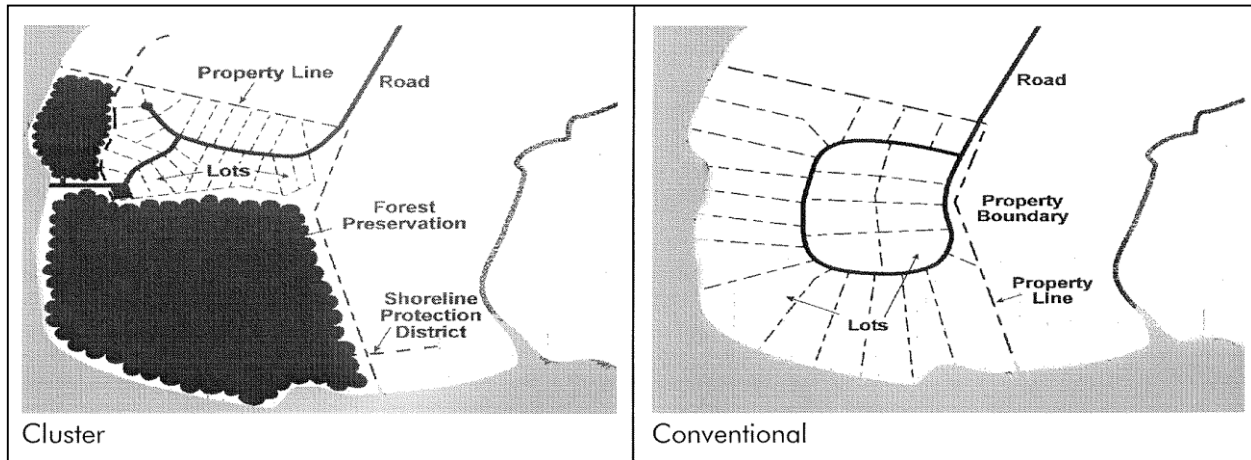


Figure 2.2. Conservation (i.e., cluster) development versus conventional development.

Conservation development projects provide a host of environmental benefits that are typically more difficult to achieve with conventional site design techniques. They provide for better natural resource protection on development sites and inherently limit increases in site imperviousness, sometimes by as much as 40 to 60 percent. Reduced site imperviousness results in reduced post-construction stormwater runoff rates, volumes and pollutant loads, which helps better protect both on-site and downstream aquatic resources from the negative impacts of the land development process. Reduced stormwater runoff rates, volumes and pollutant loads also help reduce the size of and need for storm drain systems and stormwater management practices on development sites.

As a number of recent studies have shown conservation development projects can also be significantly less expensive to build than more conventional development projects. Most of the cost savings can be attributed to the reduced amount of infrastructure (e.g., roads, sidewalks, post-construction stormwater management practices) needed on these development projects. And while these projects are frequently less expensive to build, developers often find that the lots located within conservation developments command higher prices and sell more quickly than those located within more conventional developments (ARC, 2001).

Table 2. 3 provides suggestions for Better Site Design techniques that will help protect valuable resources such as buffers, trees, wetlands, and open space.

Table 2. 3. Better Site Design principles for conservation.

Principle	Description
Vegetated Buffer System	Create a variable width, naturally vegetated buffer system along all streams that also encompasses critical environmental features such as the 100-year floodplain, steep slopes, and freshwater wetlands. <i>Recommended buffer widths are included in Table 3.2-4 in Ellis et al., 2014</i>
Buffer Maintenance	The riparian buffer should be preserved or restored with native vegetation that can be maintained through delineation, plan review, construction, and occupancy stages of development.
Clearing and Grading	Clearing and grading of forests and native vegetation should be limited to the minimum amount needed to build lots, allow access, and provide fire protection. A fixed portion of any community open space should be managed as protected green space in a consolidated manner.
Tree Conservation	Conserve trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native plants. Wherever practical, manage community open space, street rights-of-way, parking lot islands, and other landscaped areas to promote natural vegetation.
Land Conservation	Open space development should be encouraged to promote conservation of stream buffers, forests, meadows, and other areas of environmental value. In addition, off-site mitigation consistent with locally-adopted watershed plans should be encouraged.
Stormwater Outfalls	New stormwater outfalls should not discharge unmanaged into jurisdictional wetlands, sole-source aquifers, or sensitive areas.

### 2.1.6 Residential Streets & Parking Lots

Up to 65% of the total impervious cover in a watershed can be attributed to streets, parking lots, and driveways (CWP, 1998). Table 2.4 describes Better Site Design principles related to techniques to reduce the impervious surfaces associated with these hardscapes.

Table 2.4. Better Site Design principles for streets and parking to meet Beaufort County Community Development Code requirements.

Principle	Description
Street Width	Design residential streets for the minimum required pavement width needed to support travel lanes; on-street parking; and emergency, maintenance, and service vehicles.
Street Length	Reduce the total length of residential streets by examining alternative street layouts to determine the best option for increasing the number of homes per unit length.

Right-of-Way Width	Wherever possible, residential street right-of-way widths should reflect the minimum required to accommodate the travel-way, the sidewalk, and vegetated open channels. Utilities and storm drains should be located within the pavement section of the right-of-way wherever feasible.
Cul-de-sacs	Minimize the number of residential cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. The radius of cul-de-sacs should be the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds should be considered.
Vegetated Open Channels	Where density, topography, soils, and slope permit, vegetated open channels should be used in the street right-of-way to convey and treat stormwater runoff.
Parking Ratios	The required parking ratio governing a particular land use or activity should be enforced as both a maximum and a minimum in order to curb excess parking space construction. Existing parking ratios should be reviewed for conformance, taking into account local and national experience to see if lower ratio is warranted and feasible.
Parking Lots	Reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in spillover parking areas.
Structured Parking	Utilize structured (e.g., parking garage) and shared parking to reduce impervious surface area.
Parking Lot Runoff	Wherever possible, provide stormwater treatment for parking lot runoff using bioretention areas, filter strips, and/or other practices that can be integrated into required landscaping areas and traffic islands.

### 2.1.7 Lot Development Principles to Meet Requirements

Development of lots follows similar guidelines for reducing impervious cover and protecting natural areas, such as open space.

Table 2. 5 summarizes Better Site Design principles for lot development. Preserving open space is critical to maintaining water quality at the regional level. Compared to traditional development, open space development can reduce the annual runoff volume from a site by 40%–60%, nitrogen loads by 42%–81%, and phosphorus loads by 42%–69% (CWP, 1998). Large, continuous areas of open space reduce and slow runoff, absorb sediments, serve as flood control, and help maintain aquatic communities. Open space can be provided by minimizing lot sizes, setbacks, and frontage distances

Table 2. 5. Better Site Design principles for lot development.

Principle	Description
Open Space Development	Utilize open space development that incorporates smaller lot sizes to minimize total impervious area, reduce total construction costs, conserve natural areas, provide community recreational space, and promote watershed protection.
Setbacks and Frontages	Consider minimum setbacks allowed by Beaufort County Community Development Code. Relax side yard setbacks and allow narrower frontages to reduce total road length in the community and overall site imperviousness. Relax front setback requirements to minimize driveway lengths and reduce overall lot imperviousness.
Sidewalks	Where practical, consider locating sidewalks on only one side of the street and providing common walkways linking pedestrian areas.
Driveways	Reduce overall lot imperviousness by promoting alternative driveway surfaces and shared driveways that connect two or more homes together.
Rooftop Runoff	Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas and should avoid routing rooftop runoff to the roadway and the stormwater conveyance system.
Open Space Management	Clearly specify how community open space will be managed and designate a sustainable legal entity responsible for managing both natural and recreational open space.

For more detailed descriptions of these techniques, please reference *Better Site Design: A Handbook for Changing Development Rules in Your Community* (CWP, 1998) and Chapter 3 of *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al., 2014).



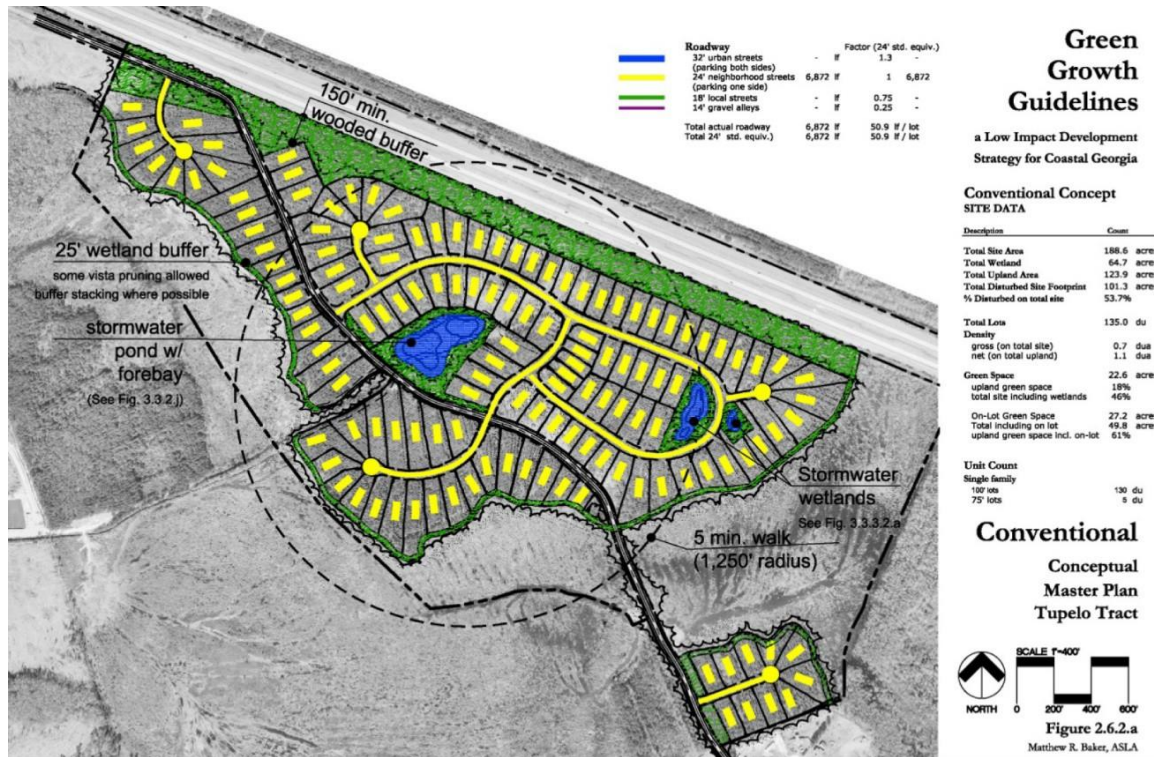


Figure 2.3. Conventional Site Design (source: Merrill et al., 2006).

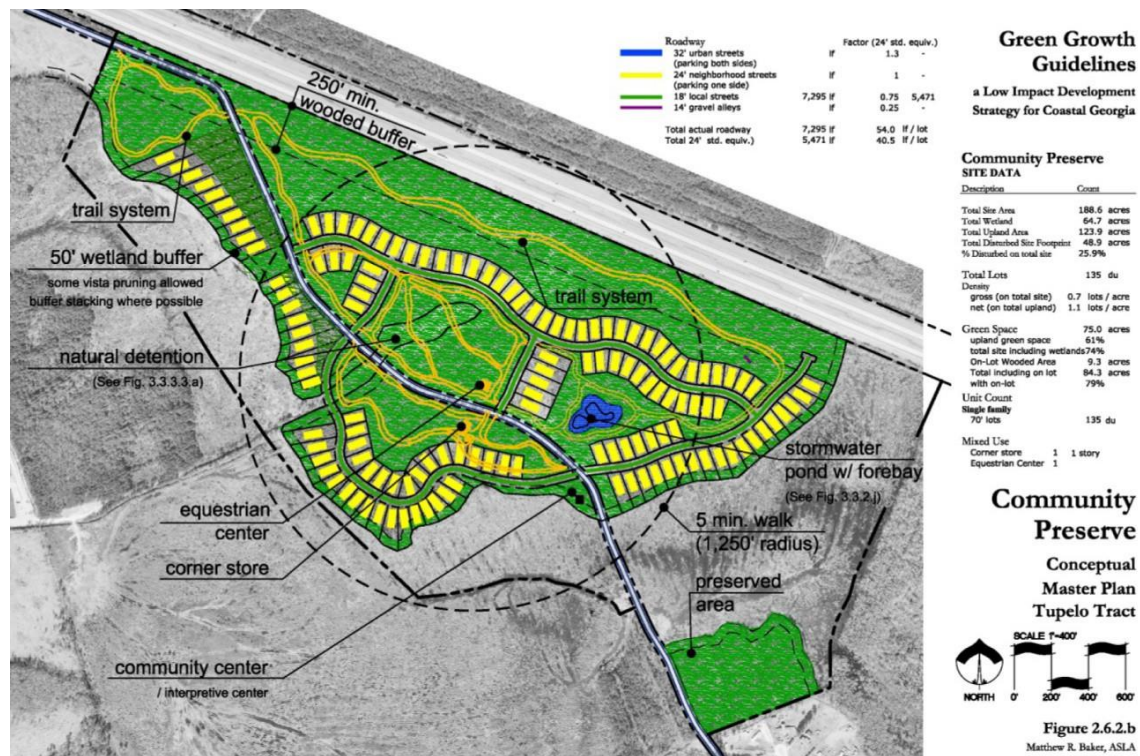


Figure 2.4. Conservation Site Design (source: Merrill et al., 2006).



Figure 2.5. New Urbanist Site Design (source: Merrill et al., 2006).

## 2.1.8 Integrating Natural Resource Protection & Stormwater Management with the Site Planning & Design Process

In order to successfully *integrate* natural resource protection and stormwater management with the site planning and design process, site planning and design teams are to consider following questions at the beginning of the process:

- What valuable natural resources, both terrestrial and aquatic, can be found on the development site?
- How can better site planning techniques be used to protect these valuable natural resources from the direct impacts of the land development process?
- How can better site design techniques be used to minimize land disturbance and the creation of new impervious and disturbed pervious cover?
- What low impact development practices can be used to help preserve pre-development site hydrology and *reduce* post-construction stormwater runoff rates, volumes and pollutant loads?
- What stormwater management practices can be used to *manage* post-construction stormwater runoff rates, volumes and pollutant loads?
- Are there any site characteristics or constraints that prevent the use of any particular low impact development or stormwater management practices on the development site?



Although answering these questions is no easy task, they can be readily obtained within the context of the six-step *stormwater management planning and design process* outlined in Figure 2.1, and the steps are described in more detail below.

- **Step 1: Pre-Application Meeting**

It is recommended that a pre-application meeting between the applicant's site planning and design team and the Beaufort County Staff Review Team with development review authority occur at the very beginning of the stormwater management planning and design process. This meeting, which should occur during the site prospecting phase of the overall site planning and design process (Figure 2.6), helps establish a relationship between the site planning and design team and the Beaufort County Staff Review Team with development review authority. The pre-application meeting also provides an opportunity to discuss the local site planning and stormwater management design criteria that will apply to the proposed development project, which increases the likelihood that the remainder of the site planning and design process will proceed both quickly and smoothly.

- **Step 2: Review of Local, State, and Federal Stormwater Management, Site Planning, & Design Requirements**

Once a pre-application meeting has been completed, it is recommended that the site planning and design team review the local, state and federal requirements that will apply to the proposed development project. This review should occur during the site prospecting phase of the overall site planning and design process (Figure 2.6), while the feasibility study is still being completed.

During their review of stormwater management and site planning and design requirements, the applicant's site planning and design teams should also investigate opportunities and incentives for land conservation, and opportunities and incentives for conservation development as illustrated earlier in Figure 2.1.

- **Step 3: Natural Resources Inventory**

Once the potential development or redevelopment project has been deemed feasible, acceptable site reconnaissance and surveying techniques must be used to complete a thorough assessment of the natural resources, both terrestrial and aquatic, found on the development site. The identification and subsequent preservation and/or restoration of these natural resources helps reduce the negative impacts of the land development process "by design." The natural resources inventory should be completed during the site assessment phase of the overall site planning and design process (Figure 2.6). A map that is created to illustrate the results of the natural resources inventory, known as a site fingerprint, should be used to prepare a stormwater management concept plan for the proposed development project.

Once the natural resources inventory has been completed and a site fingerprint has been created, the site planning and design team should have a better understanding of a development site's characteristics and constraints. This information can be used to identify primary and secondary conservation areas (Figure 2.6. Buildable Area and Primary/Secondary Conservation Areas (source: Merrill et al., 2006).) and define the actual buildable area available on the development site. Along with information about adjacent land uses and available infrastructure (e.g., roads, utilities), the site

fingerprint can also be used to make some preliminary decisions about the layout of the proposed development project and to guide the creation of the stormwater management concept plan.

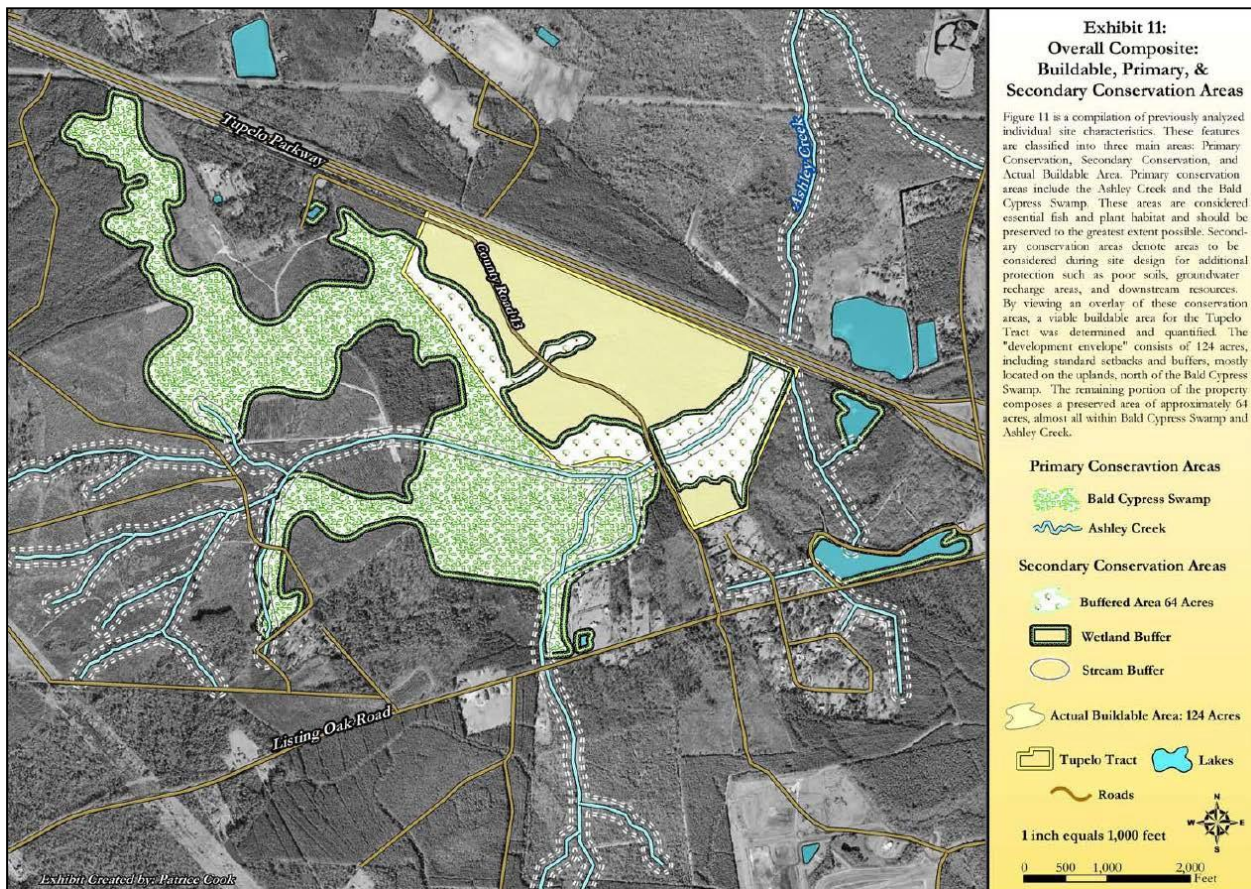


Figure 2.6. Buildable Area and Primary/Secondary Conservation Areas (source: Merrill et al., 2006).

- **Step 4: Prepare Stormwater Management Concept Plan**

After the natural resources inventory has been completed, it is recommended that the site fingerprint be used to develop a stormwater management concept plan for the proposed development project. The stormwater management concept plan should illustrate the layout of the proposed development project and should show, in general, how post-construction stormwater runoff will be managed on the development site.

The creation of a stormwater management concept plan allows the applicant's site planning and design team to make some preliminary decisions about the layout of the proposed development project. If it is submitted to the local development review authority prior to the preparation and submittal of the stormwater management design plan, it can also be used to solicit early feedback on the project and on the green infrastructure and stormwater management practices that will be used to manage post-construction stormwater runoff on the development site.

During the creation of the stormwater management concept plan, most of the site layout, including the layout of lots, buildings, roadways, parking areas, sidewalks and green infrastructure and stormwater management practices, will be completed. Therefore, it is very important that natural resource protection and stormwater management be considered throughout this part of the stormwater management planning and design process.

- **Step 6: Prepare Stormwater Management Design Plan**

Subsequent to review and approval of the stormwater management concept plan, the site planning and design team should prepare a stormwater management design plan. The stormwater management design plan should detail how post-construction stormwater runoff will be managed on the development site and should include maps, narrative descriptions and design calculations (e.g., hydrologic and hydraulic calculations) that show how the stormwater management and site planning and design criteria that apply to the development project have been met. The stormwater management design plan should be submitted to the local development review authority for review and approval.

## **2.2 Submittal & Review Process of Stormwater Management Plans**

The Stormwater Management Plan (SWMP) consists of the entire submittal package and includes the following components:

- Project description and narrative;
- Description of selected stormwater management systems;
- Erosion and sediment control plans;
- Sufficient information to evaluate the environmental characteristics of the affected areas, the potential impacts of the proposed development on water resources, the effectiveness and acceptability of stormwater best management practices (BMPs), and land covers for managing stormwater runoff;
- Supporting computations and drawings; and
- Construction, inspection, and maintenance schedules.

All SWMPs must include the Stormwater submittal checklist (Appendix D) and calculations summary. The plans must include the calculated stormwater retention volume (SWRv) for each BMP and for the overall project, the pre and post development peak flow comparison, extreme flood requirements, and any off-site retention or detention volume obligation.

The SWMP and accompanying documentation may be submitted according to the Beaufort County Public Works Department process, but the applicant must also submit one paper copy of the SWMP carrying the stamp of a registered professional engineer licensed in the State of South Carolina with all supporting documentation to Beaufort County Public Works Department.

Upon acceptance of a complete application (which includes payment of filing fees), the Beaufort County Public Works Department will review the SWMP and make a determination to approve, approve with conditions, or disapprove the SWMP. Relatively large and/or complicated projects tend to require a longer review time than smaller and less complicated projects. A written response of approval or disapproval will be provided to the applicant. If it is determined that more information is needed or that a significant number of changes must be made before the SWMP can be approved, the applicant must resubmit the applications with the revisions required and certified by the registered professional engineer according to the plan resubmittal process of the Beaufort County Public Works Department.

When a SWMP approval is granted, a final submission package is required, including the following:

- One PDF copy of the SWMP, certified by a registered professional engineer licensed in the State of South Carolina,
- A declaration of covenants that has been approved for legal sufficiency by the Beaufort County Public Works Department, and
- All supporting documents specified within this Manual or as requested during the review process according to the Beaufort County Public Works Department requirements.

### **2.2.1 Components of a Stormwater Management Plan**

As itemized in the SWMP checklist in Appendix D Design Checklists, a SWMP includes the following:

#### **Site Plan**

The following information must be formatted to print as a standard drawing size of 24 by 36 inches. The site drawing will provide details of existing and proposed conditions:

- A cover page that contains a blank space measuring 7 inches wide by 9.5 inches high. The blank space must be located 1 inch below the top edge and 1 inch from the left edge of the page;
- A plan showing property boundaries and the complete address of the property;
- Lot number or property identification number designation (if applicable);
- North arrow, scale, and date;
- Property lines (include longitude and latitude);
- Location of easements (if applicable);
- Existing and proposed structures, utilities, roads, and other paved areas;
- Existing and proposed topographic contours;
- Soil information for design purposes;
- Area(s) of soil disturbance;
- Drainage area(s) within the limits of disturbance (LOD) and contributing to the LOD;
- Contributing drainage area (CDA) to each BMP;
- Location(s) of BMPs, marked with the BMP ID Numbers to agree with the BMP design summary list;
- Delineation of existing and proposed land covers including natural cover, compacted cover, and impervious surfaces. Consult Appendix G Compliance Calculator Instructions for details;
- Natural resources inventory with site fingerprint map;

- ⑦ All plans and profiles must be drawn at a scale of 1 in. = 10 ft, 1 in. = 20 ft, 1 in. = 30 ft, 1 in. = 40 ft, 1 in. = 50 ft, or 1 in. = 100 ft. Although, 1 in. = 10 ft, 1 in. = 20 ft, and 1 in. = 30 ft, are the most commonly used scales. Vertical scale for profiles must be 1 in. = 2 ft, 1 in. = 4 ft, 1 in. = 5 ft, or 1 in. = 10 ft;
- ⑦ Drafting media that yield first- or second-generation, reproducible drawings with a minimum letter size of No. 4 (1/8 inch);
- ⑦ Location and size of existing utility lines including gas lines, sanitary lines, telephone lines or poles, electric utilities and water mains;
- ⑦ A legend identifying all symbols used on the plan;
- ⑦ Applicable flood boundaries and FEMA map identification number for sites lying wholly or partially within the 100-year floodplain;
- ⑦ Site development plan and stormwater management narrative;
- ⑦ Assess potential application of green infrastructure practices in the form of better site planning and design techniques. Low impact development practice should be used to the maximum extent practicable during the creation of a stormwater management concept plan. A demonstration of better site planning is required. The following site information and practices shall be considered:
  - Soil type (from Soil Study);
  - Depth of ground water on site;
  - Whether the type of development proposed is a hotspot as defined by the Ordinance and Design Manual and address how this influences the concept proposal;
  - Protection of primary and secondary conservation areas;
  - Reduced clearing and grading limits;
  - Reduced roadway lengths and widths;
  - Reduced parking lot and building footprints to minimize impervious surface;
  - Soil restoration;
  - Site reforestation/revegetation;
  - Impervious area disconnection;
  - Green roof (for redevelopment, infill and major substantial improvement projects); and
  - Permeable pavements.
- ⑦ Stormwater Pollution Prevention Plan (SWPPP) or Erosion and Sediment Control narrative (for projects disturbing over an acre);
- ⑦ Information regarding the mitigation of any off-site impacts anticipated as a result of the proposed development;
- ⑦ Construction specifications;
- ⑦ Design and As-Built Certification, including the following:
  - i Certification by a registered professional engineer licensed in the State of South Carolina seal that the site design, land covers, and design of the BMPs conforms to the standard of care applicable to the treatment and disposal of stormwater pollutants and that the Facility has been designed in accordance with the specifications required under the stormwater ordinance of the Beaufort County Public Works Department.
  - ii Submission one set of the As-Built drawings sealed by a registered professional engineer licensed in the State of South Carolina within 21 days after completion of construction of the site, all BMPs, land covers, and stormwater conveyances.
  - iii For a project consisting entirely of work in the public right-of-way (PROW), the submission of a Record Drawing certified by an officer of the project contracting company is acceptable if it details the as-built construction of the BMP and related stormwater infrastructure.

- Maintenance sheet for stormwater BMPs, including the following:
  - i A maintenance plan that identifies routine and long-term maintenance needs and a maintenance schedule;
  - ii A maintenance agreement and schedule for all post construction best management practices in a form and manner that meets the Beaufort County Public Works Department requirements.
  - iii For applicants using Rainwater Harvesting, submission of third-party testing of end-use water quality may be required at equipment commissioning as determined by the requirements in Appendix J Rainwater Harvesting Treatment and Management Requirements. Additional regular water quality reports certifying compliance for the life of the BMP may also be required in Appendix J Rainwater Harvesting Treatment and Management Requirements.

### **Stormwater Retention Volume Computations**

The following summary calculations must be included on the plan set. Supporting documentation and the South Carolina DHEC C-SWPPP are not in the plan set but provided separately.

- ☐ Calculation(s) of the required SWRv for the entire site within the LOD and each site drainage area (SDA) within the LOD;
- ☐ Calculation(s) for each proposed BMP demonstrating retention value towards SWRv in accordance with Chapters 2 and 4;
- ☐ For Rainwater Harvesting BMP, calculations demonstrating the annual water balance between collection, storage, and demand, as determined using the Rainwater Harvesting Retention Calculator;
- ☐ For proprietary and non-proprietary BMPs follow the guidance in Chapter 4.13 to identify/receive approval or denial to use these practice(s); and
- ☐ Off-site stormwater volume requirement.
- ☐ Compliance Calculator sheets identifying that proposed BMP(s) meet standards for water quality

### **Pre-/Post-Development Hydrologic Computations**

Include in the plan set a summary of the pre-/post-runoff analysis with the following information at a minimum:

- ☐ A summary of soil conditions and field data;
- ☐ Pre- and post-project curve number summary table;
  - Pre and post construction peak flow summary table for the 2-, 10-, 25-, 50-, 100-year 24-hour storm events for each SDA within the project's LOD; and
- ☐ Flow control structure elevations.

### **Hydraulic Computations**

Hydraulic computations for the final design of water quality and quantity control structures may be accomplished by hand or through the use of software using equations/formulae as noted in Chapters 3 and 4. The summary of collection or management systems will include the following:

- ☐ Existing and proposed SDA must be delineated on separate plans with the flow paths used for calculation of the times of concentration;
- ☐ Hydraulic capacity and flow velocity for drainage conveyances, including ditches, swales, pipes, inlets, and gutters. Plan profiles for all open conveyances and pipelines, with energy and hydraulic gradients for the 2-, 10-, 25-, 50-, 100-year, 24-hour storms;



- ⑦ The proposed development layout including the following:
  - Location and design of BMP(s) on site, marked with the BMP ID Numbers;
  - Stormwater lines and inlets;
  - A list of design assumptions (e.g., design basis, 2 through 50-year return periods);
  - The boundary of the CDA to the BMP;
  - Schedule of structures (a listing of the structures, details, or elevations including inverts); and
  - Manhole to manhole profile, listing of pipe size, pipe type, slope, (i.e., a storm drain pipe schedule) computed velocity, and computed flow rate, energy grade line (EGL) and hydraulic grade line (HGL).

### **Supporting Documentation**

Provide a written report with the following supporting documentation:

- ⑦ Pre- and post-project curve number selection
- ⑦ Time of concentration calculation;
- ⑦ Travel time calculation;
- Hydrologic computations supporting peak discharges assumed for each SDA within the project's LOD for the 2-, 10-, 25-, 50-, and 100-year, 24-hour storm events;
- SC DHEC's Construction Stormwater Pollution Prevention Plan (C-SWPPP).

A professional engineer registered in the State of South Carolina must also submit the following:

1. Elevation and topographic data illustrating changes in topography and drainage;
2. Impacts upon local flood flows (2-, 10-, 25-, 50-, and 100-year storm events);
3. Identify areas where stormwater flows are discharged off-site or off-property;
4. For proposed off-site/property discharge points, perform analysis of receiving off-site conveyance systems to confirm safe conveyance from the proposed developed property, no negative impact to adjacent properties, and adequacy of the receiving, existing conveyance system for 25-yr storm flows. Such analysis shall be taken to point where the 25-yr storm conveyance is determined to be adequate in the public stormwater conveyance/infrastructure system; and
5. Documentation supporting safe passage of the 100-yr post development flow according to the 10% Rule (see Section 3.8);

### **2.2.2 Resubmission of Stormwater Management Plans**

If changes occur in the design or construction of an accepted SWMP, the applicant may be required to resubmit the SWMP for approval. Examples of changes during design and construction that will require SWMP resubmission for review include, but may not be limited to the following:

1. Revision to the property boundary, property size, or LOD boundaries that may require redesigning BMPs;
2. Any change to SWRV through land cover designation change;
3. Change in compaction or infiltration rates due to construction activities;
4. Encountering contaminated soil or other underground source of contamination;
5. Changes to floodplain designation or requirements;
6. Changes in any component of the BMP that may adversely affect the intended capacity of the approved BMP, such as the following:

- a. Modification to approved BMP selection, dimensions, or location
  - b. Modification to approved material specification
  - c. Changes to the size, invert, elevation, and slopes of pipes and conveyances
  - d. Installation of new drains and conveyance structures
  - e. Need for a new storm sewer outlet connection to the sanitary/storm sewer main
  - f. Changes to the amount of off-site requirements
  - g. Changes to the CDA to a BMP
- 7. Revision to the approved grading and drainage divides and that may require redesigning BMPs;
  - 8. Relocation of an on-site storm sewer or conveyance; or
  - 9. Abandonment, removal, or demolition of a BMP.

If the applicant resubmits an SWMP after making changes, the resubmission must contain a list of the changes made and may be in the form of a response to comments. The resubmittal plans and calculations must include the stamp of the registered professional engineer in South Carolina.

However, if any of the following minor changes are made to the SWMP, resubmission is not required. These minor changes may be made anytime during inspection or at the as-built submittal by Beaufort County Public Works Department.

- 1. Changes to SWM components that do not adversely affect BMP capacity while in consultation with Beaufort County Public Works Department. The inspector should review the appropriate manufacturer's documentation to his/her satisfaction before approving such a change and should ensure that such changes are recorded as red line changes or deviations in the as-built plans. These changes include the following:
  - a. Changes to parts type of similar function (e.g. dewatering valve)
  - b. Change in hole pattern or size of underdrain pipe perforations
  - c. Change in project address, ownership, permit status, or zoning

### **Design Certifications**

The engineer shall certify that this Plan satisfies all requirements of the Southern Lowcountry Ordinance and Stormwater Design Manual. The following statement with engineer's seal is required in the Plan submittal.

The engineering features of all stormwater best management practices (BMPs), stormwater infrastructure, and land covers (collectively the "Facility") have been designed/examined by me and found to be in conformity with the standard of care applicable to the treatment and disposal of stormwater pollutants. The Facility has been designed in accordance with the specification required under of Beaufort County Stormwater Ordinance.

## **2.3 Construction Inspection Requirements**

### **2.3.1 Inspection Schedule & Reports**

Prior to the approval of a SWMP, the applicant will submit a proposed construction inspection schedule. Beaufort County Public Works Department will review the schedule to determine if changes are required. The construction schedule should reflect the construction sequences defined in each BMP section Stormwater Best Management Practices (BMPs) of this Manual. The construction and inspection schedule must be included in the SWMP. Beaufort County Public Works Department may conduct inspections and file reports of inspections during construction of BMPs and site stormwater conveyance systems to ensure compliance with the approved plans.

Note: No stormwater management work may proceed past the stage of construction that Beaufort County Public Works Department has identified as requiring an inspection unless

- Beaufort County Public Works Department has issued an “approved” or “passed” report;
- Beaufort County Public Works Department has approved a plan modification that eliminates the inspection requirement; or
- Beaufort County Public Works Department has eliminated or modified the inspection requirement in writing.

Beaufort County Public Works Department may require that the professional engineer responsible for sealing the approved SWMP, the professional engineer responsible for certifying the as-built SWMP, or, for a project entirely in the PROW, the officer of the contracting company responsible for certifying the Record Drawing be present during inspections.

If Beaufort County Public Works Department conducts an inspection and finds work that is not in compliance with the SWMP, Beaufort County Public Works Department may issue a Notice of Violation, and the applicant must take prompt corrective action. The written notice provides details on the nature of corrections required and the time frame within which corrections must be made.

### **2.3.2 Inspection Requirements Before & During Construction**

Beaufort County Public Works Department construction stormwater inspection form is provided in Appendix E Construction Inspection Form.

**Preconstruction Meetings.** These meetings are required prior to the commencement of any land-disturbing activities and prior to the construction of any BMPs. The applicant is required to contact Beaufort County Public Works Department to schedule preconstruction meetings three (3) days prior to beginning any construction activity subject to the requirements Beaufort County Public Works Department.

**Inspections During Construction.** The applicant is required to contact Beaufort County Public Works Department to schedule inspection three (3) days prior to any stage of BMP construction, or other construction activity, requiring an inspection. For large, complicated projects, the applicant and Beaufort County Public Works Department may agree during the preconstruction meeting to an alternative approach such as a weekly notification schedule. Any such agreement must be made in writing and signed by all parties. Beaufort County Public Works Department will revert to the 3-day notification procedure if the agreement is not followed.

**During construction, Beaufort County Public Works Department may require the presence of the professional engineer responsible for sealing the approved SWMP; the professional engineer responsible for certifying the as-built SWMP; or for a project entirely in the PROW, the officer of the contracting company responsible for certifying the Record Drawing.**

**Final Inspection.** The applicant is required to contact Beaufort County Public Works Department to schedule a final inspection one week prior to the completion of a BMP construction to schedule a final inspection of the BMP. Upon completion of the BMP, Beaufort County Public Works Department will conduct a final inspection to determine if the completed work was constructed in accordance with approved plans.

**Inspection Requirements by BMP Type.** Chapter 4 Stormwater Best Management Practices (BMPs) of this Manual provides details about the construction sequences for each BMP. After holding a preconstruction meeting, regular inspections may be made at the following specified stages of construction:

- **Infiltration Systems and Bioretention Areas** may be inspected at the following stages to ensure proper placement and allow for infiltration into the subgrade:
  - During on-site or off-site percolation or infiltration tests;
  - Upon completion of stripping, stockpiling, or construction of temporary sediment control and drainage facilities;
  - Upon completion of excavation to the subgrade;
  - Throughout the placement of perforated PVC/HDPE pipes (for underdrains and observation wells) including bypass pipes (where applicable), geotextile materials, gravel, or crushed stone course and backfill; and
  - Upon completion of final grading and establishment of permanent stabilization;
- **Flow Attenuation Devices**, such as open vegetated swales upon completion of construction;
- **Retention and Detention Structures**, at the following stages:
  - Upon completion of excavation to the sub-foundation and, where required, installation of structural supports or reinforcement for structures, including but not limited to the following:
  - During testing of the structure for water tightness;
  - During placement of structural fill and concrete and installation of piping and catch basins;
  - During backfill of foundations and trenches;
  - During embankment construction; and
  - Upon completion of final grading and establishment of permanent stabilization.
- **Stormwater Filtering Systems**, at the following stages:
  - Upon completion of excavation to the sub-foundation and installation of structural supports or reinforcement for the structure;
  - During testing of the structure for water tightness;
  - During placement of concrete and installation of piping and catch basins;
  - During backfill around the structure;
  - During prefabrication of the structure at the manufacturing plant;
  - During pouring of floors, walls, and top slab;
  - During installation of manholes/trap doors, steps, orifices/weirs, bypass pipes, and sump pit (when applicable);
  - During placement of the filter bed; and
  - Upon completion of final grading and establishment of permanent stabilization.

- **Green Roof Systems**, at the following stages:
  - During placement of the waterproofing layer, to ensure that it is properly installed and watertight;
  - During placement of the drainage layer and drainage system;
  - During placement of the growing media, to confirm that it meets the specifications and is applied to the correct depth (certification for vendor or source must be provided);
  - Upon installation of plants, to ensure they conform to the planting plan (certification from vendor or source must be provided); and
  - At the end of the first or second growing season, to ensure desired surface cover specified in the Care and Replacement Warranty has been achieved.

### **2.3.3 Final Construction Inspection Reports**

Beaufort County Public Works Department will conduct a final inspection to determine if the completed work is constructed in accordance with approved plans and the intent of this Manual and the Stormwater Ordinance. Within 21 days of the final inspection, the applicant must submit an as-built package, including one PDF copy of the as-built SWMP certified by a registered professional engineer licensed in the State of South Carolina. For a project consisting entirely of work in the PROW, the submission of a Record Drawing certified by an officer of the project contracting company is acceptable if it details the as-built construction of the BMPs, related stormwater infrastructure, and land covers.

A registered professional engineer licensed in South Carolina is required to certify as-built SWMPs and state that all activities including clearing, grading, site stabilization, the preservation or creation of pervious land cover, the construction of drainage conveyance systems, the construction of BMPs, and all other stormwater-related components of the project were accomplished in strict accordance with the approved SWMP and specifications. As stated in Section 2.2.2 Resubmission of Stormwater Management Plans, all plan changes are subject to Beaufort County Public Works Department approval. The as-built certification must be on the original SWMP.

Upon completion, these plans will be submitted to Beaufort County Public Works Department for processing. The estimated time for processing will be two weeks (10 working days), after which the plans will be returned to the engineer. Beaufort County Public Works Department will provide the applicant with written notification of the final inspection results.

### **2.3.4 Inspection for Preventative Maintenance**

The Stormwater Ordinance requires maintenance inspections for BMPs and land covers to ensure their ongoing performance is in compliance with their original design. The inspection will occur at least once every three (3) years. Maintenance inspection forms are provided in Appendix F Maintenance Inspection Checklists. Beaufort County Public Works Department may conduct these maintenance inspections, though it may, in certain circumstances, allow a property to self-inspect and provide documentation.

Beaufort County Public Works Department will maintain maintenance inspection reports for all BMPs that they inspect and are provided by the landowner. The reports will evaluate BMP functionality based on the detailed BMP requirements of Stormwater Best Management Practices (BMPs) and inspection forms found in Appendix F Maintenance Inspection Checklists.

If, after an inspection by Beaufort County Public Works Department, the condition of a BMP presents an immediate danger to the public safety or health because of an unsafe condition or improper maintenance, Beaufort County Public Works Department may take such action as may be necessary to

protect the public and make the BMP safe. Any costs incurred by Beaufort County Public Works Department may be assessed against the owner(s).

## **2.4 Inspections & Maintenance**

### **2.4.1 Inspections & Maintenance Responsibilities**

A site with an approved SWMP must also have a responsible party inspect and maintain the BMPs and land covers according to the inspections and maintenance schedule in the SWMP and this Manual. Land covers must be maintained in type and extent as approved. Approved BMPs must be kept in good condition, including all the engineered and natural elements of each practice, as well as conveyance features (e.g., grade surfaces, walls, drains, structures, vegetation, soil erosion and sediment control measures, and other protective devices). All repairs or restorations must be in accordance with the approved SWMP.

A Maintenance Agreement including an exhibit stating the owner's specific maintenance responsibilities must be recorded with the property deed at the Record of Deeds. An inspection and maintenance schedule for any BMP will be developed for the life of the project and shall state the inspection and maintenance to be completed, the time for completion, and who will perform the inspections and maintenance. The schedule will be printed on the SWMP and will appear as an exhibit in the Maintenance Agreement.

### **2.4.2 Inspection & Maintenance Agreements**

Inspection and maintenance obligations are binding on current and future owners of a property subject to recorded covenants. Beaufort County Public Works Department will not issue final approval of a complete set of the SWMP for private parcels until the applicant has executed a stormwater maintenance agreement providing notice of this obligation to current and subsequent owners of the land served by the BMP(s) and land covers. Inspection and maintenance agreements by regulated projects include providing access to the site and the BMP(s) at reasonable times for regular inspection by Beaufort County Public Works Department and for regular or special assessments of property owners, as needed, to ensure that the BMP(s) is maintained in proper working condition and the land covers are retained as approved in the SWMP. An example of the declaration of covenants/maintenance agreement for a site with BMPs and designated land covers is provided at the end of this chapter.

The applicant must record the agreement as a declaration of covenants with Beaufort County Public Works Department Recorder of Deeds. The agreement must also provide that, if after written notice by Beaufort County Public Works Department to correct a violation requiring maintenance work, satisfactory corrections are not made by the owner(s) of the land served by the BMP within a reasonable period of time, not to exceed 45 to 60 days unless an extension is approved in writing by Beaufort County Public Works Department. Beaufort County Public Works Department may perform all necessary work to place the BMP in proper working condition. The owner(s) of property served by the BMP will be assessed the cost of the work and any potential penalties/fines.

### **As-Built Submittals**

One set of As-Built drawings sealed by a registered professional engineer licensed in the State of South Carolina must be submitted as required by the procedure for handling close out documents for private development projects by Beaufort County Planning and Zoning department.

The following items must be completed and provided:

#### **General Information:**

- Words As-Built in or near the project title
- As-Built Signature/Approval block on each sheet
- As-builts shall have a coordinate system based on the South Carolina Coordinate System North American Datum of 1983 (NAD83).
- Elevations shown shall be based on the North American Vertical Datum of 1988 (NAVD88).
- Vicinity map
- Sheets numbered correctly
- Project ID number, Project Name, Permit number and name, address and contact information of project engineer
- All measurements and coordinates shall be shown on all drainage structures, detention and BMP structure outlets, outlet control structures and manholes.
- Any change to BMP capacities, dimensions, specifications or location shall be shown as mark-through of the original design on the drawings
- Elevations to the nearest 0.1 ft.

**Basins:**

- At least two benchmarks on the plans
- Profile of the top of berm
- Cross-section of emergency spillway at the control section
- Profile along the centerline of the emergency spillway
- Cross-section of berm at the principle spillway
- Elevation of the principle spillway crest or top of structure elevations
- Elevation of the principle spillway inlet and outlet invert
- Riser diameter/dimensions and riser base size
- Diameter, invert elevation and sizes of any stage orifices, weirs or storm drain pipes
- Barrel diameter, length, and slope
- Types of material used
- Outfall protection length, width, depth, size of rip rap and filter cloth
- Size, location, and type of anti-vortex and trash rack device (height and diameter, elevations and spacing)
- Pipe cradle information
- On plan view show length, width and depth of pond and contours of the basin area so that design volume is specified
- As-built spot elevations with the disturbed area required for basin construction in sufficient detail to provide accurate as-built contours
- Core trench limits and elevations of bottom of cut off trench
- Show length width and depth of outfall rip rap
- Certification by a Geotechnical Engineer for compact and unified soil classes
- Vegetation cover certification
- Show location of planted landscaping
- Utility locations and elevations encountered, test pitted and/or relocation during contract work

**Storm Drain Piping:**

- At least two benchmarks on the plans
- Diameter and class of pipe
- Invert of pipe at outfall, structures and/or field connections

- Slope of pipe
- Pipe lengths (show stationing)
- Types of materials
- Location of all pipes and structures horizontally on the plan
- Length, width and depth of all rip rap and other outfall protection as specified
- Elevation of rip rap at outfall and at changes in grade
- Utility locations and elevations encountered, test pitted and/or relocation during contract work

**Post construction BMP Specific details:**

- Provide as-built details as described for each best management practice in Chapter 4.



## Chapter 3. Minimum Control Requirements

### 3.1 Introduction

This chapter establishes the minimum stormwater control standards necessary to implement the Southern Lowcountry Stormwater Ordinance within Beaufort County Public Works Department. The term “runoff reduction” is used throughout this chapter to describe the retention of the stormwater on site. The SWRV is used to describe the volume of stormwater to be retained on site.

Two levels of stormwater retention are prescribed, the 85<sup>th</sup> and the 95<sup>th</sup> percentile storm, and are assigned based on a site’s subwatershed as identified by the U.S. Geological Survey Hydrologic Unit Code 12 (HUC-12) presented in Section 3.5.1 below. In addition, peak discharge control of the post-development 2-, 10-, 25-, 50-, 100-year, 24-hour storms to their predevelopment flow shall be provided by a combination of structural controls, GI/LID practices and other non-structural BMPs. As well, requirements to manage the 100-yr, 24-hour storm event are provided in the extreme flood event section below. Further, this Manual and Appendices provide the framework and necessary tools to document the methods proposed by development plans to comply with these requirements. It should be noted that stormwater ponds are considered the least favorable structural best management practice to meet the SWRV and water quality requirements of this Manual.

### 3.2 Regulated Site Definition

According to the Stormwater Ordinance, the design criteria of this Manual shall be applicable to any new development, redevelopment or major substantial improvement activity, including, but not limited to, site plan applications, public improvement projects, and subdivision applications that meet the applicability standards found in Chapter 1.4.

The Southern Lowcountry stormwater design requirements are applied according to the flow chart in Figure 3.1 and should be determined as follows:

- 1) In sequence, first determine which HUC-12 watershed that the project is in according to Table 3.1. Stormwater design criteria for the development follows the watershed area in which it is located. Next, determine the square feet of impervious area to be created, added or replaced as a part of the development or redevelopment. Will the project disturb greater than 5000 sq feet If the answer is “yes”, the project plan must meet the requirements for stormwater management in this Manual for their respective watershed area.
- 2) If a project is a major substantial improvement, refer to section 1.4.1 it must meet the water quality criteria for its respective watershed protection area to the maximum extent practicable (MEP) or obtain off-site stormwater credit. The terms MEP and off-site stormwater credit are further explained in Section 3.9 and 3.10 below. A waiver to meet Peak control requirements for major substantial improvement projects may be applied for. Approval is at the discretion of the Public Works Director or their designee.

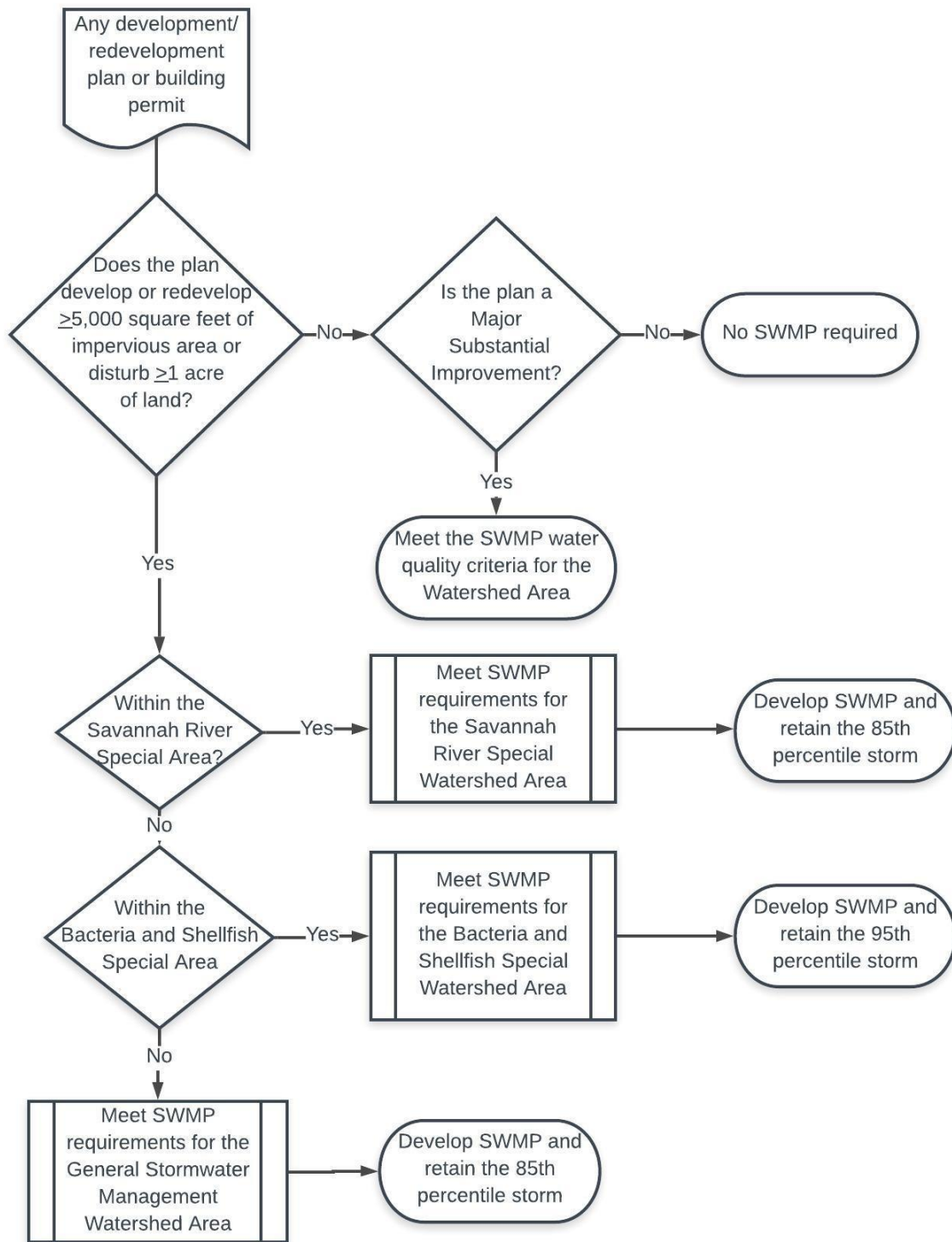


Figure 3.1. Southern Lowcountry Stormwater Design Manual applicability diagram.

### 3.3 Infill & Redevelopment

An infill project is one on a previously platted property that may or may not have stormwater management capacity in its original development plan. Regardless of size, infill that is part of a larger common plan of development, even through multiple, separate, and distinct land disturbing activities that may take place at different times and on different schedules must comply with this Manual. Such projects may include Planned Unit Developments (PUDs) that have stormwater systems built that do not meet the requirements of this Manual. If the proposed project meets the applicability criteria of Section 1.4.1, the stormwater plan review in this Manual is necessary. If the development's original stormwater management plan is sufficient to meet the current requirements of this Manual and is documented through approved plans and as-built drawings, or current field measurements and engineering calculations, no further stormwater requirements must be met. When the infill project is part of an original plan that does not meet the current stormwater requirements, the level of stormwater management that is provided in the current development may be credited toward the current volume and hydrologic analysis. Infill locations that, due to the municipal jurisdiction's zoning or land use requirements or site conditions, cannot meet the requirements of this Manual must complete the maximum extent practicable (MEP) evaluation in Section 3.9 for approval by the Public Works Director and/or their designee for project advancement/approval.

Similarly, redevelopment may be credited for the level of stormwater in place. If the redevelopment's original stormwater management plan is sufficient to meet the current requirements of this Manual and is documented through approved plans and as-built drawings, or current field measurements and engineering calculations, no further stormwater requirements must be met. When the redevelopment is part of an original plan that does not meet the current stormwater requirements, the level of stormwater management that is provided in the current development may be credited toward the current volume and hydrologic analysis. Redevelopment projects that, due to the municipal jurisdiction's zoning or land use requirements or site conditions, cannot meet the requirements of this Manual must complete the maximum extent practicable (MEP) evaluation in Section 3.9 for project approval.

### 3.4 Stormwater Runoff Quality & Peak Discharge Control

Since its inception, the Clean Water Act was designed to address the water quality impacts of stormwater runoff. As it has been applied through successive stormwater permit cycles, the Act's requirements have been interpreted to mean application of stormwater best management practices to the maximum extent practicable. The U.S. Environmental Protection Agency (EPA) has stated that such conditions include specific tasks or best management practices (BMPs), BMP design requirements, and performance requirements (EPA, 81 Fed. Reg. 3).

Consistent with the EPA's Phase II MS4 permit, this Manual requires that stormwater runoff shall be adequately treated before it is discharged from a development site. A stormwater management system is assumed to meet the stormwater runoff quality criteria by satisfying the stormwater runoff volume criteria for its respective Watershed Area presented in this Manual. If any of the required stormwater runoff volume cannot be reduced on the site, due to impractical site characteristics or constraints, the following questions shall be addressed in the permitting process:

1. Can the required stormwater volume be obtained from an adjacent site owned or available for stormwater retention purposes;
2. Is there available stormwater retention volume within the adjacent right-of-way and available through fee-in-lieu arrangements within this jurisdiction; and
3. Is a waiver granted based on a maximum extent practicable evaluation?

Further, a stormwater management system is presumed to comply with these criteria if:

- It intercepts and treats stormwater runoff in stormwater management practices that have been selected, designed, constructed and maintained in accordance with this Manual;
- It is provided with documentation to show that total suspended solids, nitrogen and bacteria removal were considered during the selection of the stormwater management practices that will be used to intercept and treat stormwater runoff on the development site;
- It is designed to provide the amount of stormwater load reduction specified in the latest edition of this Manual; and
- It manages the peak flow and extreme flood event storms in accordance with this Manual.

### **3.5 Southern Lowcountry Stormwater Management Performance Requirements**

Stormwater management requirements of this Manual are intended to enhance the quality of development, protect and enhance stormwater quality and management, protect aquatic resources from the negative impacts of the land development process, address water quality impairments or a total maximum daily load, as identified by the South Carolina Department of Health and Environmental Control (DHEC), or address localized flooding issues.

#### **3.5.1 Watershed Protection Area Designations**

Not all watersheds of the Southern Lowcountry region require the same level of post-construction stormwater management. Currently, three watershed protection areas are designated with specific unique stormwater management requirements based on the current and anticipated water quality control measures for their contributing watersheds. The Southern Lowcountry Stormwater Ordinance provides Beaufort County Public Works Department the flexibility and authority to designate sub watersheds or drainage areas as Special Watershed Protection Areas that may lead to more restrictive requirements or special criteria. Such special designations and criteria will be provided as a future appendix to this manual.

In the Southern Lowcountry, impairments include recreational water use impairment from bacteria (*Enterococcus* for saltwater and *E. coli* for freshwater), aquatic life use impairment from turbidity or dissolved oxygen, and shellfish harvesting use impairment from fecal coliform bacteria. Stormwater best management practices for these types of impairments include erosion and sediment control for turbidity impairments, illicit discharge detection, vegetated conveyances, vegetated buffers, pet waste programs, and post-construction runoff control. Currently, Southern Lowcountry water quality impairments do not include nutrient impairments, but nutrients can also be addressed through erosion and sediment control and the stormwater best management practices outlined in this Manual.

Most of Beaufort County and the lower reaches of the Jasper County watersheds have shellfish receiving waters or are recreational waters and are therefore sensitive to bacteria impairments. Land development and redevelopment projects in these watersheds require greater scrutiny to ensure that

low impact development methods are designed, implemented and maintained to be protective of these water uses.

Watersheds tributary to the Savannah River in the Southern Lowcountry include most of the freshwater wetlands of the region. River water quality is excellent and is a supply for drinking water for the City of Savannah and the Beaufort Jasper Water and Sewer Authority. Savannah River impairments downstream of the I-95 bridge are primarily aquatic life use due to low dissolved oxygen. Since the Savannah River is the boundary of Georgia and South Carolina, it is reasonable to align stormwater requirements within Jasper County with those in Chatham and Effingham Counties, GA. Stormwater permits for the Georgia jurisdictions require use of the Georgia Coastal Stormwater Supplement to the Georgia Stormwater Management Manual, which is primarily a green infrastructure/low impact development (GI/LID) design Manual with requirements specific to the Georgia coastal counties.

The remaining watersheds of the Southern Lowcountry are more upland areas and in agricultural or silvicultural use or are conservation lands. For these areas new development is subject to stormwater management requirements similar to previous county requirements. This Manual unifies stormwater management standards across the designated watersheds rather than differing across county or jurisdictional lines.

The map in Figure 3.2 outlines the boundaries of the three watershed protection areas of the Southern Lowcountry. Requirements specific to each area are further developed in this chapter. Table 3.1 lists the US Geological Survey 12-Digit Hydrologic Unit Code (HUC-12) for the watersheds in each area. To identify a site's HUC-12, refer to the South Carolina DHEC Watershed Atlas, available online at <https://gis.dhec.sc.gov/watersheds/>. After identifying the site's HUC 12, use Table 3.2 to identify the watershed protection area.

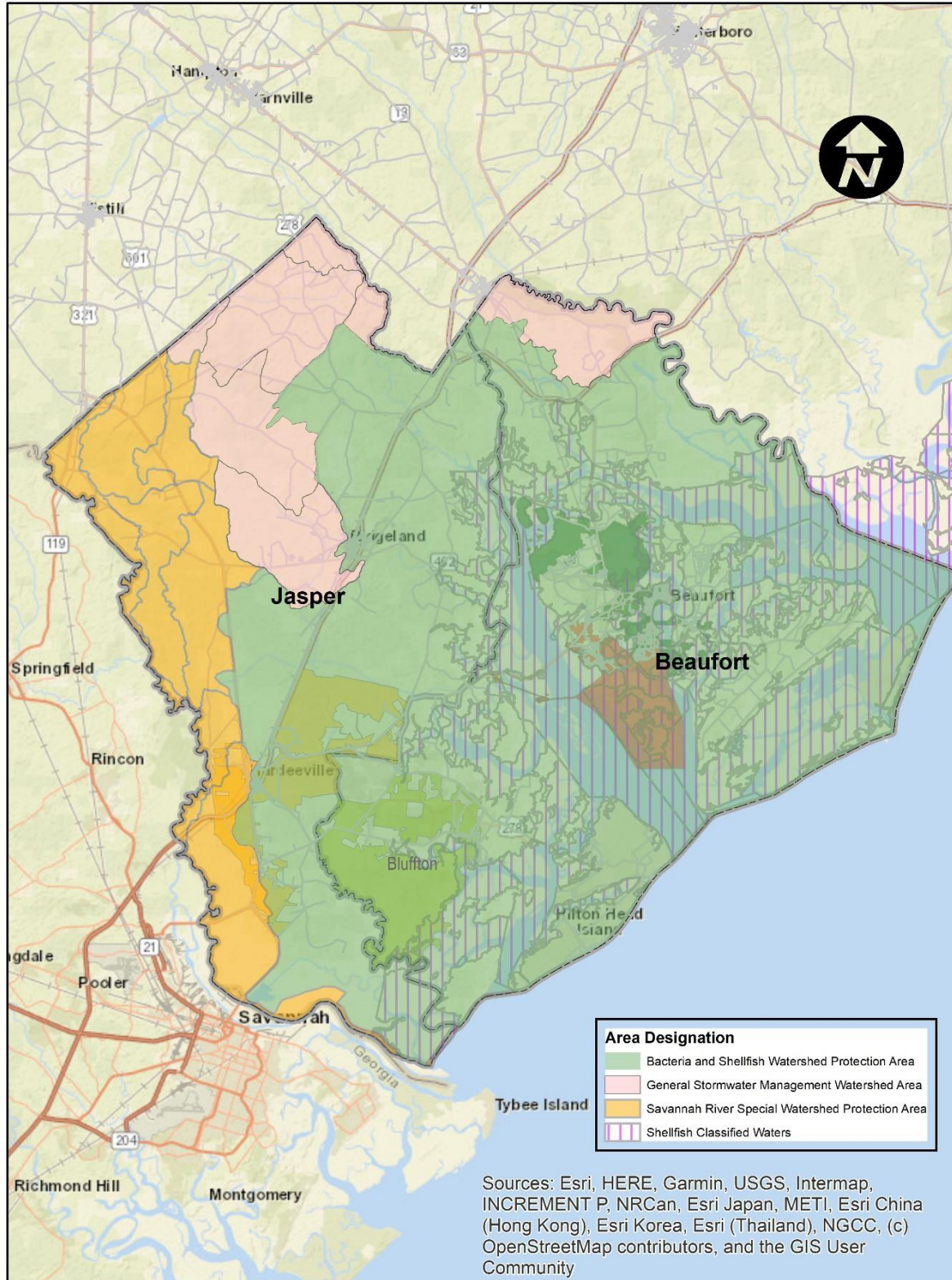


Figure 3.2. Watershed Protection Areas of the Southern Lowcountry.



Table 3.1. Watershed Protection Area HUC-12 Codes.

General Stormwater Management Watershed Areas		Savannah River Watershed Protection Area	
HUC-12 No.	Watershed Name	HUC-12 No.	Watershed Name
030502070704	Middle Combahee River	030601090107	Hog Branch-Savannah River
030502080301	Johns Pen Creek	030601090301	Cypress Branch
030502080302	Cypress Creek	030601090302	Black Swamp
030502080404	Mcpherson Creek-Coosawhatchie River	030601090303	Coleman Run
030502080405	Early Branch-Coosawhatchie River	030601090304	Sand Branch
030601100101	Gillison Branch	030601090305	Dasher Creek-Savannah River
030601100102	Upper Great Swamp	030601090307	Outlet Savannah River
Bacteria and Shellfish Watershed Protection Area			
HUC-12 No.	Watershed Name	HUC-12 No.	Watershed Name
030502070706	Lower Combahee River	030502080605	Boyd Creek-Broad River
030502071101	Wimbee Creek	030502080606	Colleton River
030502071102	Coosaw River	030502080607	Chechessee River
030502071103	Morgan River	030502080608	Broad River-Port Royal Sound
030502071104	Coosaw River-St. Helena Sound	030502100101	Harbor River-St. Helena Sound
030502080406	Bees Creek	030502100102	Harbor River-Trenchards Inlet
030502080407	Tulifiny River-Coosawhatchie River	030601090306	Wright River
030502080501	Battery Creek	030601100103	Lower Great Swamp
030502080502	Upper Beaufort River-Atlantic Intracoastal Waterway	030601100201	Upper New River-Atlantic Intracoastal Waterway
030502080503	Lower Beaufort River-Atlantic Intracoastal Waterway	030601100202	Lower New River-Atlantic Intracoastal Waterway
030502080601	Pocotaligo River-Broad River	030601100301	May River
030502080602	Huspa Creek	030601100302	Broad Creek
030502080603	Whale Branch	030601100303	Cooper River-Calibogue Sound
030502080604	Euhaw Creek	030601100304	Calibogue Sound

### 3.5.2 Overall Performance Requirements

Based on the watershed water quality criteria, its impairment status, or stormwater permit requirements, development and redevelopment stormwater management performance requirements will differ. These requirements are interpreted in terms of sizing and performance criteria. Table 3.2 presents a summary of the sizing criteria used to achieve the stormwater management performance requirements for each watershed protection area.

Table 3.2. Watershed Area Overall Performance Requirements.

General Stormwater Management Watershed Protection Areas	Savannah River Watershed Protection Area
Overall Performance Requirements	Overall Performance Requirements
<ul style="list-style-type: none"> <li>☐ Water Quality: Implement Better Site Design, maintain pre-development hydrology of the site to the Maximum Extent Practicable (MEP) for the 85<sup>th</sup> percentile storm event.</li> <li>☐ Peak Control: Control post-development peak runoff discharge rate to pre-development rate for: 2-, 10- and 25-year, 24-hour design storm events.</li> <li>☐ Accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures. Provide 10% rule analysis.</li> <li>☐ As a pollutant removal minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.</li> <li>☐ Complete a natural resources inventory for new site development applications.</li> </ul>	<ul style="list-style-type: none"> <li>☐ Water Quality: Implement Better Site Design, retain the 85<sup>th</sup> percentile storm event on-site to the MEP or obtain off-site credit.</li> <li>☐ Peak Control: Control post-development peak runoff discharge rate to pre-development rate for: 2-, 10- and 25-year, 24-hour design storm events.</li> <li>☐ Accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures. Provide 10% rule analysis.</li> <li>☐ As a pollutant removal minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.</li> <li>☐ Complete a natural resources inventory for new site development applications.</li> </ul>
Rationale	Rationale
The previous Jasper County stormwater design manual specified these overall performance requirements.	The Savannah River watershed adjoins Georgia counties that are subject to similar overall performance requirements as outlined in the Georgia Coastal Stormwater Supplement.
Bacteria and Shellfish Watershed Protection Area	
Overall Performance Requirements	
<ul style="list-style-type: none"> <li>• Water Quality: Implement Better Site Design and retain the 95<sup>th</sup> percentile storm on-site with approved infiltration/filtering BMPs. Fulfill MEP requirements or, as a last resort, fulfill off-site credit and/or fee-in-lieu requirements.</li> <li>• As a pollutant removal minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.</li> </ul>	<ul style="list-style-type: none"> <li>• Peak control: Control the post-development peak runoff discharge rate for the 2, 10, 25, 50, 100-year, 24-hour design storm events to the pre-development discharge rates.</li> <li>• Accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures. Provide 10% rule analysis.</li> <li>• Complete a natural resources inventory for new site development applications.</li> </ul>
Rationale	
The Bacteria and Shellfish Watershed Protection Areas are either impaired or have TMDLs, or the receiving waters are classified for shellfish harvesting. These watersheds require greater protection due to their Clean Water Act status or water quality classification. The site's natural resource inventory is a necessary component of permit application.	



### 3.5.3 Southern Lowcountry Stormwater Precipitation & Runoff

As in the natural environment, a site's stormwater runoff volume depends upon soil conditions and land cover. To evaluate each site's development plan, this Manual relies on the rainfall runoff estimating methods of the Natural Resources Conservation Service National Engineering Handbook (NEH).

Sometimes referred to as the curve number method or soil cover complex method, NEH chapter 9 describes the runoff response to rainfall events based on hydrologic soil group (HSG A, B, C or D) and land cover type with an integer between 29 and 100 (NRCS, 2004). Accordingly, information documenting the site's soils, their permeability, predeveloped land use or natural cover, and post-developed land cover, as well as the shallow groundwater table, are required in development plans in order to review and permit the development activity.

Precipitation event size and distribution are set by this Manual for the three watershed protection areas that make up the Southern Lowcountry.

The precipitation event distribution terms used in this Manual are defined as follows:

**85<sup>th</sup> Percentile Storm** is the 24-hour rainfall amount that according to the National Oceanic and Atmospheric Administration records for the past 30 years in which 85% of all rainfall events do not exceed at the nearest US Weather Service station to the County seat. For the General Stormwater Management Watershed Areas and the Savannah River Watershed Protection Areas, this number is 1.16 inches of rainfall.

**95<sup>th</sup> Percentile Storm** is the 24-hour rainfall amount that according to the National Oceanic and Atmospheric Administration records for the past 30 years in which 95% of all rainfall events do not exceed at the nearest US Weather Service station to the County seat. For the Bacteria and Shellfish Watershed Protection Areas this is 1.95 inches of rainfall.

Plans submitted for new development or redevelopment must demonstrate through accepted hydrologic methods that the development at post-construction will attenuate and treat the prescribed storm events. This includes volume reduction, peak flow management and extreme flood protection both on site and downstream.

### 3.5.4 Savannah River Watershed Protection Area

Upon implementation of this Manual, any applicable new development, redevelopment or major substantial improvement in the designated HUC-12 watersheds that are part of the Savannah River watershed shall meet the following requirements:

- Complete a natural resources inventory for new site development applications.
- Document use of Better Site Design.
- Retain the 85<sup>th</sup> percentile storm event on-site to the MEP or obtain off-site credit.
- Control the post-development peak runoff discharge rate for the 2, 10 and 25-year, 24-hour design storm events to the pre-development discharge rates.
- Accommodate 100-year, 24-hour storm event through the development without causing damage to the on-site and offsite structures. Provide 10% rule analysis.
- At a minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.

### 3.5.5 Bacteria & Shellfish Watershed Protection Area

Upon implementation of this Manual, any applicable new development, redevelopment or major substantial improvement in the designated HUC-12 watersheds that are part of the Bacteria and Shellfish Watershed Protection Area shall meet the following requirements:

- Complete a natural resources inventory for new site development applications.
- Document use of Better Site Design.
- Retain the 95<sup>th</sup> percentile storm on-site with approved infiltration/filtering BMPs.
- Fulfill MEP requirements or, as a last resort, fulfill off-site credit and/or fee-in-lieu requirements.
- At a minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.
- Control the post-development peak runoff discharge rate for the 2, 10, 25, 50, and 100-year, 24-hour design storm events to the pre-development discharge rates.
- Accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures. Provide 10% rule analysis.

### 3.5.6 General Stormwater Management Watershed Area

Upon implementation of this Manual, any applicable new development, redevelopment or major substantial improvement in the designated HUC-12 watersheds for the General Stormwater Management Watershed Area shall meet the following requirements:

- Complete a natural resources inventory for new site development applications.
- Document use of Better Site Design.
- Maintain pre-development hydrology of the site to the Maximum Extent Practicable (MEP) for the 85<sup>th</sup> percentile storm event.
- Control post-development peak runoff discharge rate for the 2, 10, 25, 50, and 100-year, 24-hour design storm events to pre-development discharge rates.
- Accommodate 100-year, 24-hour storm event through the development without causing damage to the on-site and offsite structures. Provide 10% rule analysis.
- As a pollutant removal minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.

### 3.5.7 Runoff Reduction & Pollutant Removal

It is the minimum criteria of this Manual that a site's stormwater best management practices shall retain the precipitation event size for its watershed protection area as summarized in Section 3.5.2. Through successive application of the practices below and that are described in detail in Chapter 4, provide at least an 80% reduction in total suspended solids loads, 30% reduction of total nitrogen load, and 60% reduction in bacteria load (Jasper County, 2011).

Stormwater best management practices, when built according to the standards in Chapter 4 and maintained according to the site's maintenance agreement, can be expected to achieve runoff reduction and pollutant removal efficiencies according to Table 3.3. These values are to be used in the pollutant removal documentation and are used within the stormwater runoff reduction calculator in Appendix H. Other water quality credits may be assigned for BMPs based on the determination by Beaufort County Public Works Department and valid study results presented with the Stormwater Management Plan submittal.

Table 3.3. Pollutant Removal Efficiencies of Structural BMPs.

BMP	Water Quality Credits			
	Runoff Reduction	TSS % Removal	Total N % Removal	Bacteria % Removal
Bioretention - No Underdrain	100% <sup>1</sup>	100% <sup>1</sup>	100% <sup>6</sup>	100% <sup>6</sup>
Bioretention – Internal Water Storage	75% <sup>1</sup>	85% <sup>1</sup>	85% <sup>4</sup>	80% <sup>5</sup>
Bioretention - Standard	60% <sup>2</sup>	85% <sup>1</sup>	75% <sup>4</sup>	80% <sup>5</sup>
Permeable Pavement - Enhanced	100% <sup>1</sup>	100% <sup>1</sup>	100% <sup>6</sup>	100% <sup>6</sup>
Permeable Pavement - Standard	30% <sup>2</sup>	80% <sup>1</sup>	45% <sup>4</sup>	30% <sup>6</sup>
Infiltration	100% <sup>1</sup>	100% <sup>1</sup>	100% <sup>6</sup>	100% <sup>6</sup>
Green Roof	100% <sup>3</sup>	100% <sup>6</sup>	100% <sup>6</sup>	100% <sup>6</sup>
Green Roof - Irrigated	50% <sup>3</sup>	50% <sup>6</sup>	50% <sup>6</sup>	50% <sup>6</sup>
Rainwater Harvesting	100% <sup>3</sup>	100% <sup>6</sup>	100% <sup>6</sup>	100% <sup>6</sup>
Impervious Surface Disconnection	40% <sup>2</sup>	80% <sup>1</sup>	40% <sup>4</sup>	40% <sup>6</sup>
Grass Channel	10% <sup>2</sup>	50% <sup>1</sup>	25% <sup>4</sup>	30% <sup>5</sup>
Grass Channel - Amended Soils	20% <sup>2</sup>	50% <sup>1</sup>	35% <sup>4</sup>	30% <sup>5</sup>
Dry Swale	60% <sup>2</sup>	85%	70% <sup>4</sup>	80% <sup>5</sup>
Wet Swale	0% <sup>1</sup>	80% <sup>1</sup>	25% <sup>4</sup>	60% <sup>5</sup>
Regenerative Stormwater Conveyance	0% <sup>1</sup>	80% <sup>1</sup>	40% <sup>6</sup>	80% <sup>6</sup>
Filtering Systems	0% <sup>3</sup>	80% <sup>1</sup>	30% <sup>4</sup>	80% <sup>6</sup>
Storage Practices	0% <sup>3</sup>	60% <sup>1</sup>	10% <sup>4</sup>	60% <sup>5</sup>
Stormwater Ponds	0% <sup>1</sup>	80% <sup>1</sup>	30% <sup>4</sup>	60% <sup>5</sup>
Stormwater Wetlands	0% <sup>1</sup>	80% <sup>1</sup>	25% <sup>4</sup>	60% <sup>5</sup>
Tree Planting and Preservation	see section 4.12			
Proprietary Practices	see section 4.13			
Conservation Areas	see section 4.14			

## Notes:

The following resources were used to develop the runoff reduction and pollutant removal values in the above table.

1. (ARC, 2016).
2. (Hirschman, 2018).
3. (DOEE, 2013)
4. (Hirschman, 2018). Nitrogen removal values from this source were applied to the remaining volume after runoff reduction was applied. The values provided in the table above represent the results of this application.
5. (Chesapeake Stormwater Network, 2018)
6. Best professional judgement was used where a BMP's pollutant removal values were not available in the above sources, or conflicts were present. In all cases, a BMP's pollutant removal value must be at least as high as its runoff reduction values (for example, if a BMP is assigned a runoff reduction value of 100%, it will also have TSS, nitrogen, and bacteria removal rates of 100%). In addition, it was assumed that a Regenerative Stormwater Conveyance (RSC) will have similar nitrogen removal to bioretention systems, so the nitrogen removal value from the Runoff Reduction Method was applied as described in reference 4, above. It was also assumed that both RSCs and filtering systems will have the same bacterial removal rate as bioretention (with no runoff reduction).

### 3.6 Erosion & Sediment Control (ESC) Requirements

The design and management of construction site runoff control measures for all qualifying developments as defined in the Ordinance shall be in accordance with SCDHEC NPDES General Permit for Stormwater Discharges from Construction Activities, the SCDHEC Erosion and Sediment Reduction and Stormwater Management regulations and its most current version of standards, where applicable. Beaufort County Public Works Department reserves the right to require additional erosion and sediment control or a higher standard of measure and make their requirement a condition of a development permit approval.

### 3.7 Retention Standard & Volume

This section provides the formulas and rationale for use of the runoff reduction method to compare predeveloped and post-development hydrology for projects submitted for approval to the Southern Lowcountry jurisdictions.

Runoff reduction is defined as “the total annual runoff volume reduced through canopy interception, soil infiltration, evaporation, transpiration, rainfall harvesting, engineered infiltration, or extended infiltration” (Hirschman, 2008). The formula to calculate the volume reduced through successive application of stormwater best management practices originates with the Natural Resources Conservation Service (NRCS) method of estimating direct runoff from storm rainfall and the curve number method of NEH Chapter 9 (NEH, 2004). As shown in Equation 3.1, rainfall event runoff (Q) is a function of depth of event rainfall (P) over the watershed, the initial abstraction ( $I_a$ ) and the maximum potential retention (S).

Equation 3.1. Curve number runoff equation.

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

$$I_a = 0.22S$$

$$Q = \frac{(P - 0.22S)^2}{(P + 0.88S)}$$

$$Q - R = \frac{(P - 0.22S)^2}{(P + 0.88S)}$$

$$S = \frac{110000}{CN^2} - 11$$

Where:

- Q = Runoff depth (in)
- P = Depth of rainfall event for the designated watershed protection area (85<sup>th</sup> or 95<sup>th</sup> percentile rain event)
- $I_a$  = Initial abstraction (in)
- S = Potential maximum retention after runoff begins (in)
- CN = Runoff curve number
- R = Retention storage provided by runoff reduction practices (in)

Not all stormwater BMPs provide runoff reduction equally. Through the crediting procedures of the Compliance Calculator found in Appendix H and the retention volumes required in this section, designers will be able to evaluate their proposed designs and submit for approval in a unified process across the Southern Lowcountry jurisdictions.<sup>1</sup>

Supplemental information on the terms below can be found in the *Low Impact Development in Coastal South Carolina: Planning and Design Guide*, and the Georgia Stormwater Management Manual (Ellis, K. et al., 2014; ARC, 2016).

The Stormwater Retention Volume (SWRv) is the volume of stormwater runoff that is required to be retained, post-development. It is calculated as shown in Equation 3.2 for the entire site and for each site drainage area (SDA). The SDA is defined as the area that drains to a single discharge point from the site or sheet flows from a single area of the site. A development site may have multiple SDAs and runoff coefficients.

Equation 3.2. Stormwater retention volume (SWRv) equation

$$SSSSRRSS = \frac{PP \times [(RRSS_{II} \times II) + (RRSS_{CC} \times CC) + (RRSS_{CC} \times CC)]}{1122}$$

Where:

- $SWRv$  = Volume required to be retained (cubic feet)
- $P$  = Depth of rainfall event for the designated watershed protection area (85<sup>th</sup> or 95<sup>th</sup> percentile rain event)
- $Rv_I$  = Runoff coefficient for impervious cover and BMP cover based on SCS hydrologic soil group (HSG) or soil type
- $I$  = Impervious cover surface area (square feet)
- $Rv_C$  = Runoff coefficient for compacted cover based on soil type
- $C$  = Compacted cover surface area (square feet)
- $Rv_N$  = Runoff coefficient for forest/open space based on soil type
- $N$  = Natural cover surface area (square feet)
- 12 = Conversion factor (inches to feet)

	Rv Coefficients			
	A soils	B Soils	C Soils	D Soils
Forest/Open Space ( $Rv_N$ )	0.02	0.03	0.04	0.05
Managed Turf ( $Rv_C$ )	0.15	0.20	0.22	0.25
Impervious Cover ( $Rv_I$ )	0.95	0.95	0.95	0.95
BMP	0.95	0.95	0.95	0.95

The Compliance Calculator in Appendix H uses best available pollutant removal efficiencies for total suspended solids, total nitrogen and fecal indicator bacteria. Use of the compliance calculator allows the designer to evaluate alternative designs to arrive at compliance with the runoff reduction and pollutant removal requirements and clearly summarize them for the local plan reviewer. The compliance

<sup>1</sup> Compliance Calculator instructions are found in Appendix G

calculator output is a necessary submittal for a plan reviewer to evaluate selected BMPs to demonstrate compliance with the watershed protection area standards of this Manual.

### **3.7.1 Total Suspended Solids, Nutrients, & Bacteria**

The minimum pollutant removal performance requirements for all watersheds of the Southern Lowcountry include the interception and treatment of stormwater runoff volume to at least an 80% reduction in total suspended solids load, 30% reduction of total nitrogen load, and 60% reduction in bacteria load. These requirements are established for the following reasons.

Stormwater in the Lowcountry conveys the plant nutrients nitrogen and phosphorus. Nitrogen tends to dissolve in water, but phosphorus is adsorbed to suspended solids predominantly. Control of total suspended solids through the BMPs in this Manual will also remove a proportional amount of phosphorus. Relying on the judgement of stormwater researchers and other state design manuals, the approach for the Southern Lowcountry is similar. If a BMP is effective at runoff reduction or retention of stormwater, it is similarly effective at removal of the initial volume of suspended solids (NCDEQ, 2014).

Many of the Southern Lowcountry watersheds at the HUC-12 size are directly tributary to bacteria and shellfish impaired waters. As these watersheds develop with rooftops, roads and other impervious surfaces, there is an increasing potential for bacteria in the stormwater from wildlife populations (deer, racoons, waterfowl), pet waste, septic system discharges and sanitary sewer system malfunctions. Similarly, nutrients can be expected to increase due to fertilizer use in erosion control practices, managed turf and landscaping, septic system leachate, and atmospheric deposition on impervious surfaces. Best management practices, along with better site design practices, can be used to reduce bacteria and nutrients in stormwater to the benefit and restoration of Southern Lowcountry water quality.

### **3.7.2 Hydrologic & Hydraulic Analysis**

In order to prevent an increase in the duration, frequency and magnitude of downstream overbank flooding and scouring, this Manual requires that enough stormwater detention be provided on a development site to control the post-development peak runoff discharge to the predevelopment runoff rates for the 2, 10, 25, 50, and 100 -year, 24-hour storm events. The capacity of the existing downstream receiving conveyance system for all off-site discharge points must be determined to be adequate. An analysis of the downstream conveyance capacity to accommodate the site's post development 25- and 100-year, 24-hour peak flow shall be provided in the engineering report. Discharge to the public right-of-way of the SC State highway system shall comply with the SCDOT Requirements for Hydraulic Design Studies. Necessary upgrades within the public right-of-way due to inadequate capacity for the post-development 25-yr flow must be identified during the permit application process. Upgrades to the downstream system to accommodate the 100-yr 24-hour flow must be considered through the MEP process outlined in Section 3.9. Documentation supporting safe passage of the 100-yr post development flow to the downstream point where the detention or storage area comprises 10% of the total drainage area, and an analysis of the surrounding neighborhood area to identify any existing capacity shortfalls or drainage blockages is required for plan approval. This analysis is called the 10% analysis rule in Section 3.8 of this Manual.

The recommended 2, 10, 25, and 100-year, 24-hour storm event values from Appendix F of the South Carolina DHEC Storm Water Management BMP Handbook, July 31, 2005 for Beaufort and Jasper Counties are in Table 3.4<sup>2</sup>.

Table 3.4. Rainfall depth (inches) for the Southern Lowcountry.

County	Return Period (years)			
	2	10	25	100
Beaufort	4.5	6.9	8.4	11.0
Jasper	4.2	6.4	7.8	10.2

In this Manual, Appendix I General Design Criteria and Guidelines provides the acceptable methodologies and computer models for estimating runoff hydrographs before and after development, as well as design criteria for stormwater collection systems and land cover designations. The following are the acceptable methodologies and computer models for estimating runoff hydrographs before and after development. These methods are used to predict the runoff response from given rainfall information and site surface characteristic conditions. The design storm frequencies used in all of the hydrologic engineering calculations will be based on design storms required in this Manual unless circumstances make consideration of another storm intensity criterion appropriate:

- Rational Method (limited to sites under 10 acres)
- Urban Hydrology for Small Watersheds TR-55
- Storage-Indication Routing
- HEC-1, WinTR-55, TR-20, ICPR v3 or 4 and SWMM computer models

These methods are given as valid in principle and are applicable to most stormwater management design situations in the Southern Lowcountry.

The following conditions should be assumed when developing predevelopment, pre-project, and post-development hydrology, as applicable:

- The design storm duration shall be the 24-hour rainfall event, using the NRCS (SCS) Type III rainfall distribution with a maximum six-minute time increment.
- The predeveloped peaking factor shall be 200 for new development (Blair et al., 2012).
- The post development peaking factor shall be 400.
- For new development sites the predeveloped condition shall be calculated as a composite CN based on the HSG and meadow conditions (NEH, 2004).
- For infill and redevelopment sites, the predeveloped condition shall be calculated as a composite CN based on the HSG and the land cover type and hydrologic condition at the time of the project's initial submittal.

<sup>2</sup> Until SCDHEC updates its Stormwater Management BMP Handbook rainfall table to the NOAA Atlas 14 values, the Southern Lowcountry region shall use the Handbook Appendix F rainfall table for 24 hour storm events.

- Antecedent Runoff Condition (ARC) II is the average adjustment factor for calculations using TR-55. ARC III is to be used for wetter conditions such as areas that receive irrigation water harvested from stormwater ponds and for poorly drained soils.

Project designs must include supporting data and source information. All storm sewer systems shall be analyzed for both inlet and outlet control (including tailwater effects) by using the following:

- a. Equations and nomographs as shown in the Federal Highway Administration (FHWA) Hydraulic Design Services (HDS) publication No. 5.
- b. Computer programs that calculate the actual hydraulic grade line for the storm sewer system can be used, provided all losses (friction, bend, junction, etc.) are taken into account using the appropriate loss coefficient (K) values.
- c. Design tailwater condition elevation shall be supported by a reasonable resource and/or analysis.
- d. Allowable headwater. The allowable headwater of all culverts, pipe systems, open channels, bridges and roadway culverts shall be established following the SCDOT Requirements for Hydraulic Design Studies.

All culverts, pipe systems, and open channel flow systems shall be sized in accordance with the design criteria found in Appendix I Hydrology and Hydraulics Design Requirements.

### 3.7.3 Maintenance Easements

Maintenance easements are provided for the protection and legal maintenance of stormwater management facilities not within a right-of-way. Drainage easements shall be required in subdivisions over any portion of a stormwater management facilities not within a right-of-way and necessary for the functioning of the system. Drainage easements for all facilities must be shown on construction drawings and approved by the stormwater manager. The easements shall be designated on the plan prior to issuance of a development permit and recorded in public records with copy of recorded easement submitted prior to Beaufort County Public Works Department permit termination. The minimum allowable width of drainage easements may be as shown in Table 3.5.

Table 3.5. Drainage maintenance access easements.

Stormwater Management Facility	Minimum Easement Width
Closed systems (storm sewers/pipes/culverts)	diameter + 4 ft + 2D(20-ft minimum)*
<b>Open drainage systems</b>	
Bottom width 20 ft or less	15 ft + BW + 2SD (30 ft minimum)**
Bottom width 20 ft to 40 ft	30 ft + BW + 2SD**
Bottom width greater than 40 ft	40 ft + BW + 2SD**
Retention/detention BMPs	20 ft around facility***
Pond Maintenance Access	A 20' maintenance access easement between lot lines and top of bank shall be provided for stormwater ponds with a permanent pool. The easement shall be provided for boat trailer access, and for all structure maintenance and repair. No permanent structures (mechanical, electrical, phone, fences) or landscaping are allowed within the 20' pond maintenance access easement.



\*Where:

D = Depth from grade to pipe invert

\*\*Where:

BW = Bottom width

S = Side slope

D = Depth of opening

Note: The minimum required width and configuration of drainage easements may be modified if deemed necessary by the stormwater manager for justifiable reasons.

### 3.8 Extreme Flood Requirement: 10% Rule

The peak discharge generated by the 100-year, 24-hour storm event under post-development conditions is considered the extreme peak discharge. The intent of the extreme flood protection is to prevent flood damage from infrequent but large storm events, maintain the boundaries of the mapped 100-year floodplain, and protect the physical integrity of the best management practices as well as downstream stormwater and flood control facilities. The 100-yr flow is to be used in the routing of runoff through the drainage system and stormwater management facilities to determine the effects on the facilities, adjacent property, and downstream. Emergency spillways of best management practices should be designed appropriately to pass the resulting flows safely.

Documentation supporting safe passage of the 100-year post-development flow shall be provided by the applicant/engineer. In order to prevent an increase in the duration, frequency and magnitude of downstream extreme flooding over existing conditions, an evaluation must be provided to include downstream analysis to the point where the project comprises 10% of the total contributing drainage area. The 10% rule evaluation must address existing conveyance system capacity and “pinch points” where a pipe/culvert would be overtopped and where the pipe/culvert will need to be upgraded or the peak discharge rate will need to be limited to the capacity of the downstream system.

The 10% rule recognizes the fact that a structural BMP control providing detention has a “zone of influence” downstream where its effectiveness can be felt. Beyond this zone of influence, the structural control becomes relatively small and insignificant compared to the runoff from the total drainage area at that point. Based on studies and master planning results from a large number of sites, that zone of influence is considered to be the point where the drainage area controlled by the detention or storage facility comprises 10% of the total drainage area. For example, if the drainage control drains 10 acres, the zone of influence ends at a point where the total drainage area is 100 acres or greater (ARC, 2016).

Demonstration of safe passage of the 100-year, 24-hour storm shall include a stage storage analysis of the system, an inflow/outflow comparison of the system, and construction of a table showing peak stage elevations in comparison to safe freeboards to structures of the system and adjacent buildings/structures/infrastructure. Safe passage to the receiving water also requires that there be no additional downstream flooding or other environmental impacts (e.g., stream channel enlargement, degradation of habitat).

Typical steps in the application of the 10% rule are:

1. Determine the target peak flow for the site for predevelopment conditions.
2. Using a topographic map, determine the lower limit of the zone of influence (10% point)

3. Using a hydrologic model, determine the predevelopment peak flows and timing of those peaks at each tributary junction beginning at the pond outlet and ending at the next tributary junction beyond the 10% point.
4. Change land use on the site to post-development and rerun the model.
5. Design the structural control facility such that the overbank flood protection (25-year) post-development flow is adequately conveyed to the lower limit of the zone of influence and the Extreme Flood (100-year) post-development flow does not impact any existing structures within the area of zone of influence.
6. If the overbank flood protection (25-year) post-development flow is not adequately conveyed to the lower limit of the zone of influence and/or Extreme Flood (100-year) post-development flow is shown to impact any structure, the structural control facility must be redesigned or one of the following options considered:
  - a. Work with Beaufort County Public Works Department to reduce the flow elevation through channel or flow conveyance structure improvements downstream.
  - b. Obtain a flow easement from downstream property owners to the 10% point.
  - c. Request a detention waiver from Beaufort County Public Works Department. This waiver would be for water quantity control only and best management practices to achieve water quality goals will still be required.

### 3.9 Maximum Extent Practicable

Maximum extent practicable (MEP) is the language of the Clean Water Act that sets the standards to evaluate efforts pursued to achieve pollution reduction to the Waters of the United States. The MEP refers to management practices; control techniques; and system, design, and engineering methods for the control of pollutants. It allows for considerations of public health risks, societal concerns, and social benefits, along with the gravity of the problem and the technical feasibility of solutions. The MEP for stormwater management is achieved, in part, through a process of selecting and implementing different design options with various structural and non-structural stormwater best management practices (BMPs), where ineffective BMP options may be rejected, and replaced when more effective BMP options are found (DOEE, 2019).

There must be a serious and demonstrated attempt to comply with this Manual, and practical solutions may not be lightly rejected. If project applicants implement and demonstrate only a few of the least expensive BMPs, and the regulated volume has not been retained, it is likely that the MEP standard has not been met. If, on the other hand, a project applicant implements all applicable and effective BMPs except those shown to be technically infeasible, then the project applicant would have achieved retention to the MEP.

Major land-disturbing activities, infill and redevelopment projects, and projects in the existing public right-of-way, must achieve the SWRv, and meet peak flow requirements for channel and extreme flood protection to the MEP. Through application of stormwater best management practices on site or at an off-site property within the same stormwater drainage catchment, land development projects should be able to comply with the Southern Lowcountry Stormwater Ordinance. It is the applicant's responsibility to demonstrate to the greatest extent that the requirements of this Manual can be met for the proposed development. The applicant must fully demonstrate that the requirements of the Manual are not possible or feasible before entering into a MEP analysis, and only after the concurrence and

approval of the Public Works director and/or their designee of Beaufort County Public Works Department based on the project submittals, documentation and discussions. The applicant must realize that if the requirements of the Manual cannot be met, the site may not be conducive for development, as proposed, in the interest of public safety and welfare.

When a new land development project, infill or redevelopment cannot meet the volume and peak flow requirements of this Manual, the following design and review process is required to comply with the MEP requirement. This evaluation is intended to be completed during the concept review stage of plan development.

- 1) Demonstrate how BSD has been implemented to the maximum extent practicable or document site restrictions that prevent BSD application.
- 2) List the site restrictions that prevent the on-site use of the stormwater BMPs of this Manual.
- 3) Cite justification for not being able to retain the SWRv and attain the required peak discharge limits.
- 4) Is there off-site capacity in the same drainage catchment as defined by Beaufort County Public Works Department to meet the volume and/or peak flow requirements for the site's contributing drainage area(s)?
- 5) Does the publicly maintained stormwater drainage system have sufficient capacity for the development site's extreme flood peak flow?
- 6) Develop a cost versus aggregated stormwater retention volume achieved curve for the site's contributing drainage area. A minimum of five cost points with three of the BMP alternatives in series as a treatment train are necessary for the curve. Include the evaluation off-site capacity cost. Identify the inflection point of the cost curve to identify the optimal solution where increased cost does not result in increased effectiveness.
- 7) The optimum aggregated retention value and BMP selection and size analysis must be submitted as a part of the stormwater management plan for the project.
- 8) Offsite stormwater volume retention credit or fee-in-lieu documents will be required for project completion.

The MEP submittal must provide documentable evidence of the process the applicant has performed that demonstrates the restrictions to the use and implementation of BMPs and approved by the Beaufort County Public Works Director and/or their designee and to meet the requirements of this Manual in whole or in part.

### **3.10 Off-Site Stormwater Management**

All stormwater management design plans shall include on-site stormwater management practices, unless post-construction stormwater runoff in an off-site or regional stormwater management practice is approved according to this Section.

The off-site or regional stormwater management practice must be located on property legally dedicated to that purpose, be designed and sized to meet the post-construction stormwater management criteria presented in this Manual, provide a level of stormwater quality and quantity control that is equal to or greater than that which would be provided by on-site green infrastructure and stormwater management practices, be in the same drainage catchment, as defined by Beaufort County Public Works Department, as the project area, and have an associated inspection and maintenance agreement and plan. In addition, appropriate stormwater management practices shall be installed, where necessary, to protect

properties and drainage channels that are located between the development site and the location of the off-site or regional stormwater management practice.

To be eligible for compliance through the use of off-site stormwater management practices, the applicant must submit a stormwater management design plan to Beaufort County Stormwater Department that demonstrates the adequacy of the off-site or regional stormwater management practice, and demonstrates, to the satisfaction of the Beaufort County Public Works Department that the off-site or regional stormwater management practice will not result in any of the following impacts:

- (1) Increased threat of flood damage or endangerment to public health or safety;
- (2) Deterioration of existing culverts, bridges, dams, and other structures;
- (3) Accelerated streambank or streambed erosion or siltation;
- (4) Degradation of in-stream biological functions or habitat; or,
- (5) Water quality impairment in violation of state water quality standards and/or violation of any other state or federal regulations.

### **3.11 Waivers**

Individuals seeking a waiver from the requirements of this Ordinance may submit to the (*administrator*) a request for a waiver in accordance with the Southern Lowcountry Stormwater Design Manual.

#### **(1) Request of a Waiver at Staff Level**

A written request for a waiver is required and shall state the specific waiver sought and the reasons, with supporting data, a waiver should be granted. The request shall include all information necessary to evaluate the proposed waiver. Requests must outline the need for such a waiver, such as site constraints, soil characteristics, or similar engineering limitations. Cost shall not be considered cause for a waiver. This waiver would be for water quantity control only and best management practices to achieve water quality goals will still be required. The applicant will address the criteria below for consideration of a waiver approval:

- a. What exceptional circumstances to the site are evident that on-site or off-site stormwater management requirements cannot be met?
- b. What unnecessary hardship is being caused?
- c. How will denial of the waiver be inconsistent with the intent of the Ordinance?
- d. How will granting the waiver comply with the intent of the Ordinance?
- e. How are state and federal regulations still being met?

#### **(2) Review of Waivers**

The Public Works Director and/or their designee will conduct a review of the request and will issue a decision within thirty (30) working days of receiving the request.

## **Chapter 4. Stormwater Best Management Practices (BMPs)**

### **4.1 Standard Stormwater BMP Design Sections**

This chapter summarizes and outlines performance criteria for 13 stormwater best management practice (BMP) categories that include:

- Bioretention (4.3)
- Permeable Pavements (4.4)
- Infiltration (4.5)
- Green Roofs (4.6)
- Rainwater Harvesting (4.7)
- Impervious Surface Disconnection (4.8)
- Open Channel Systems (4.9)
- Filtering Systems (4.10)
- Storage Practices (4.11)
- Ponds (4.12)
- Stormwater Wetlands (4.13)
- Tree Planting and Preservation (4.14)
- Proprietary Practices (4.15)

Following these criteria is the criteria to credit for stormwater benefit the use of conservation areas and open space preservation.

#### **4.1.1 Format of Standard Stormwater BMP Design Sections**

BMP performance criteria are based on several critical design factors to ensure effective and long-lived BMPs. For each BMP, the following factors are discussed:

- General Feasibility
- Conveyance
- Pretreatment
- Design and Sizing
- Landscaping
- Construction Sequencing
- Maintenance
- Stormwater Compliance Calculations

Design components that differ from these specifications, but meet their intent, may be included at Beaufort County Public Works Department's discretion.

#### **4.1.2 Standard Nomenclature**

In this chapter, and throughout the guidebook, the terms, *must* or *shall*, denote required aspects of BMPs or their design and implementation. The term, *should*, denotes a recommendation, however, justification may be necessary for design or implementation that does not correspond to certain recommendations.

## **4.2 Summary of BMP Stormwater Management Capabilities, Site Applicability, & Physical Feasibility**

Stormwater management requirements for a given site vary based on the site's location, and minimum control requirements discussed in detail in Section 3.5.

### **4.2.1 Stormwater Retention & Water Quality Treatment**

It is important to note that this Manual, and the associated compliance calculators, make a distinction between stormwater retention volume and stormwater water quality treatment. Not all BMPs achieve stormwater retention and/or water quality treatment equally, as was summarized in Table 3.3. The level to which a BMP provides stormwater retention and water quality treatment is provided in the BMP summary table of each BMP. The stormwater runoff reduction (SWRv) rates are expressed as a percentage of the storage volume provided by the BMP. Calculations for determining storage volume are included in each BMP's specifications. Each BMP's performance on the water quality parameters of total suspended solids, nitrogen and bacteria are also included in the BMP summary table. Note that many BMPs whose main purpose is water quality treatment typically do not have enough volume control to manage larger storm events.

### **4.2.2 Site Applicability**

Certain BMPs are more appropriate than others in certain land uses. Table 4.1 describes the site applicability for each BMP for the following factors:

- Rural Use: This column indicates whether or not the stormwater management practice is typically suited for use in rural areas and on low-density development sites.

- **Suburban Use:** This column indicates whether or not the stormwater management practice is typically suited for use in suburban areas and on medium-density development sites.
- **Urban Use:** This column identifies the stormwater management practices that are typically suited for use in urban and ultra-urban areas where space is at a premium.
- **Construction Cost:** This column assesses the relative construction cost of each of the stormwater management practices.
- **Maintenance:** This column assesses the relative maintenance burden associated with each stormwater management practice. Note that all stormwater management practices require routine inspection and maintenance.

Table 4.1. Site applicability for BMPs.

BMP	Rural Use	Suburban Use	Urban Use	Construction Cost	Maintenance
Bioretention	Yes	Yes	Yes	Medium	Medium
Permeable Pavement	Maybe	Yes	Yes	High	High
Infiltration	Yes	Yes	Yes	Medium	Medium
Green Roof	Maybe	Yes	Yes	High	Low
Rainwater Harvesting	Yes	Yes	Yes	Medium	Medium
Disconnection	Yes	Yes	Maybe	Low	Low
Open Channels	Yes	Yes	No	Low-Medium	Medium
Filtration	Maybe	Yes	Yes	High	High
Dry Ponds	Yes	Yes	No	Low	Low
Wet Ponds	Yes	Yes	No	Low	Low
Stormwater Wetlands	Yes	Yes	No	Low	Medium

#### 4.2.3 Site Conditions & Physical Feasibility

While some BMPs can be applied almost anywhere, others require specific conditions to be most effective. Physical feasibility refers to the physical site conditions necessary to effectively design and install a BMP. Table 4.2 includes the feasibility factors listed below.

- **Contributing Drainage Area (CDA):** Volume of water received by a practice can affect BMP performance. This column indicates the contributing drainage areas that typically apply for each BMP.
- **Slope:** This column describes the influence that site slope can have on the performance of the BMP. It indicates the maximum slope on which the BMP should be installed.
- **Minimum Head:** This column provides an estimate of the minimum amount of elevation difference needed within the BMP, from the inflow to the outflow, to allow for gravity operation.
- **Minimum Depth to Seasonal High Water Table:** This column indicates the minimum distance that should be provided between the bottom of the stormwater management practice and the top of the water table.
- **Soils:** This column describes the influence that the underlying soils (i.e., hydrologic soil groups) can have on the performance of the stormwater management practice.

Table 4.2. Feasibility limitations for BMPs.

BMP	Contributing Drainage Area	Slope	Minimum Head	Minimum Depth to Water Table	Soils
Bioretention	Up to 2.5 acres	Up to 5% <sup>2</sup>	4 - 5 feet	0.5 feet	All soils <sup>3</sup>
Permeable Pavement	Up to 5 times practice surface area	Up to 5%	1 – 4 feet	0.5 feet	All soils <sup>3</sup>
Infiltration	Up to 2 acres	Up to 6% <sup>2</sup>	2 feet	0.5 feet	Must drain within 72 hours
Green Roof	Green roof area + 100%	Up to 30% <sup>4</sup>	N/A	N/A	N/A
Rainwater Harvesting	No limit	No limit	N/A	N/A	N/A
Disconnection	Up to 1,000 ft <sup>2</sup> per downspout	Up to 5%	N/A	N/A	All soils
Open Channels	Up to 2.5 acres	Up to 4% <sup>2</sup>	Varies	Varies	All soils
Filtration					



Irrigation from ponds is not included as a specific best management practice in this *Manual* but is included as Rainwater Harvesting (§4.5). Requirements and guidance for irrigation use of retained stormwater have been included in Hydrologic and Hydraulic Analysis (ARC requirements in §3.7.2); Ponds (§4.10); and Rainwater Harvesting Treatment and Management Requirements (Appendix J). The Rainwater Harvesting Calculator in Appendix K will be used to determine the SWRv credit for ponds used for irrigation, and then these ponds are entered in the Compliance Calculator in Appendix H as rainwater harvesting. Instructions for these entries are included in Appendix G Compliance Calculator Instructions.

Filtration	Up to 5 acres	Up to 6%	2 – 10 feet	0.5 feet	All soils
Storage Practices	Varies	No limit	5 feet	0.5 feet	All soils
Ponds	Greater than 10 acres <sup>1</sup>	Up to 15%	6 – 8 feet	No limit	Slow-draining soils preferred
Stormwater Wetlands	Varies	Up to 8% <sup>2</sup>	2 – 4 feet	No limit	Slow-draining soils preferred
<sup>1</sup> CDA can be smaller if practice intersects the water table. <sup>2</sup> Check dams may be necessary to create sufficient ponding volume. <sup>3</sup> Slow-draining soils may require an underdrain. <sup>4</sup> Roof slope.					

### 4.3 Bioretention

Bioretention				
<b>Definition:</b> Practices that capture and store stormwater runoff and pass it through a filter bed of engineered filter media composed of sand, soil, and organic matter. Filtered runoff may be collected and returned to the conveyance system or allowed to infiltrate into the soil.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small to Large	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1,2</sup>
		85%–100%	75%–100%	80%–100%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
Moderate	Moderate	High		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	No Underdrain	IWS	Standard
Quarterly	Every 2–3 years	100% of Sv	75% of Sv	60%
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Easily incorporated into new development</li><li>▪ High community acceptance</li><li>▪ Good for small, highly paved drainage areas (i.e. parking lots)</li></ul>		<ul style="list-style-type: none"><li>▪ Maximum CDA is 1 to 2.5 acres</li><li>▪ Requires pretreatment to prevent clogging</li><li>▪ Requires detailed landscape planning</li><li>▪ Not appropriate for steep slopes</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Pretreatment</li><li>▪ Conveyance system</li><li>▪ Ponding area</li><li>▪ Soils/Filter Media/Mulch</li><li>▪ Observation Well/Monitoring Port</li><li>▪ Plants</li></ul>		<ul style="list-style-type: none"><li>▪ Maximum ponding depth 18 inches</li><li>▪ Minimum filter media bed depth 18 inches</li><li>▪ Depth to seasonal high water table must be at least 6 inches below bottom of practice</li><li>▪ Underdrain system may be needed</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Mow turf cover periodically</li><li>▪ Replace mulch as needed to maintain depth of mulch</li></ul>		<ul style="list-style-type: none"><li>▪ Replace plant material, as needed</li><li>▪ Replace soil if it becomes clogged</li><li>▪ Clean conveyance system(s)</li></ul>		

*Credited pollutant load removal*

Bioretention areas, shallow depressional areas that are filled with an engineered soil media and are planted with trees, shrubs, and other herbaceous vegetation, are one of the most effective stormwater management practices that can be used to reduce post-construction stormwater runoff rates, volumes, and pollutant loads. They also provide a number of other benefits, including improved aesthetics, wildlife habitat, urban heat island mitigation, and improved air quality. See Figure 4.1 for an example image.

They are designed to capture and temporarily store stormwater runoff in the engineered soil media, where it is subjected to the hydrologic processes of evaporation and transpiration, before being

conveyed back into the storm drain system through an underdrain or allowed to infiltrate into the surrounding soils. The engineered soil media is comprised of sand, soil, and organic matter.

Typically, bioretention systems are not designed to provide stormwater detention of larger storms (e.g., 2-, 10-, 25-year), but in some circumstances that may be possible. Bioretention practices should generally be combined with a separate facility to provide those controls.



Figure 4.1. Bioretention in parking lot (photo credit: Center for Watershed Protection, Inc.).

**Definition.** Practices that capture and store stormwater runoff and pass it through a filter bed of engineered filter media composed of sand, soil, and organic matter. Filtered runoff may be collected and returned to the conveyance system or allowed to infiltrate into the soil. Design variants include the following:

- B-1 Bioretention
- B-2 Streetscape bioretention
- B-3 Engineered tree pits
- B-4 Stormwater planters
- B-5 Residential rain gardens (for single family homes)

There are three different bioretention design configurations:

- **No Underdrain.** Practices that can infiltrate the design storm volume within 72 hours, and therefore need no underdrain (see Figure 4.2).
- **Internal Water Storage (IWS).** Practices that include an infiltration sump/storage layer (see ) below the underdrain.
- **Standard.** Practices with underdrains (see Figure 4.4).

The particular design configuration to be implemented on a site is typically dependent on specific site conditions and the characteristics of the underlying soils. These criteria are further discussed in this chapter.

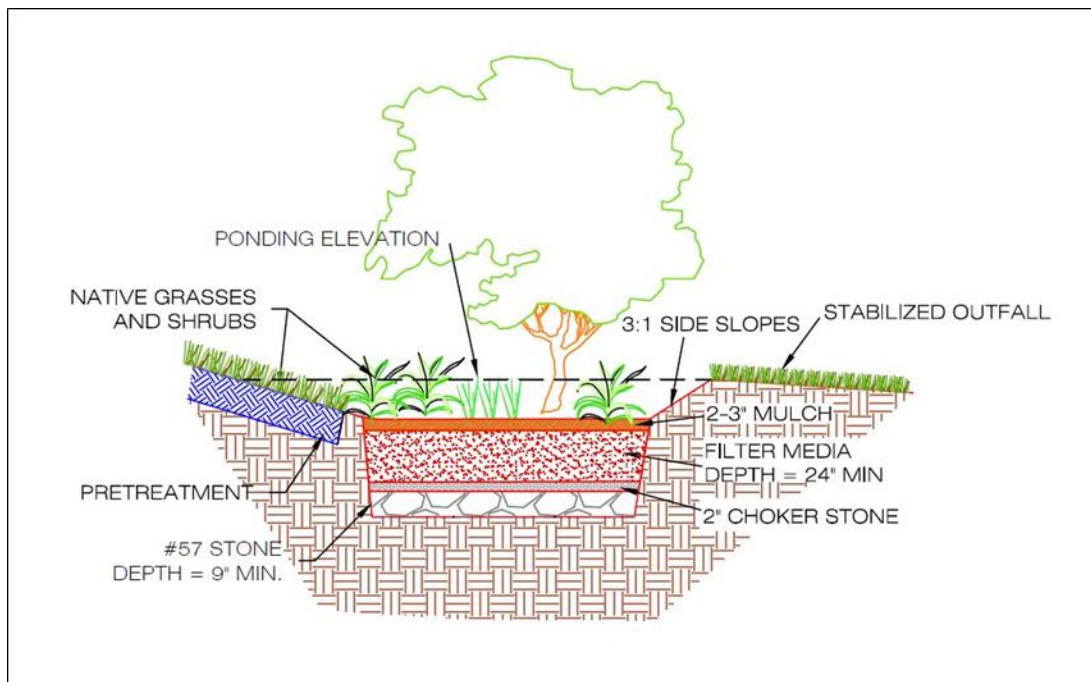


Figure 4.2. Example bioretention design without an underdrain.

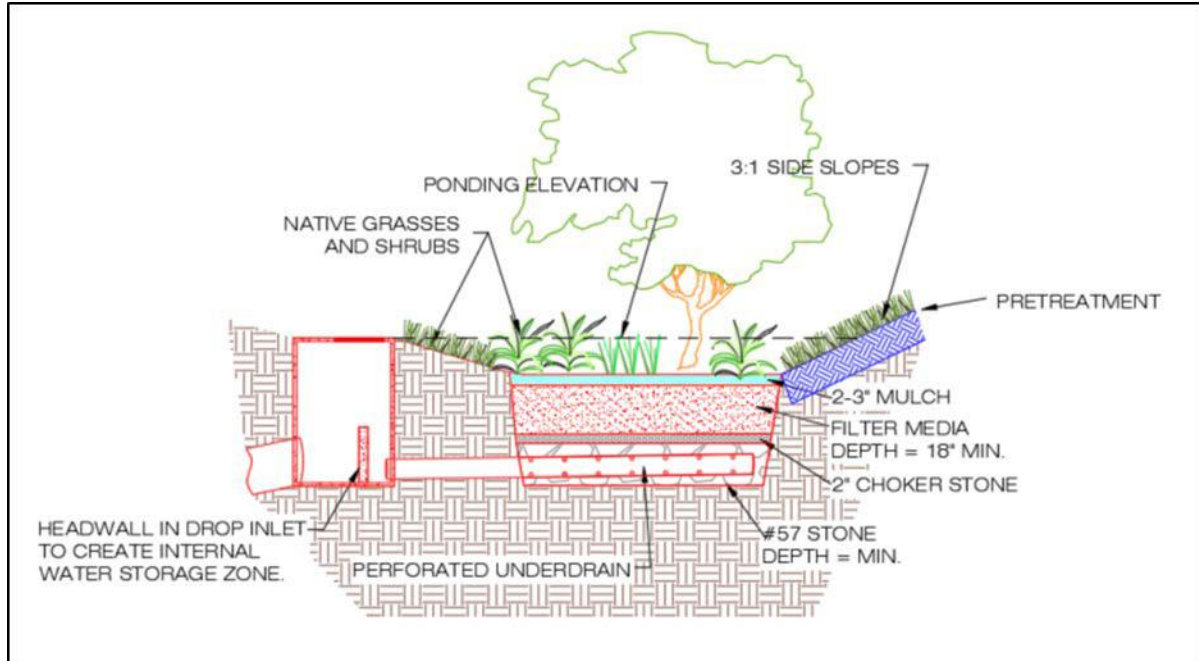


Figure 4.3. Example bioretention design with internal water storage (IWS).

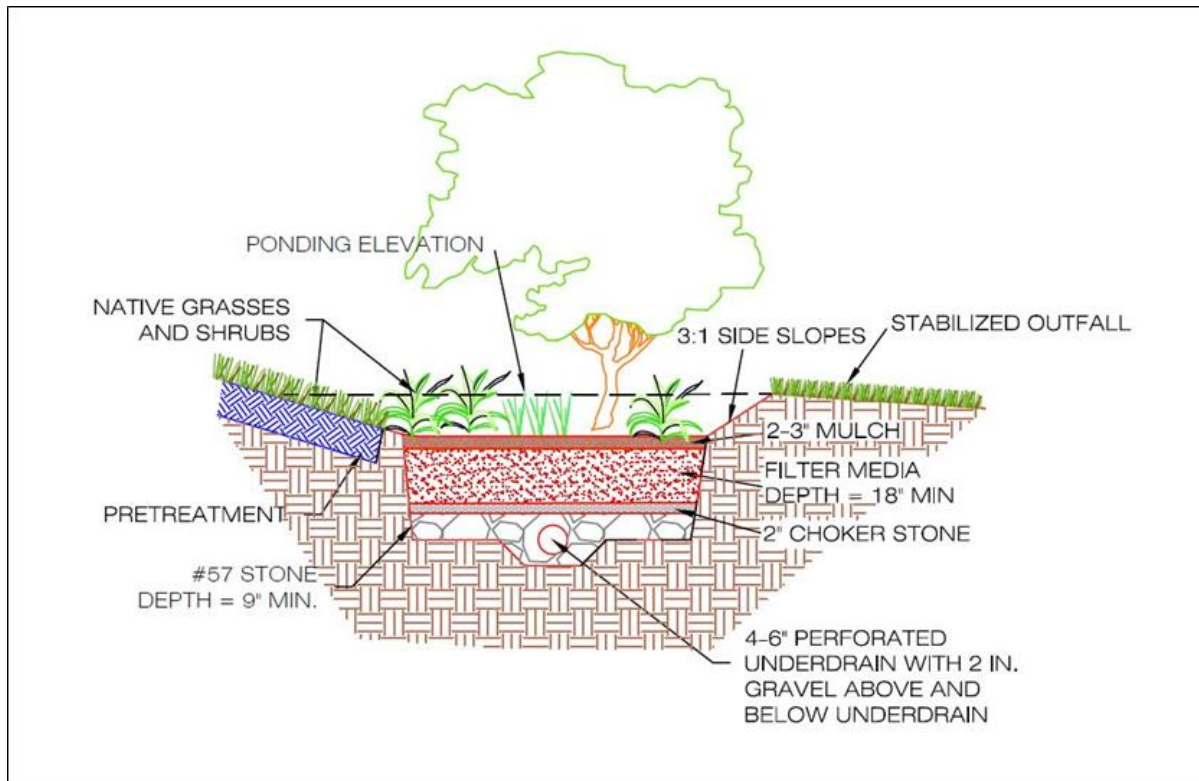


Figure 4.4. Example standard bioretention design.





Figure 4.5. Example streetscape bioretention.

#### **4.3.1 Bioretention Feasibility Criteria**

Bioretention can be applied in most soils or topography, since runoff simply percolates through an engineered soil bed and is infiltrated or returned to the stormwater system via an underdrain. Key constraints with bioretention include the following:

##### **Required Space**

Planners and designers can assess the feasibility of using bioretention facilities based on a simple relationship between the CDA and the corresponding bioretention surface area. The surface area is recommended to be approximately 3 to 6% of CDA, depending on the imperviousness of the CDA and the desired bioretention ponding depth.

##### **Site Topography**

Bioretention can be used for sites with a variety of topographic conditions, but it is best applied when the grade of the area immediately adjacent to the bioretention practice (within approximately 15 to 20 feet) is greater than 1% and less than 5%.

##### **Available Hydraulic Head**

Bioretention is fundamentally constrained by the invert elevation of the existing conveyance system to which the practice discharges (i.e., the bottom elevation needed to tie the underdrain from the bioretention area into the storm drain system). In general, 4 to 5 feet of elevation above this invert is

needed to accommodate the required ponding and filter media depths. If the practice does not include an underdrain or if an inverted or elevated underdrain design is used, less hydraulic head may be adequate.

### **Water Table**

Bioretention must be separated from the water table to ensure that groundwater does not intersect the filter bed. Mixing can lead to possible groundwater contamination or failure of the bioretention facility. A separation distance of no less than 0.5 feet is required between the bottom of the excavated bioretention area and the seasonally high groundwater table.

### **Tidal Impacts**

For systems with an underdrain, the underdrain should be located above the tidal mean high water elevation. For entirely infiltration-based systems, the bottom of the stone reservoir should be located above the mean high water elevation. Where this is not possible, portions of the practice below the tidal mean high water elevation cannot be included in the volume calculations. Also, salt-tolerant vegetation may be necessary in these areas.

### **Soils and Underdrains**

Soil conditions do not typically constrain the use of bioretention, although they do determine whether an underdrain is needed. Underdrains may be required if the measured permeability of the underlying soils is less than 0.3 inches per hour. When designing a bioretention practice, designers must verify soil permeability by using the on-site soil investigation methods provided in Appendix B for Geotechnical Information Requirements for Underground BMPs. Impermeable soils will require an underdrain.

For fill soil locations, geotechnical investigations are required to determine if it is necessary to use an impermeable liner and underdrain.

### **Contributing Drainage Area**

Bioretention cells work best with smaller CDAs, where it is easier to achieve flow distribution over the filter bed. The maximum CDA to a standard bioretention area (B-1) is 2.5 acres and can consist of up to 100% impervious cover. The CDA for smaller bioretention practices (B-2, B-3, B-4, and B-5) is a maximum of 1 acre. However, if hydraulic considerations are adequately addressed to manage the potentially large peak inflow of larger CDAs, such as off-line or low-flow diversions, or forebays, there may be case-by-case instances where the maximum CDAs can be adjusted. summarizes typical recommendations for bioretention CDAs.

Table 4.3. Maximum contributing drainage area (CDA) to bioretention.

Bioretention Type	Design Variants	Maximum CDA (acres of impervious cover)
Standard	B-1	2.5
Small-scale bioretention	B-2, B-3, B-4, and B-5	1.0

### **Pollutant Hotspot Land Uses**

Bioretention may not be an appropriate stormwater management practice for certain pollutant-generating sites. In areas where higher pollutant loading is likely (i.e. oils and greases from fueling stations or vehicle storage areas, sediment from un-stabilized pervious areas, or other pollutants from

industrial processes), appropriate pretreatment, such as an oil- water separator or filtering device must be provided. These pretreatment facilities should be monitored and maintained frequently to avoid negative impacts to the bioretention area and subsequent water bodies.

On sites with existing contaminated soils, infiltration is not allowed. An impermeable bottom liner and an underdrain system must be employed when a bioretention area will receive untreated hotspot runoff, and the No Underdrain design configuration cannot be used.

Bioretention can still be used to treat parts of the site that are outside of the hotspot area. For instance, roof runoff can go to bioretention while vehicular maintenance areas would be treated by a more appropriate hotspot practice.

### **No Irrigation or Baseflow**

The planned bioretention area should not receive baseflow, irrigation water, chlorinated wash-water or any other flows not related to stormwater. During the establishment period of the bioretention area, irrigation is allowed, however, to ensure plant survival. In addition, rain gardens or bioretention practices may be incorporated into the design of a Rainwater Harvesting System (See Section 4.7).

### **Setbacks**

To avoid the risk of seepage, stormwater cannot flow from the bioretention area reservoir layer to the traditional pavement base layer, existing structure foundations, or future foundations which may be built on adjacent properties.

Bioretention areas should be located at least:

- ⑦ 10 feet from building foundations\*
- ⑦ 10 feet from property lines
- ⑦ 150 feet from private water supply wells
- ⑦ 50 feet from septic systems

\*For building foundations, where the 10-foot setback is not possible, an impermeable liner may be used along the sides and bottom of the bioretention area (extending from the surface to the bottom of the practice and outward to meet the 10-foot setback) to prevent seepage or foundation damage.

### **Proximity to Utilities**

Designers should ensure that future tree canopy growth in the bioretention area will not interfere with existing overhead utility lines. When large site development is undertaken the expectation of achieving avoidance will be high. Conflicts may be commonplace on smaller sites and in the PROW. Consult with each utility company on recommended offsets, which will allow utility maintenance work with minimal disturbance to the bioretention system. Where conflicts cannot be avoided, follow these guidelines:

- ⑦ Consider altering the location or sizing of the bioretention to avoid or minimize the utility conflict. Consider an alternate BMP type to avoid conflict.
- ⑦ Use design features to mitigate the impacts of conflicts that may arise by allowing the bioretention and the utility to coexist. The bioretention design may need to incorporate impervious areas, through geotextiles or compaction, to protect utility crossings.
- ⑦ Work with the utility to evaluate the relocation of the existing utility and install the optimum placement and sizing of the bioretention.



- ⑦ If utility functionality, longevity, and vehicular access to manholes can be assured, accept the bioretention design and location with the existing utility. Incorporate into the bioretention design sufficient soil coverage over the utility or general clearances or other features such as an impermeable liner to assure all entities the conflict is limited to maintenance.

When accepting utility conflict into the bioretention location and design, it is understood the bioretention will be temporarily impacted during utility work but the utility owner will replace the bioretention or, alternatively, install a functionally comparable bioretention according to the specifications in the current version of this Manual. If the bioretention is located in the PROW, the bioretention restoration will also conform with the State of South Carolina Department of Transportation design specifications.

### **Minimizing External Impacts**

Urban bioretention practices may be subject to higher public visibility, greater trash loads, pedestrian traffic, vandalism, and even vehicular loads. Designers should design these practices in ways that prevent, or at least minimize, such impacts. In addition, designers should clearly recognize the need to perform frequent landscaping maintenance to remove trash, check for clogging, and maintain vigorous vegetation. The urban landscape context may feature naturalized landscaping or a more formal design. When urban bioretention is used in sidewalk areas of high foot traffic, designers should not impede pedestrian movement or create a safety hazard. Designers may also install low fences, grates, or other measures to prevent damage from pedestrian short-cutting across the practices.

When bioretention will be included in public rights-of-way or spaces, design manuals and guidance developed by agencies or organizations other than Beaufort County Public Works Department may also apply (e.g., State Department of Transportation).

### **Economic Considerations**

Bioretention areas can be particularly cost effective when they are included in areas of the site already planned for landscaping.

#### **4.3.2 Bioretention Conveyance Criteria**

There are two basic design approaches for conveying runoff into, through, and around bioretention practices:

1. Off-line: Flow is split or diverted so that only the design storm or design flow enters the bioretention area. Larger flows bypass the bioretention treatment.
2. On-line: All runoff from the CDA flows into the practice. Flows that exceed the design capacity exit the practice via an overflow structure or weir.

If runoff is delivered by a storm drain pipe or is along the main conveyance system, the bioretention area should be designed off-line so that flows do not overwhelm or damage the practice.

### **Off-line Bioretention**

Overflows are diverted from entering the bioretention cell. Optional diversion methods include the following:

- Create an alternate flow path at the inflow point into the structure such that when the maximum ponding depth is reached, the incoming flow is diverted past the facility. In this case, the higher

flows do not pass over the filter bed and through the facility, and additional flow is able to enter as the ponding water filters through the filter media. With this design configuration, an overflow structure in the bioretention area is not required.

- Utilize a low-flow diversion or flow splitter at the inlet to allow only the design storm volume (i.e., the SWRV) to enter the facility (calculations must be made to determine the peak flow from the 85<sup>th</sup> or 95<sup>th</sup> percentile storm). This may be achieved with a weir, curb opening, or orifice for the target flow, in combination with a bypass channel or pipe. Using a weir or curb opening helps minimize clogging and reduces the maintenance frequency. With this design configuration, an overflow structure in the bioretention area is required (see on-line bioretention below).

### **On-line Bioretention**

An overflow structure must be incorporated into on-line designs to safely convey larger storms through the bioretention area (see Figure 4.6). The following criteria apply to overflow structures:

- An overflow shall be provided within the practice to pass storms greater than the design storm storage to a stabilized water course. A portion of larger events may be managed by the bioretention area so long as the maximum depth of ponding in the bioretention cell does not exceed 18 inches.
- The overflow device must convey runoff to a storm sewer, stream, or the existing stormwater conveyance infrastructure, such as curb and gutter or an existing channel.
- Common overflow systems within bioretention practices consist of an inlet structure, where the top of the structure is placed at the maximum ponding depth of the bioretention area, which is typically 6 to 18 inches above the surface of the filter bed.
- The overflow device should be scaled to the application. This may be a landscape grate or yard inlet for small practices or a commercial-type structure for larger installations.
- Sufficient depth must be provided between the top of the overflow device and the top of the bioretention area to ensure that the 25-year storm can be safely conveyed through the overflow device.
- The overflow associated with the 2- to 25-year design storms must be controlled so that velocities are non-erosive (generally less than 6 feet per second) at the outlet point, to prevent downstream erosion.

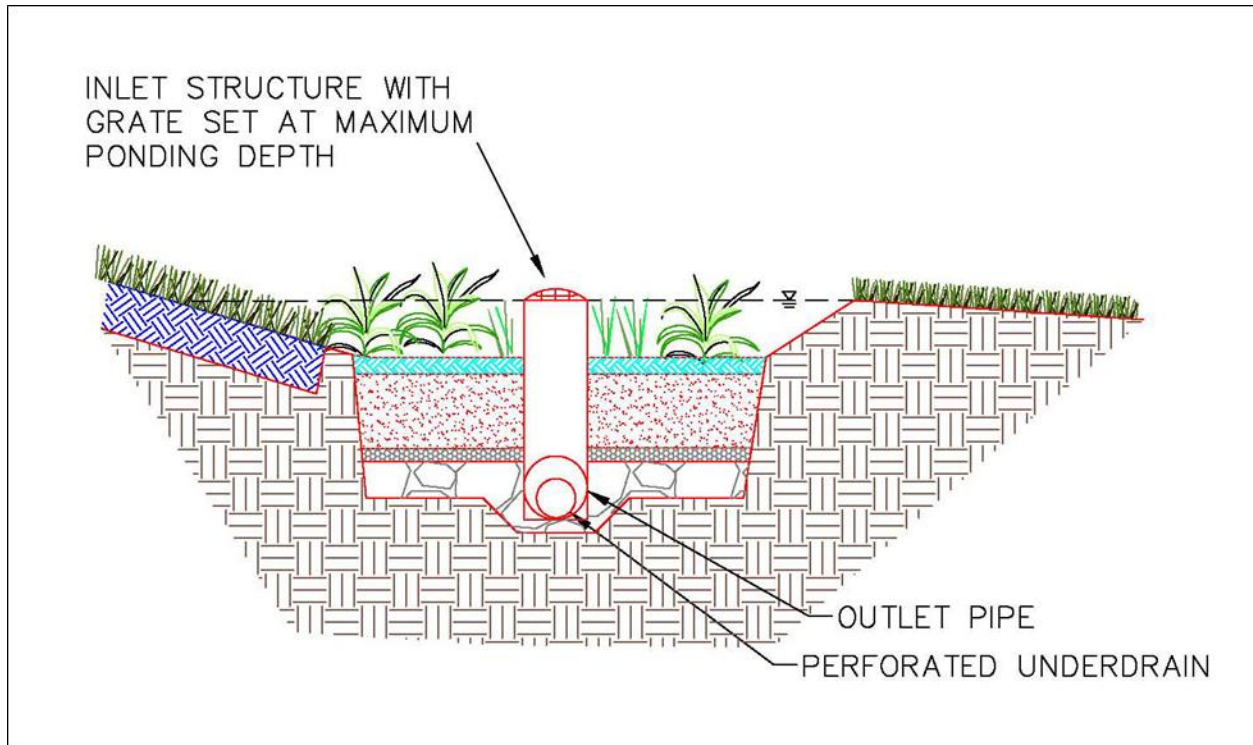


Figure 4.6. Example design of an on-line bioretention with an overflow structure.

#### 4.3.3 Bioretention Pretreatment Criteria

Pretreatment of runoff entering bioretention areas is necessary to trap coarse sediment particles before they reach and prematurely clog the filter bed. Pretreatment measures must be designed to evenly spread runoff across the entire width of the bioretention area. Several pretreatment measures are feasible, depending on the type of the bioretention practice and whether it receives sheet flow, shallow concentrated flow, or deeper concentrated flows. The following are appropriate pretreatment options:

##### **Standard Bioretention (B-1)**

- **Pretreatment Cells** (for channel flow). Similar to a forebay, this cell is located at piped inlets or curb cuts leading to the bioretention area and consists of an energy dissipator sized for the expected rates of discharge. It has a storage volume equivalent to at least 15% of the total storage volume (inclusive) with a recommended 2:1 length-to-width ratio. The cell may be formed by a wooden or stone check dam or an earthen or rock berm. Pretreatment cells do not need underlying engineered filter media, in contrast to the main bioretention cell. However, if the volume of the pretreatment cell will be included as part of the bioretention storage volume, the pretreatment cell must de-water between storm events. It cannot have a permanent ponded volume.
- **Grass Filter Strips** (for sheet flow). Grass filter strips that are perpendicular to incoming sheet flow extend from the edge of pavement, with a slight drop at the pavement edge, to the bottom of the bioretention basin at a 5H:1V slope or flatter. Alternatively, if the bioretention basin has side slopes that are 3H:1V or flatter, a 5-foot grass filter strip can be used at a maximum 5% (20H:1V) slope.
- **Stone Diaphragms** (for sheet flow). A stone diaphragm located at the edge of the pavement should be oriented perpendicular to the flow path to pretreat lateral runoff, with a 2- to 4-inch drop from

the pavement edge to the top of the stone. The stone must be sized according to the expected rate of discharge.

- **Gravel or Stone Flow Spreaders** (for concentrated flow). The gravel flow spreader is located at curb cuts, downspouts, or other concentrated inflow points, and should have a 2- to 4-inch elevation drop from a hard-edged surface into a gravel or stone diaphragm. The gravel must extend the entire width of the opening and create a level stone weir at the bottom or treatment elevation of the basin.
- **Filter System** (see Section 4.10 Filtering Systems). If using a filter system as a pretreatment facility, the filter will not require a separate pretreatment facility.
- **Innovative or Proprietary Structure**. An approved proprietary structure with demonstrated capability of reducing sediment and hydrocarbons may be used to provide pretreatment. Refer to Section 0 Proprietary Practices for information on approved proprietary structures.

Other pretreatment options may be appropriate, but they must trap coarse sediment particles and evenly spread runoff across the entire width of the bioretention area.

### **Small-Scale Bioretention (B-2, B-3, B-4, and B-5)**

- **Leaf Screens**. A leaf screen serves as part of the gutter system to keep the heavy loading of organic debris from accumulating in the bioretention cell.
- **Pretreatment Cells** (for channel flow). Pretreatment cells are located above ground or covered by a manhole or grate. Pretreatment cells are atypical in small-scale bioretention and are not recommended for residential rain gardens (B-5).
- **Grass Filter Strips** (for sheet flow). Grass filter strips are applied on residential lots, where the lawn area can serve as a grass filter strip adjacent to a rain garden.
- **Stone Diaphragm** (for either sheet flow or concentrated flow). The stone diaphragm at the end of a downspout or other concentrated inflow point should run perpendicular to the flow path to promote settling.

Note: stone diaphragms are not recommended for school settings.

- **Trash Racks** (for either sheet flow or concentrated flow). Trash racks are located between the pretreatment cell and the main filter bed or across curb cuts to allow trash to collect in specific locations and make maintenance easier.

### **4.3.4 Bioretention Design Criteria**

#### **Design Geometry**

Bioretention basins must be designed with an internal flow path geometry such that the treatment mechanisms provided by the bioretention are not bypassed or short-circuited. So that the bioretention area to have an acceptable internal geometry, the travel time from each inlet to the outlet should be maximized by locating the inlets and outlets as far apart as possible. In addition, incoming flow must be distributed as evenly as possible across the entire filter surface area.

#### **Inlets and Energy Dissipation**

Where appropriate, the inlet(s) to streetscape bioretention (B-2), engineered tree boxes (B-3), and stormwater planters (B-4) should be stabilized using No. 3 stone, splash block, river stone, or other acceptable energy dissipation measures. The following types of inlets are recommended:

- ❑ Downspouts to stone energy dissipators.
- ❑ Sheet flow over a depressed curb with a 3-inch drop.
- ❑ Curb cuts allowing runoff into the bioretention area.
- ❑ Covered drains that convey flows across sidewalks from the curb or downspouts.
- ❑ Grates or trench drains that capture runoff from a sidewalk or plaza area.
- ❑ Drop structures that appropriately dissipate water energy.

Inlets must be designed with sufficient width and slope to avoid unintended bypass. This is of particular concern for curb cuts on streetscape bioretention designs.

### **Ponding Depth**

The recommended surface ponding depth is 6 to 12 inches. Minimum surface ponding depth is 3 inches (averaged over the surface area of the BMP). Ponding depths can be increased to a maximum of 18 inches. However, when higher ponding depths are utilized, the design must consider carefully issues such as safety, fencing requirements, aesthetics, the viability and survival of plants, and erosion and scour of side slopes. This is especially true where bioretention areas are built next to sidewalks or other areas where pedestrians or bicyclists travel. Shallower ponding depths (typically 6 to 12 inches) are recommended for streetscape bioretention (B-2), engineered tree boxes (B-3), and stormwater planters (B-4).

### **Side Slopes**

Traditional bioretention areas (B-1) and residential rain gardens (B-5) should be constructed with side slopes of 3H:1V or flatter. In space-constrained areas, a drop curb design or a precast structure can be used to create a stable, vertical side wall. These drop curb designs should not exceed a vertical drop of more than 12 inches, unless safety precautions, such as railings, walls, grates, etc. are included.

### **Filter Media**

The filter media of a bioretention practice consists of an engineered soil mixture that has been carefully blended to create a filter media that maintains long-term permeability while also providing enough nutrients to support plant growth. The final filter media shall consist of a well-blended mixture of medium to coarse **sand**, **loam soil**, and an **organic amendment** (compost). The sand maintains the desired permeability of the media while the limited amount of loam soil and organic amendments are considered adequate to help support initial plant growth. It is anticipated that the gradual increase of organic material through natural processes will continue to support plant growth without the need to add fertilizer, and the root structure of maturing plants and the biological activity of the media will maintain sufficient long-term permeability.

The following is the recommended composition of the three media ingredients:

- **Sand (Fine Aggregate).** Sand should consist of silica-based medium to coarse sand and be angular or round in shape. The materials shall not be derived from serpentine, shall be free of surface coatings or any other deleterious materials, and shall contain less than 0.5% mica by weight when tested with ASTM C295, Standard Guide for Petrographic Examination of Aggregates for Concrete.

ASTM C-33 concrete sand will typically meet the requirements for the sand to be used in filter media. However, some samples of ASTM C-33 sand may have too high a fraction of fine sand and silt- and clay-sized particles to meet the final filter media particle size distribution requirements. In general, coarser gradations of ASTM C-33 will better meet the filter media particle size distribution and hydraulic conductivity requirements.

Any other materials, such as manufactured sand, limestone-based sands, or crushed glass, shall meet the required particle size distribution (of final filter media mixture) and be demonstrated as adequately durable when tested by AASHTO T-103 or T-104.

- **Loam Soil.** Loam soil is generally defined as the combination of sand-sized material, fines (silt and clay), and any associated soil organic matter. Since the objective of the specification is to carefully establish the proper blend of these ingredients in the final filter media, the designer (or contractor or materials supplier) must carefully select the topsoil source material so as not exceed the amount of any one ingredient.

Generally, a natural loamy sand, sandy loam, or loam (per the USDA Textural Triangle) A-horizon topsoil free of subsoil, large stones, earth clods, sticks, stumps, clay lumps, roots, viable noxious weed seed, plant propagules, brush, or other objectionable, extraneous matter or debris is suitable for the loam soil source material.

- **Organic Amendments.** Organic amendments shall consist of stable, well-composted, natural, carbon-containing organic materials such as leaf mulch, peat moss, humus, or yard waste (consistent with the material specifications found in Appendix C Soil Compost Amendment Requirements). The material shall be free of debris such as plastics, metal, concrete, stones larger than ½ inch, larger branches and roots, and wood chips over 1 inch in length or diameter.

### **Complete Filter Media**

The complete filter media shall consist of a pug milled or mechanically blended mix of the three source materials. Mixing the filter media on site with excavation or loading equipment is not sufficient to achieve the required blending. The resulting filter media must meet the following particle size composition:

- 80%–90% sand
- 10%–20% silt and clay
- ☐ Maximum 10% clay

The particle size analysis must be conducted on the mineral fraction only or following **appropriate treatments to remove organic matter before particle size analysis. Note: The above percentages are based on weight rather than volume.**

**Additionally, the final filter media mix must either meet the grain size distribution indicated in Table 4.4, or have a saturated hydraulic conductivity of 2 to 6 inches per hour according to test procedure ASTM D2434 when compacted (at 60% to 80% optimum moisture content) to a minimum of 86% of the maximum density as determined by AASHTO T 99 (ASTM, 2006).**

Table 4.4. Filter media grain size distribution.

Sieve Type	Particle Size (mm)	Percent Passing (%)
-	8.0	100
No. 5	4.0	92–100
No. 10	2.0	72–100
No. 18	1.0	43–95
No. 35	0.5	20–65
No. 60	0.25	11–37
No. 140	0.105	10–25
No. 270	0.053	10–20
-	0.002	0–10

The filter media shall also meet the following criteria (see summary in Table 4.5):

- ☐ Organic content shall be between 3.0% and 5.0% by weight;
- ☐ pH shall be between 6.0 and 7.5;
- ☐ Cation exchange capacity (CEC) shall be a minimum of 5 meq/100g or cmol+/kg;
- ☐ Phosphorus content shall meet one of the following:
  - P-Index between 10 and 30;
  - 15 mg/kg Mehlich I Extraction;
  - 18 to 40 mg/kg Mehlich III Extraction; and
- ☐ Soluble salts shall be less than 500 ppm or less than 0.5 mmhos/cm.

Notes:

1. P-Index is an agronomic test used in North Carolina to indicate the potential for P leaching from soil. The test method has been revised to add P concentration to facilitate local lab testing. The value of the P-Index is the correlation between the CEC and P concentrations: higher CEC indicates greater adsorption sites within the media, thus increasing the ability to fix P within the soil, thereby allowing higher P concentrations without leaching. While P-Index may be a better overall representation of P, the test method may not be readily available.

Tests for organic content, CEC, soluble salts, and pH are referenced to be in accordance with Recommended Soil Testing Procedures from the Southeastern United States, Current Edition, Southern Cooperative Series Bulletin No. 419. Use the following tests from Southern Cooperative Series Bulletin No. 419:

- (a) Test for soil content by loss of weight on ignition
- (b) Test for soil CEC by exchangeable acidity method
- (c) Test for soluble salts shall be by the 1:2 (v:v) soil:water Extract Method
- (d) Test for pH by the SMP method

Table 4.5. Summary of filter media criteria for bioretention.

Filter Media Criterion	Description	Standard(s)
General Composition	Filter media must have the proper proportions of sand, loam soil, and organic amendments to promote plant growth, drain at the proper rate, and filter pollutants.	80%–90% sand; 10%–20% soil fines; maximum of 10% clay; and 3%–5% organic content  Must meet final filter media grain size distribution OR have a saturated hydraulic conductivity of 2–6 inches per hour
Sand	Medium to coarse aggregate	Based on final filter media grain size distribution
Loam Soil	Loamy sand, sandy loam, or loam	USDA Textural Triangle
Organic Amendments	Stable, well-composted, natural, carbon-containing organic materials such as leaf mulch, peat moss, humus, or yard waste.	Appendix C
P-Index or Phosphorus (P) Content	Filter media with high P levels will export P through the media and potentially to downstream conveyances or receiving waters.	P-Index of 10–30 or P content = 5–15 mg/kg (Mehlich I) or 18–40 mg/kg (Mehlich III)
Cation Exchange Capacity (CEC)	The CEC is determined by the amount of soil fines and organic matter. Higher CEC will promote pollutant removal.	CEC > 5 milliequivalents per 100 grams
pH	Soil pH influences nutrient availability and microbial populations.	Between 6.0 and 7.5
Soluble Salts	Filter media with high levels of soluble salts can injure or kill plants.	Less than 500 ppm or less than 0.5 mmhos/cm.

In cases where greater removal of specific pollutants is desired, additives with documented pollutant removal benefits, such as water treatment residuals, alum, iron, or other materials, may be included in the filter media if accepted by Beaufort County Public Works Department.

### **Filter Media Depth**

The filter media bed depth must be a minimum of 18 inches for the No Underdrain or Standard designs. The media depth must be 24 inches or greater for the IWS design **In order to receive the full credit for bacteria removal a minimum media depth of 24” is required.** The media depth must not exceed 6.0



feet. Turf, perennials, or shrubs should be used instead of trees to landscape shallower filter beds. See Table 4.7 and Table 4.8 for a list of recommended native plants.

### **Surface Cover**

Mulch is the recommended surface cover material, but other materials may be substituted, as described below:

- **Mulch.** A 2- to 3-inch layer of mulch on the surface of the filter bed enhances plant survival, suppresses weed growth, pretreats runoff before it reaches the filter media, and prevents rapid evaporation of rainwater. Shredded hardwood bark mulch, aged for at least 6 months, is recommended/required for surface cover, as it retains a significant amount of pollutants and typically will not float away. The maximum depth of the mulch layer is 3 inches.
- **Alternative to Mulch Cover.** In some situations, designers may consider alternative surface covers, such as turf, native groundcover, erosion control matting (e.g., coir or jute matting), river stone, or pea gravel. The decision regarding the type of surface cover to use should be based on function, expected pedestrian traffic, cost, and maintenance. When alternative surface covers are used, methods to discourage pedestrian traffic should be considered. Stone or gravel are not recommended in parking lot applications, since they increase soil temperature and have low water-holding capacity.
- **Media for Turf Cover.** One adaptation suggested for use with turf cover is to design the filter media primarily as a sand filter with organic content only at the top. Compost, as specified in Appendix C Soil Compost Amendment Requirements, tilled into the top layers will provide organic content for the vegetative cover. If grass is the only vegetation, the ratio of organic matter in the filter media composition may be reduced.

### **Choking Layer**

A 2- to 4-inch layer of choker stone (e.g., typically ASTM D448 No. 8 or No. 89 washed gravel) should be placed beneath the filter media and over the underdrain stone.

### **Geotextile**

If the available head is limited, or the depth of the practice is a concern, geotextile fabric may be used in place of the choking layer. An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements, and has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability must be used. Geotextile fabric may be used on the sides of bioretention areas as well.

### **Underdrains**

Many bioretention designs will require an underdrain (see Section 4.3.1 Bioretention Feasibility Criteria). The underdrain should be a 4- or 6-inch perforated schedule 40 PVC pipe, or equivalent corrugated HDPE for small bioretention BMPs, with three or four rows of 3/8-inch perforations at 6 inches on center. The underdrain must be encased in a layer of clean, double washed ASTM D448 No.57 or smaller (No. 68, 8, or 89) stone. The maximum depth of the underdrain stone layer combined with the choking layer is 12 inches, and it cannot extend beyond the surface dimensions of the bioretention filter media. The underdrain must be sized so that the bioretention BMP fully drains within 72 hours or less.

Multiple underdrains may be necessary for bioretention areas wider than 40 feet, and each underdrain is recommended to be located no more than 20 feet from the next pipe or the edge of the bioretention.

For long and narrow applications, a single underdrain running the length of the bioretention is sufficient. Each underdrain must include a cleanout pipe (minimum 4 inches in diameter).

All bioretention practices should include at least one observation well and/or cleanout pipe (minimum 4 inches in diameter). The observation wells should be tied into any of the Ts or Ys in the underdrain system and must extend upward above the surface of the bioretention area.

### **Internal Water Storage (IWS)**

In cases where limited head is a site constraint and the bioretention must be designed to be relatively shallow (e.g., depth to groundwater, relatively flat sites, or other factors), or where increased nitrogen removal is desired, an internal water storage design that creates an infiltration sump below the underdrain can be used. The internal water storage zone may be created by an upturned elbow in the underdrain, a weir in the outlet structure, or other means that create a permanently saturated depth above the underdrain. The internal water storage zone must be kept at least 12 inches below the surface of the bioretention area. For more information on this design consult North Carolina Stormwater Design Manual Chapter C-2. (NCDEQ, 2017)

### **Observation Wells**

All bioretention practices must include at least one observation well consisting of a well-anchored, 4- to 6-inch diameter PVC pipe (see Figure 4.7). For standard and IWS bioretention designs, the non-perforated observation wells should be tied into any of the Ts or Ys in the underdrain system and must extend upward above the ponding level. These observation wells can also double as cleanouts. Observation wells for bioretention designs without underdrains should be perforated in the gravel layer only and also must extend upward to the top of ponding.

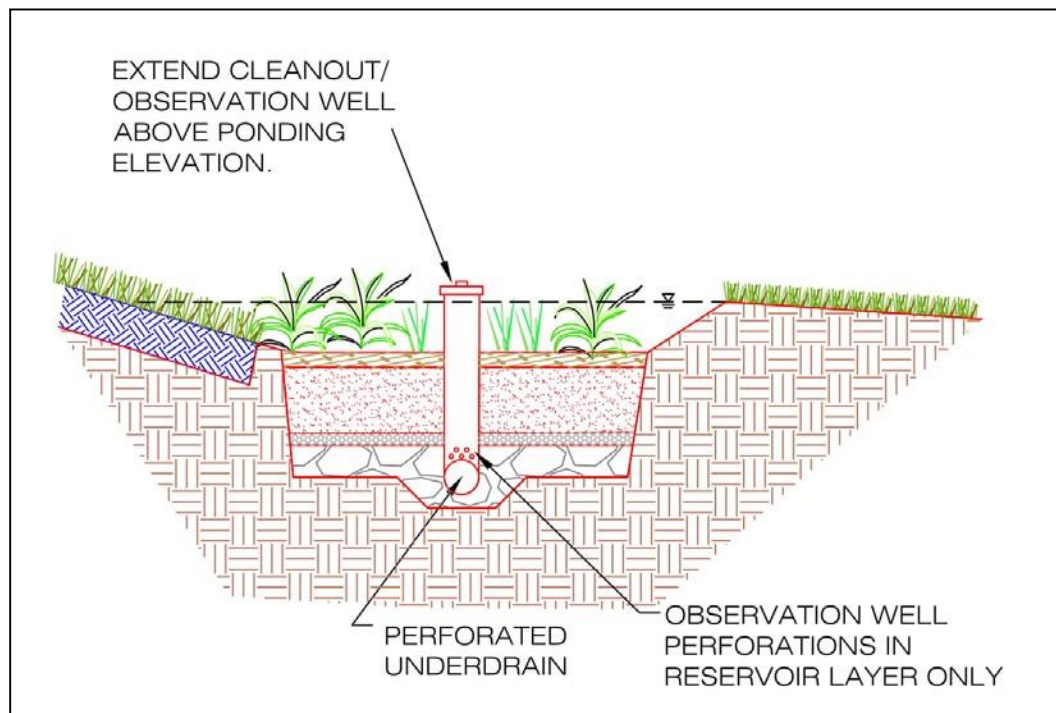


Figure 4.7. Example design of a bioretention with an observation well/cleanout device.

**Underground Storage Layer (optional)**

For IWS bioretention designs, an underground storage layer consisting of chambers, perforated pipe, stone, or other acceptable material can be incorporated below the filter media layer and underdrain to increase the storage for larger storm events. Unlike the underdrain stone layer, this storage layer can be extended beyond the surface dimensions of the bioretention filter media if additional storage volume is needed. The underground storage layer may be designed to provide detention for the 2- to 25-year, or 100-year storms, as needed. The depth and volume of the storage layer will depend on the target storage volumes needed to meet the applicable detention criteria. Suitable conveyance must also be provided to ensure that the storage is fully utilized without overflow of the bioretention area.

**Impermeable Liner (optional)**

An impermeable liner is not typically required, although it may be utilized for Standard designs in fill applications where deemed necessary by a geotechnical investigation, on sites with contaminated soils, or on the sides of the practice to protect adjacent structures from seepage. Use a PVC geomembrane liner or equivalent of an appropriate thickness (follow manufacturer's instructions for installation). Field seams must be sealed according to the liner manufacturer's specifications. A minimum 6-inch overlap of material is required at all seams.

**Material Specifications**

Recommended material specifications for bioretention areas are shown in Table 4. 6.

Table 4.6. Bioretention material specifications.

Material	Specification	Notes
Filter Media	<ul style="list-style-type: none"> <li>See Table 4.5 and Table 4.6</li> </ul>	Minimum depth of 24 inches (18 inches for standard design). To account for settling/compaction, it is recommended that 110% of the plan volume be utilized.
Mulch Layer	Use aged, shredded hardwood bark mulch	Lay a 2- to 3-inch layer on the surface of the filter bed.
Alternative Surface Cover	Use river stone or pea gravel, coir and jute matting, or turf cover.	Lay a 2- to 3-inch layer of to suppress weed growth.
Topsoil for Turf Cover	Loamy sand or sandy loam texture, with less than 5% clay content, pH corrected to between 6 and 7, and an organic matter content of at least 2%.	3-inch tilled into surface layer.
Geotextile or Choking Layer	An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability must be used	Can use in place of the choking layer where the depth of the practice is limited. Geotextile fabric may be used on the sides of bioretention areas as well.
	Lay a 2- to 4-inch layer of choker stone (e.g., typically No.8 or No.89 washed gravel) over the underdrain stone.	
Underdrain Stone	1-inch diameter stone must be double-washed and clean and free of all fines (e.g., ASTM D448 No. 57 or smaller stone).	At least 2 inches above and below the underdrain.
Storage Layer (optional)	To increase storage for larger storm events, chambers, perforated pipe, stone, or other acceptable material can be incorporated below the filter media layer.	
Impermeable Liner (optional)	Where appropriate, use a PVC Geomembrane liner or equivalent material of an appropriate thickness.	
Underdrains, Cleanouts, and Observation Wells	Use 4- or 6-inch rigid schedule 40 PVC pipe, or equivalent corrugated HDPE for small bioretention BMPs, with three or four rows of 3/8-inch perforations at 6 inches on center. Multiple underdrains may be necessary for bioretention areas wider than 40 feet, and each underdrain is recommended to be located no more than 20 feet from the next pipe or the edge of the bioretention.	Lay the perforated pipe under the length of the bioretention cell and install non-perforated pipe as needed to connect with the storm drain system or to daylight in a stabilized conveyance. Install T's and Y's as needed, depending on the underdrain configuration. Extend cleanout pipes to the surface of ponding.
Plant Materials	See Section 4.3.5 Bioretention Landscaping Criteria	Establish plant materials as specified in the landscaping plan and the recommended plant list.

## **Signage**

Bioretention units in highly urbanized areas should be stenciled or otherwise permanently marked to designate it as a structural BMP. The stencil or plaque should indicate (1) its water quality purpose, (2) that it may pond briefly after a storm, and (3) that it is not to be disturbed except for required maintenance.

## **Specific Design Issues for Streetscape Bioretention (B-2)**

Streetscape bioretention is installed in the road right-of-way either in the sidewalk area or in the road itself. In many cases, streetscape bioretention areas can also serve as traffic-calming or street-parking control devices. The basic design adaptation is to move the raised concrete curb closer to the street or in the street, and then create inlets or curb cuts that divert street runoff into depressed vegetated areas within the right-of-way. Roadway stability can be a design issue where streetscape bioretention practices are installed. Designers should consult design standards pertaining to roadway drainage. It may be necessary to provide an impermeable liner on the road-side of the bioretention area to keep water from saturating the road's sub-base. Streetscape bioretention in the PROW should comply with State Department of Transportation requirements, where applicable.

## **Specific Design Issues for Engineered Tree Boxes (B-3)**

Engineered tree boxes are installed in the sidewalk zone near the street where urban street trees are normally installed (see Figure 4.8). The soil volume for the tree pit is increased and used to capture and treat stormwater. Treatment is increased by using a series of connected tree planting areas together in a row. The surface of the enlarged planting area may be mulch, grates, permeable pavers, or conventional pavement. The large and shared rooting space and a reliable water supply increase the growth and survival rates in this otherwise harsh planting environment. Engineered tree boxes in the PROW should comply with State Department of Transportation requirements, where applicable.

When designing engineered tree boxes, the following criteria may apply.

- ⑦ Engineered tree box designs sometimes cover portions of the filter media with pervious pavers or cantilevered sidewalks (see Figure 4.9). In these situations, the following design considerations must be incorporated:
  - The filter media must be connected beneath the surface so that stormwater and tree roots can share this space.
  - As with all bioretention areas, a minimum surface ponding depth of 3 inches, averaged over the surface area of the bioretention area, is required. For example, if the additional surface area under the pavement doubles the overall surface area, then the ponding depth will need to be at least 6 inches.
  - Sand based structural soil (SBSS) may be considered as bioretention filter media if it meets the same phosphorus content limits. However, if the SBSS is to be compacted beyond the State Standards' maximum compaction for bioretention, it shall be assigned a porosity of 0.10. The State Standards call for bioretention soil to be compacted to 84% maximum dry density while SBSS is to be compacted to 93%.
- ⑦ Installing an engineered tree pit grate over filter bed media is one possible solution to prevent pedestrian traffic and trash accumulation.

- ❑ Low, wrought iron fences can help restrict pedestrian traffic across the tree pit bed and serve as a protective barrier if there is a drop-off from the pavement to the micro-bioretentation cell.
- ❑ A removable grate may be used to allow the tree to grow through it.
- ❑ Each tree needs a minimum rootable soil volume as described in Section 4.14.12 Tree Planting and Preservation.
- ❑ See Section 4.14.2 Planting Trees for further guidance and requirements on tree planting.

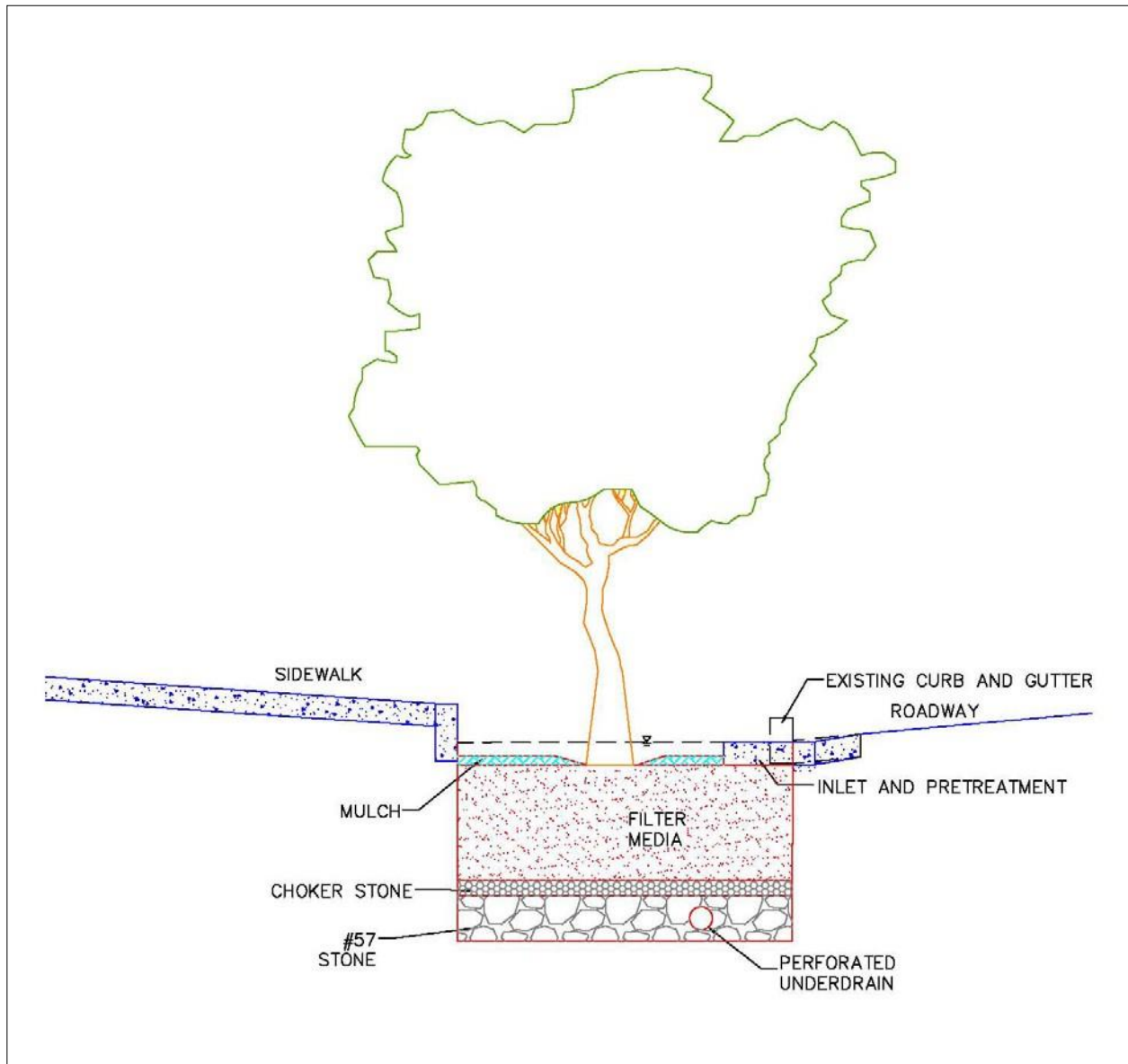


Figure 4.8. Example design of a tree box.

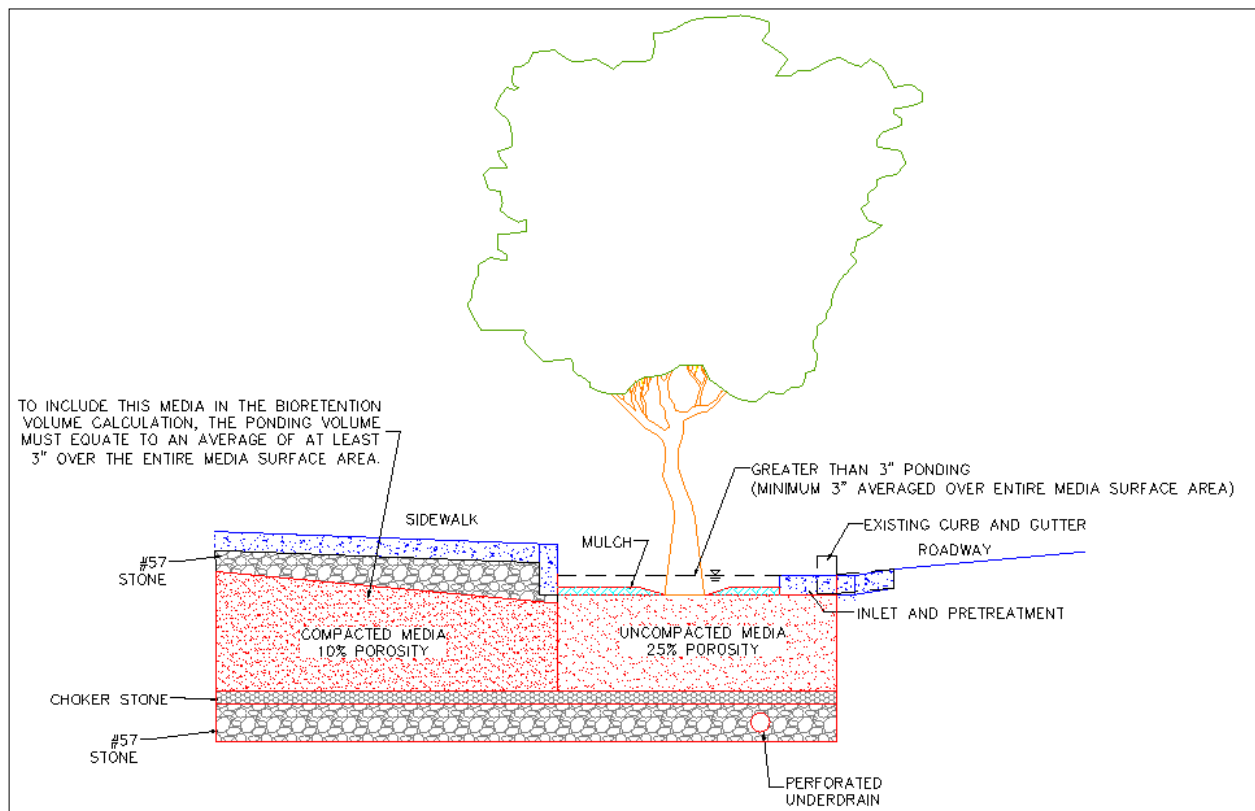


Figure 4.9. Example design of a tree box with compacted media extending below sidewalk.

#### **Specific Design Issues for Stormwater Planters (B-4)**

Stormwater planters are a useful option to disconnect and treat rooftop runoff, particularly in ultra-urban areas. Stormwater planters combine an aesthetic landscaping feature with a functional form of stormwater treatment. Stormwater planters generally receive runoff from adjacent rooftop downspouts and are landscaped with plants that tolerate periods of both drought and inundation. The two basic design variations for stormwater planters are the infiltration planter and the filter planter. A filter planter is illustrated in Figure 4.10.

An infiltration planter filters rooftop runoff through soil in the planter followed by infiltration into soils below the planter. Infiltration planters should be placed at least 10 feet away from a building to prevent possible flooding or basement seepage damage.

A filter planter does not allow for infiltration and is constructed with a watertight concrete shell or an impermeable liner on the bottom to prevent seepage. Since a filter planter is self-contained and does not infiltrate into the ground, it can be installed right next to a building. Runoff is captured and temporarily ponded above the planter bed. Overflow pipes are installed to discharge runoff when maximum ponding depths are exceeded, to avoid water spilling over the side of the planter. In addition, an underdrain is used to carry runoff to the storm sewer system.

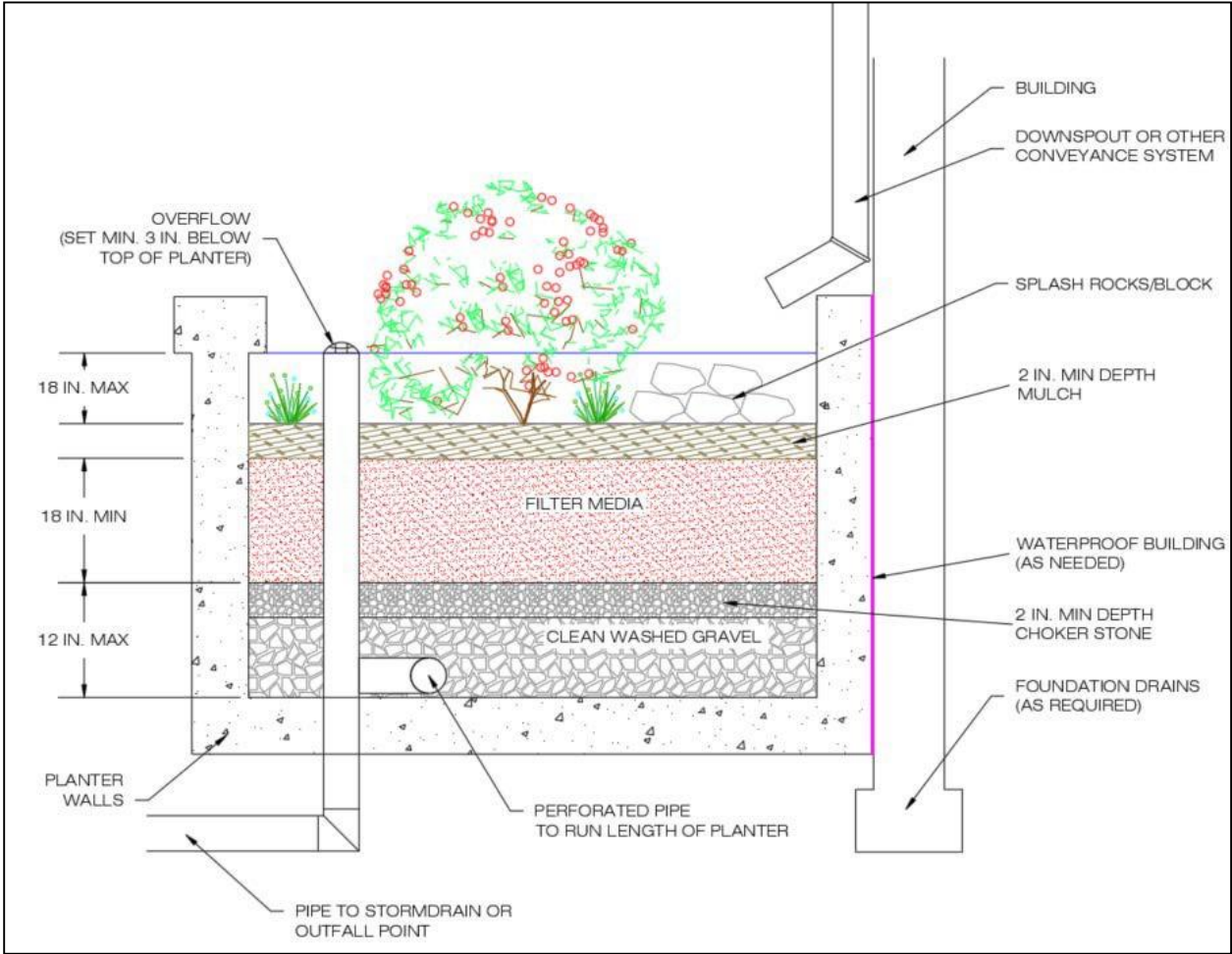


Figure 4.10. Example design of a stormwater planter (B-4).

Plant materials must be capable of withstanding moist and seasonally dry conditions. The planter can be constructed of stone, concrete, brick, wood, or other durable material. If treated wood is used, care should be taken so that trace metals and creosote do not leach out of the planter.

### **Specific Design Issues for Residential Rain Gardens (B-5)**

For some residential applications, front, side, and/or rear yard bioretention may be an attractive option. This form of bioretention captures roof, lawn, and driveway runoff from low- to medium- density residential lots in a depressed area (i.e., 6 to 12 inches) between the home and the primary stormwater conveyance system (i.e., roadside ditch or pipe system).

## **BMP Sizing**

Bioretention is typically sized to capture the SWRV or larger design storm volumes in the surface ponding area, filter media, and gravel reservoir layers of the BMP.

Total storage volume of the BMP is calculated using Equation 4.1.



Equation 4.1. Bioretention storage volume.

$$S_v = SA_{\text{bottom}} \times d_{\text{media}} \times \eta_{\text{media}} + d_{\text{gravel}} \times \eta_{\text{gravel}} + (SA_{\text{average}} \times d_{\text{ponding}})$$

Where:

- $S_v$  = Total storage volume of bioretention (cubic feet)  
 $SA_{\text{bottom}}$  = Bottom surface area of bioretention (square feet)  
 $d_{\text{media}}$  = Depth of filter media, including mulch later (ft)  
 $\eta_{\text{media}}$  = Effective porosity of the filter media (typically 0.25)  
 $d_{\text{gravel}}$  = Depth of the underdrain and underground storage gravel layer, including choker stone (ft)  
 $\eta_{\text{gravel}}$  = Effective porosity of the gravel layer (typically 0.4)  
 $SA_{\text{average}}$  = Average surface area of the bioretention (square feet), where  $SA_{\text{top}}$  is the surface area of the top of the bioretention

$$SA_{\text{average}} = \frac{SA_{\text{bottom}} + SA_{\text{top}}}{2}$$

- $d_{\text{ponding}}$  = Maximum ponding depth of bioretention (ft)

Equation 4.1 can be modified if the storage depths of the filter media, gravel layer, or ponded water vary in the actual design or with the addition of any surface or subsurface storage components (e.g., additional area of surface ponding, subsurface storage chambers, etc.). The maximum depth of ponding in the bioretention must not exceed 18 inches. If storage practices will be provided off-line or in series with the bioretention area, the storage practices should be sized using the guidance in Section 4.11, and section 4.9 Storage Practices.

Note: In order to increase the storage volume of a bioretention area, the ponding surface area may be increased beyond the filter media surface area. However, the top surface area of the practice (i.e., at the top of the ponding elevation) may not be more than twice the size of the surface area of the filter media ( $SA_{\text{bottom}}$ ).

For bioretention designs without an underdrain, the storage volume must infiltrate within 72 hours, as in Equation 4.2.

Equation 4.2. Bioretention infiltration rate check equation.

$$S_{v_{\text{infiltrate}}} = \frac{SA_{\text{bottom}}(K_{\text{sat}} \times t_d)}{12}$$

$S_{v_{\text{infiltrate}}}$ =	Storage volume that will infiltration within 72 hours (cubic feet)
$SA_{\text{bottom}}$ =	Bottom surface area of bioretention (square feet)
$K_{\text{sat}}$ =	Field-verified saturated hydraulic conductivity for the native soils (ft/day)
$t_d$ =	Drawdown time (3 days)

If  $S_{v_{infiltrate}}$  is greater than or equal to  $S_v$ , then the entire  $S_v$  will infiltrate within 72 hours. If it is not, the storage volume of the bioretention area should be reduced accordingly.

Bioretention can be designed to address, in whole or in part, the detention storage needed to comply with channel protection and/or flood control requirements. The  $S_v$  can be counted as part of the 2- to 25-year runoff volumes to satisfy stormwater quantity control requirements.

#### 4.3.5 Bioretention Landscaping Criteria

Landscaping is critical to the performance and function of bioretention areas. Therefore, a landscaping plan shall be provided for bioretention areas.

Minimum plan elements include the proposed bioretention template to be used, delineation of planting areas, and the planting plan including the following:

- ☐ Common and botanical names of the plants used
- ☐ Size of planted materials
- ☐ Mature size of the plants
- ☐ Light requirements
- ☐ Maintenance requirements
- ☐ Source of planting stock
- ☐ Any other specifications
- ☐ Planting sequence

It is recommended that the planting plan be prepared by a qualified landscape architect professional (e.g., licensed professional landscape architect, certified horticulturalist) to tailor the planting plan to the site-specific conditions.

Native plant species are preferred over non-native species, but some ornamental species may be used for landscaping effect if they are not aggressive or invasive. Some popular native species that work well in bioretention areas and are commercially available can be found in Table 4.7 and Table 4.8.

The degree of landscape maintenance that can be provided will determine some of the planting choices for urban bioretention areas. Plant selection differs if the area will be frequently mowed, pruned, and weeded, in contrast to a site that will receive minimum annual maintenance. In areas where less maintenance will be provided and where trash accumulation in shrubbery or herbaceous plants is a concern, consider a “turf and trees” landscaping model where the turf is mowed along with other turf areas on the site. Spaces for herbaceous flowering plants can be included.

Table 4.7. Bioretention-appropriate plants: perennial and grass

Scientific Name	Common Name	Wetland Indicator <sup>1</sup>	Inundation Tolerance	Salt Tolerance	Notes
<i>Aletris farinosa</i>	White Colicroot	FAC	Moist soil	None	
<i>Andropogon gerardii</i>	Big Bluestem	FAC	No	Moderate	
<i>Aquilegia canadensis</i>	Wild Columbine	FACU	No	None	
<i>Asclepias incarnata</i>	Swamp Milkweed	OBL	Saturated	None	
<i>Asclepias lanceolata</i>	Red Milkweed	OBL	Wet soils	Moderate / brackish	
<i>Aster novae-angliae</i>	New England Aster	FACW	Moist soils, yes	Yes	
<i>Athyrium filix-femina</i>	Lady Fern	FAC	Moist to wet soils	None	
<i>Canna glauca</i>	Water Canna	OBL	Moist to wet soils	None	
<i>Canna flaccida</i>	Golden Canna	OBL	Moist to wet soils	None	
<i>Carex stricta</i>	Tussock Sedge	OBL	Saturated, 0-6"	None	
<i>Chasmanthium latifolium</i>	River Oats	FAC	Moist soils	None	
<i>Chelone glabra</i>	White Turtlehead	OBL	Moist to wet soils		
<i>Conoclinium coelestinum</i>	Blue Mistflower	FAC	Moist to Wet soils		
<i>Crinum americanum</i>	Southern Swamp Lily	OBL	Saturated		
<i>Dulichium arundinaceum</i>	Threeway Sedge	OBL	Saturated, shallow	None	
<i>Echinodorus cordifolius</i>	Creeping Burhead	OBL	Saturated, shallow		
<i>Equisetum hyemale</i>	Scouring Rush	FACW	Saturated, shallow		
<i>Eupatorium fistulosum</i>	Joe Pye Weed	FACW	Moist to Wet Soils		
<i>Geranium maculatum</i>	Spotted Geranium	FACU	Moist Soils		

Scientific Name	Common Name	Wetland Indicator <sup>1</sup>	Inundation Tolerance	Salt Tolerance	Notes
<i>Helianthus angustifolius</i>	Swamp Sunflower, Narrowleaf Sunflower	FACW	Wet Soils		
<i>Hibiscus coccineus</i>	Scarlet Swamp Hibiscus	OBL	Saturated, shallow		
<i>Hibiscus moscheutos</i>	Rose Mallow, Hibiscus	OBL	Saturated, shallow	Low	
<i>Hymenocallis caroliniana</i>	Spider Lily	OBL	Saturated, shallow	None	
<i>Iris versicolor</i>	Virginia Iris	OBL	Shallow	None	
<i>Juncus effuses</i>	Common Rush	OBL	Shallow <6"	Low	
<i>Liatis spicata</i>	Gayfeather, Blazing Star	FAC	Moist Soils	Low	
<i>Lobelia cardinalis</i>	Cardinal Flower	FACW	Moist to Wet Soils	None	
<i>Lobelia siphilitica</i>	Blue Lobelia	OBL	Moist to wet soils		
<i>Lysimachia ciliata</i>	Fringed Loosestrife	FACW	Moist to wet soils, seasonal flooding		
<i>Mimulus ringens</i>	Allegheny Monkeyflower	OBL	Saturated, shallow		
<i>Onoclea sensibilis</i>	Sensitive Fern	FACW	Moist to wet soils		
<i>Osmunda cinnamomea</i>	Cinnamon Fern	FACW	Moist to wet soils	Low	
<i>Osmunda spectabilis</i>	Royal Fern	OBL	Moist to wet soils	None	
<i>Orontium aquaticum</i>	Golden Club	OBL	Up to 10"		
<i>Panicum virgatum</i>	Switch Grass	FAC	Moist soil	Moderate	
<i>Peltandra virginica</i>	Green Arrow Arum	OBL	Shallow < 1'	Low (< 2 ppt)	
<i>Pontederia cordata</i>	Pickernelweed	OBL	Shallow < 1'	Low (< 3 ppt)	
<i>Physostegia virginiana</i>	Obedient Plant	FACW	Moist soil		
<i>Polygonatum biflorum</i>	Great Solomon's Seal	FACU	Moist soil		

Scientific Name	Common Name	Wetland Indicator <sup>1</sup>	Inundation Tolerance	Salt Tolerance	Notes
<i>Rhynchospora colorata</i>	Starrush Whitetop	FACW	Saturated		
<i>Rudbeckia laciniata</i>	Cutleaf Coneflower	FACW	Moist soil	None	
<i>Sagittaria latifolia</i>	Common Arrowhead, Duck Potato	OBL	Up to 2.0'	None	
<i>Saururus cernuus</i>	Lizard's Tail	OBL	Shallow < 4"	None	
<i>Schizachyrium scoparium</i>	Little Bluestem	FACU	Moist soil	None	
<i>Schoenoplectus tabernaemontani</i>	Softstem Bulrush	OBL	Wet soil to standing water	Fresh or Brackish	
<i>Solidago sempervirens</i>	Seaside Goldenrod	FACW	Yes	High	
<i>Sorghastrum nutans</i>	Indiangrass	FACU	Moist soil	Moderate	
<i>Spartina alterniflora</i>	Saltmarsh Cordgrass	OBL	Yes	High	
<i>Spartina bakeri</i>	Sand cordgrass	FACW	Moist to wet soils	Fresh - Saline	
<i>Spartina patens</i>	Saltmeadow Cordgrass	FACW	Wet soils	High	
<i>Thalia dealbata</i>	Powdery Alligator-flag	OBL	up to 1.5'	Yes	
<i>Tradescantia virginiana</i>	Virginia Spiderwort	FAC	Moist soils	None	
<i>Vernonia noveboracensis</i>	Ironweed	FACW	Moist soils	None	

1. Wetland Indicator Notes:

FAC = Facultative, equally likely to occur in wetlands or non-wetlands (estimated probability 34%–66%).

FACU = Facultative Upland, usually occurs in non-wetlands (estimated probability 67%–99%), but occasionally found on wetlands (estimated probability 1%–33%).

FACW = FACW Facultative Wetland, usually occurs in wetlands (estimated probability 67%–99%), but occasionally found in non-wetlands.

OBL = Obligate Wetland, occurs almost always (estimated probability 99%) under natural conditions in wetlands

Table 4.8. Bioretention-appropriate plants: shrubs and bushes

Scientific Name	Common Name	Wetland Indicator <sup>1</sup>	Inundation Tolerance	Salt Tolerance	Notes
<i>Baccharis halimifolia</i>	Groundsel Tree, Salt Myrtle	FAC	Wet soils	High	
<i>Callicarpa americana</i>	Beautyberry	FACU	Moist soils	None	
<i>Cephalanthus occidentalis</i>	Button Bush	OBL	Up to 3 ft	Low	
<i>Clethra alnifolia</i>	Summersweet Sweet Pepperbush	FACW	Moist to wet soils	None	
<i>Cyrilla racemiflora</i>	Swamp Titi	FACW	Moist to wet soils	Low	
<i>Hamamelis virginiana</i>	Witch Hazel	FACU	Moist to wet soils	None	
<i>Hypericum prolificum</i>	Shrubby St. John's Wort	FAC	Moist soils, flood tolerant	None	
<i>Ilex glabra</i>	Inkberry	FACW	Wet soils, flood tolerant	Moderate	
<i>Ilex verticillata</i>	Winterberry Holly	FACW	Moist to wet soils	None	
<i>Ilex vomitoria</i>	Yaupon Holly	FAC	Moist soils	Moderate	
<i>Itea virginica</i>	Virginia Sweetspire	FACW	Moist to wet soils	None	
<i>Kosteletzkya virginica</i>	Seashore Mallow	OBL	Moist to wet soils	Moderate	
<i>Lindera benzoin</i>	Spicebush	FACW	Seasonal inundation	None	
<i>Myrica cerifera</i>	Wax Myrtle	FAC	Moist to wet soils	Moderate	
<i>Photinia pyrifolia</i>	Red Chokeberry	FACW	Moist soils	Low	
<i>Rhododendron canescens</i>	Dwarf Azalea	FACW	Moist soils	None	
<i>Rhododendron viscosum</i>	Swamp Azalea	OBL	Wet soil	None	
<i>Rosa carolina</i>	Carolina Rose	FACU	Moist to wet soils	Moderate	
<i>Sabal minor</i>	Dwarf Palmetto	FACW	Moist to wet soils	None	
<i>Sambucus canadensis</i>	Elderberry	FACW	Moist to wet soils	None	

Scientific Name	Common Name	Wetland Indicator <sup>1</sup>	Inundation Tolerance	Salt Tolerance	Notes
<i>Serenoa repens</i>	Saw Palmetto	FACU	Occasionally wet	None	
<i>Vaccinium corymbosum</i>	Highbush Blueberry	FACW	Wet soil	High	
<i>Viburnum dentatum</i>	Arrowwood	FAC	Moist to wet	None	

1. Wetland Indicator Notes:

FAC = Facultative, equally likely to occur in wetlands or non-wetlands (estimated probability 34%–66%).

FACU = Facultative Upland, usually occurs in non-wetlands (estimated probability 67%–99%), but occasionally found on wetlands (estimated probability 1%–33%).

FACW = FACW Facultative Wetland, usually occurs in wetlands (estimated probability 67%–99%), but occasionally found in non-wetlands.

OBL = Obligate Wetland, occurs almost always (estimated probability 99%) under natural conditions in wetlands.

Planting recommendations for bioretention facilities are as follows:

- The primary objective of the planting plan is to cover as much of the surface areas of the filter bed as quickly as possible. Herbaceous or ground cover layers are as or more important than more widely spaced trees and shrubs.
- Native plant species should be specified over non-native species.
- Plants should be selected based on a specified zone of hydric tolerance and must be capable of surviving both wet and dry conditions (“Wet footed” species should be planted near the center, whereas upland species do better planted near the edge).
- Woody vegetation should not be located at points of inflow; trees should not be planted directly above underdrains but should be located closer to the perimeter.
- Shrubs and herbaceous vegetation should generally be planted in clusters and at higher densities (i.e., 5 feet on-center and 1 to 1.5 feet on-center, respectively).
- If trees are part of the planting plan, a tree density of approximately one tree per 250 square feet (i.e., 15 feet on-center) is recommended.
- Designers should also remember that planting holes for trees must be at least 3 feet deep to provide enough soil volume for the root structure of mature trees. This applies even if the remaining filter media layer is shallower than 3 feet.
- Tree species should be those that are known to survive well in the compacted soils and the polluted air and water of an urban landscape.
- If trees are used, plant shade-tolerant ground covers within the dripline.

#### 4.3.6 Bioretention Construction Sequence

##### **Soil Erosion and Sediment Controls**

The following soil erosion and sediment control guidelines must be followed during construction:

- All bioretention areas must be fully protected by silt fence or construction fencing.
- Bioretention areas intended to infiltrate runoff must remain outside the limits of disturbance during construction to prevent soil compaction by heavy equipment and loss of design infiltration rate.
  - Where it is infeasible keep the proposed bioretention areas outside of the limits of disturbance, there are several possible remedies for the impacted area. If excavation in the proposed bioretention area can be restricted, then the remediation can be achieved with deep tilling practices. This is only possible if in situ soils are not disturbed any deeper than 2 feet above the final design elevation of the bottom of the bioretention. In this case, when heavy equipment activity has ceased, the area is excavated to grade, and the impacted area must be tilled to a depth of 12 inches below the bottom of the bioretention.
  - Alternatively, if it is infeasible to keep the proposed bioretention areas outside of the limits of disturbance, and excavation of the area cannot be restricted, then infiltration tests will be required prior to installation of the bioretention to ensure that the design infiltration rate is still present. If tests reveal the loss of design infiltration rates, then deep tilling practices may be used in an effort to restore those rates. In this case further testing must be done to establish design rates exist before the bioretention area can be installed.
  - Finally, if it is infeasible to keep the proposed bioretention areas outside of the limits of disturbance, excavation of the area cannot be restricted, and infiltration tests reveal design rates cannot be restored, then a resubmission of the SWMP will be required.
- Bioretention areas must be clearly marked on all construction documents and grading plans.
- Large bioretention applications may be used as small sediment traps or basins during construction. However, these must be accompanied by notes and graphic details on the soil erosion and sediment control plan specifying that:
  - (1) the maximum excavation depth of the trap or basin at the construction stage must be at least 1 foot higher than the post-construction (final) invert (bottom of the facility), and
  - (2) the facility must contain an underdrain.

The plan must also show the proper procedures for converting the temporary sediment control practice to a permanent bioretention BMP, including dewatering, cleanout, and stabilization.

##### **Bioretention Installation**

The following is a typical construction sequence to properly install a bioretention basin. These steps may be modified to reflect different bioretention applications or expected site conditions:

#### **1. Stabilize Contributing Drainage Area**

Construction of the bioretention area may only begin after the entire CDA has been stabilized with vegetation. It may be necessary to block certain curb or other inlets while the bioretention area is being constructed. The proposed site should be checked for existing utilities prior to any excavation.



## **2. Preconstruction Meeting**

The designer, the installer, and Beaufort County Public Works Department inspector may have a preconstruction meeting, checking the boundaries of the CDA and the actual inlet elevations to ensure they conform to original design. Since other contractors may be responsible for constructing portions of the site, it is quite common to find subtle differences in site grading, drainage and paving elevations that can produce hydraulically important differences for the proposed bioretention area. The designer should clearly communicate, in writing, any project changes determined during the preconstruction meeting to the installer and the inspector. Material certifications for aggregate, filter media, and any geotextiles should be submitted for approval to the inspector at the preconstruction meeting.

## **3. Install Soil Erosion and Sediment Control Measures to Protect the Bioretention**

Temporary soil erosion and sediment controls (e.g., diversion dikes, reinforced silt fences) are needed during construction of the bioretention area to divert stormwater away from the bioretention area until it is completed. Special protection measures, such as erosion control fabrics, may be needed to protect vulnerable side slopes from erosion during the construction process.

## **4. Install Pretreatment Cells**

Any pretreatment cells should be excavated first and then sealed to trap sediment.

## **5. Avoid Impact of Heavy Installation Equipment**

Excavators or backhoes should work from the sides to excavate the bioretention area to its appropriate design depth and dimensions. Excavating equipment should have scoops with adequate reach so they do not have to sit inside the footprint of the bioretention area. Contractors should use a cell construction approach in larger bioretention basins, whereby the basin is split into 500- to 1,000-square foot temporary cells with a 10- to 15-foot earth bridge in between, so that cells can be excavated from the side.

## **6. Promote Infiltration Rate**

It may be necessary to rip the bottom soils to a depth of 6 to 12 inches to promote greater infiltration.

## **7. Order of Materials**

If using a geotextile fabric, place the fabric on the sides of the bioretention area with a 6-inch overlap on the sides. If a stone storage layer will be used, place the appropriate depth of No. 57 stone (clean, double washed) on the bottom, install the perforated underdrain pipe, pack No. 57 stone at least 2 inches above the underdrain pipe, and add the choking layer or appropriate geotextile layer as a filter between the underdrain and the filter media layer. If no stone storage layer is used, start with at least 2 inches of No. 57 stone on the bottom and proceed with the layering as described above.

## **8. Layered Installation of Media**

Apply the media in 12-inch lifts until the desired top elevation of the bioretention area is achieved. Wait a few days to check for settlement and add additional media, as needed, to achieve the design elevation.

Note: The batch receipt confirming the source of the filter media should be submitted to the Beaufort County Public Works Department inspector.

## 9. Prepare Filter Media for Plants

Prepare planting holes for any trees and shrubs, install the vegetation, and water accordingly. Install any temporary irrigation.

## 10. Planting

Install the plant materials as shown in the landscaping plan, and water them as needed.

## 11. Secure Surface Area

Place the surface cover (i.e., mulch, river stone, or turf) in both cells, depending on the design. If coir or jute matting will be used in lieu of mulch, the matting will need to be installed prior to planting (Step 10), and holes or slits will have to be cut in the matting to install the plants.

## 12. Inflows

If curb cuts or inlets are blocked during bioretention installation, unblock these after the CDA and side slopes have good vegetative cover. It is recommended that unblocking curb cuts and inlets take place after two to three storm events if the CDA includes newly installed asphalt, since new asphalt tends to produce a lot of fines and grit during the first several storms.

## 13. Final Inspection

Conduct the final construction inspection using a qualified professional, providing Beaufort County Public Works Department with an as-built, then log the GPS coordinates for each bioretention facility, and submit them for entry into the maintenance tracking database.

## 14. Construction Supervision

Supervision during construction is recommended to ensure that the bioretention area is built in accordance with the approved design and this specification. Qualified individuals should use detailed inspection checklists that include sign-offs at critical stages of construction, to ensure that the contractor's interpretation of the plan is consistent with the designer's intentions.

Construction phase inspection checklist can be found in Appendix E Construction Inspection Checklists.

### 4.3.7 Bioretention Maintenance Criteria

When bioretention practices are installed, it is the owner's responsibility to ensure they, or those managing the practice:

- (1) be educated about their routine maintenance needs,
- (2) understand the long-term maintenance plan, and
- (3) be subject to a maintenance covenant or agreement, as described below.

Maintenance of bioretention areas should be integrated into routine landscape maintenance tasks. If landscaping contractors will be expected to perform maintenance, their contracts should contain specifics on unique bioretention landscaping needs, such as maintaining elevation differences needed for ponding, proper mulching, sediment and trash removal, and limited use of fertilizers and pesticides.

Maintenance tasks and frequency will vary depending on the size and location of the bioretention, the landscaping template chosen, and the type of surface cover in the practice. A generalized summary of common maintenance tasks and their frequency is provided in Table 4.9.

Table 4.9. Typical maintenance tasks for bioretention practices.

Frequency	Maintenance Tasks
Upon establishment	<ul style="list-style-type: none"> <li>For the first 6 months following construction, the practice and CDA should be inspected at least twice after storm events that exceed 0.5 inch of rainfall. Conduct any needed repairs or stabilization.</li> <li>Inspectors should look for bare or eroding areas in the CDA or around the bioretention area and make sure they are immediately stabilized with grass cover.</li> <li>One-time, spot fertilization may be needed for initial plantings.</li> <li>Watering is needed once a week during the first 2 months, and then as needed during first growing season (April through October), depending on rainfall.</li> <li>Remove and replace dead plants. Up to 10% of the plant stock may die off in the first year, so construction contracts should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction.</li> </ul>
At least 4 times per year	<ul style="list-style-type: none"> <li>Mow grass filter strips and bioretention with turf cover</li> <li>Check curb cuts and inlets for accumulated grit, leaves, and debris that may block inflow</li> </ul>
Twice during growing season	<ul style="list-style-type: none"> <li>Spot weed, remove trash, and rake the mulch</li> </ul>
Annually	<ul style="list-style-type: none"> <li>Conduct a maintenance inspection</li> <li>Supplement mulch in devoid areas to maintain a 3-inch layer</li> <li>Prune trees and shrubs</li> <li>Remove sediment in pretreatment cells and inflow points</li> </ul>
Once every 2–3 years	<ul style="list-style-type: none"> <li>Remove sediment in pretreatment cells and inflow points</li> <li>Remove and replace the mulch layer</li> </ul>
As needed	<ul style="list-style-type: none"> <li>Add reinforcement planting to maintain desired vegetation density</li> <li>Remove invasive plants using recommended control methods</li> <li>Remove any dead or diseased plants</li> <li>Stabilize the CDA to prevent erosion</li> </ul>

Standing water is the most common problem outside of routine maintenance. If water remains on the surface for more than 72 hours after a storm, adjustments to the grading may be needed or underdrain repairs may be needed. The surface of the filter bed should also be checked for accumulated sediment or a fine crust that builds up after the first several storm events. There are several methods that can be used to rehabilitate the filter. These are listed below, starting with the simplest approach and ranging to more involved procedures (i.e., if the simpler actions do not solve the problem):

- Open the underdrain observation well or cleanout and pour in water to verify that the underdrains are functioning and not clogged or otherwise in need of repair. The purpose of this check is to see if there is standing water all the way down through the soil. If there is standing water on top, but not in the underdrain, then there is a clogged soil layer. If the underdrain and stand pipe indicates standing water, then the underdrain must be clogged and will need to be cleaned out.
- Remove accumulated sediment and till 2 to 3 inches of sand into the upper 6 to 12 inches of soil.

- Install sand wicks from 3 inches below the surface to the underdrain layer. This reduces the average concentration of fines in the media bed and promotes quicker drawdown times. Sand wicks can be installed by excavating or auguring (i.e., using a tree auger or similar tool) down to the top of the underdrain layer to create vertical columns that are then filled with a clean open-graded coarse sand material (e.g., ASTM C-33 concrete sand or similar approved sand mix for bioretention media). A sufficient number of wick drains of sufficient dimension should be installed to meet the design dewatering time for the facility.
- Remove and replace some or all of the filter media.

### **Maintenance Inspections**

It is recommended that a qualified professional: state law states anyone that can stamp a set of plans (surveyors, engineers, landscape architects) conduct a spring maintenance inspection and cleanup at each bioretention area. Maintenance inspections should include information about the inlets, the actual bioretention facility (sediment buildup, outlet conditions, etc.), and the state of vegetation (water stressed, dead, etc.) and are intended to highlight any issues that need or may need attention to maintain stormwater management functionality. Reporting to the Beaufort County Public Works Department may be required to be submitted on an annual basis.

Maintenance inspection checklists for bioretention areas and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

### **Waste Material**

Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### **4.3.8 Bioretention Stormwater Compliance Calculations**

Bioretention performance varies depending on the design configuration of the system.

### **No Underdrain**

Bioretention designs with no underdrain are credited with 100% retention for the storage volume (Sv) provided by the practice as well as 100% TSS, TN, and bacteria removal (Table 4.10).

Table 4.10. Retention and pollutant removal for bioretention practices without underdrains.

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

### **Internal Water Storage (IWS)**

Bioretention designs with IWS are credited with 75% retention for the storage volume (Sv) provided by the practice as well as 85% TSS, 85% TN, and 80% bacteria removal (Table 4.11).

Table 4.11. Retention and pollutant removal for bioretention practices with IWS design.

Retention	= 75%
TSS Removal	= 85%
TN Removal	= 85%
Bacteria Removal	= 80%

**Standard**

Standard bioretention designs are credited with 60% retention for the storage volume (Sv) provided as well as 85% TSS, 75% TN, and 80% bacteria removal. (Table 4.12).

Table 4.12. Retention and pollutant removal for standard bioretention practices.

Retention	= 60%
TSS Removal	= 85%
TN Removal	= 75%
Bacteria Removal	= 80%

The practice must be sized using the guidance detailed in Section 4.1.4 Bioretention Design Criteria.

Note: Additional retention can be achieved if trees are utilized as part of a bioretention area (see Section 4.14 Tree Planting and Preservation).

Bioretention also contributes to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume (Sv) from the total runoff volume for the 2-year through the 100-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

#### 4.4 Permeable Pavement Systems

Permeable Pavement Systems				
<b>Definition:</b> Paving systems that capture and temporarily store the SWRv by filtering runoff through voids in an alternative pavement surface into an underlying stone reservoir. Filtered runoff may be collected and returned to the conveyance system or allowed to partially (or fully) infiltrate into the soil.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		80-100%	45-100%	30-100%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
High	High	Moderate		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	Standard Design		Enhanced Design
2-4 times per year	Every 2-3 years	30%		100%
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Reduces runoff volume, attenuates peak runoff rate and outflow</li><li>▪ Reduces slick surfaces during rain</li><li>▪ Water quality enhancement from filtration of stormwater</li></ul>		<ul style="list-style-type: none"><li>▪ Sediment-laden runoff can clog pervious pavement, causing it to fail</li><li>▪ Incorrect installation practices can clog pores</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Open graded pavement mix or pavers with open surfaces</li><li>▪ Bedding course</li><li>▪ Open-graded base material</li><li>▪ Underdrain (where required)</li><li>▪ Subgrade with minimal compaction</li></ul>		<ul style="list-style-type: none"><li>▪ Same basic considerations as any paved area</li><li>▪ Infiltration rate of native soil determines applicability and need for underdrain</li><li>▪ Depth to seasonal high water table must be at least 6 inches below bottom of practice</li><li>▪ Not appropriate for heavy or high traffic areas</li><li>▪ Accessibility, aesthetics, maintainability</li></ul>		
Installation Considerations		Maintenance Activities		
<ul style="list-style-type: none"><li>▪ Proper construction sequencing and installation is crucial to ensure proper functioning</li><li>▪ Subgrade cannot be overly compacted</li></ul>		<ul style="list-style-type: none"><li>▪ Vacuum or jet wash to increase pavement life and avoid clogging</li><li>▪ Ensure that contributing area is clear of debris and sediment.</li></ul>		

<sup>1</sup>Credited pollutant load removal

Permeable pavement systems represent alternative paving surfaces that capture and temporarily store the design volume by filtering runoff through voids in the pavement surface into an underlying stone reservoir (see Figure 4.11). Filtered runoff may be collected and returned to the conveyance system, or it may be allowed to infiltrate into the soil.

Permeable pavement systems may also provide stormwater detention of larger storms (e.g., 2- to 25-year).

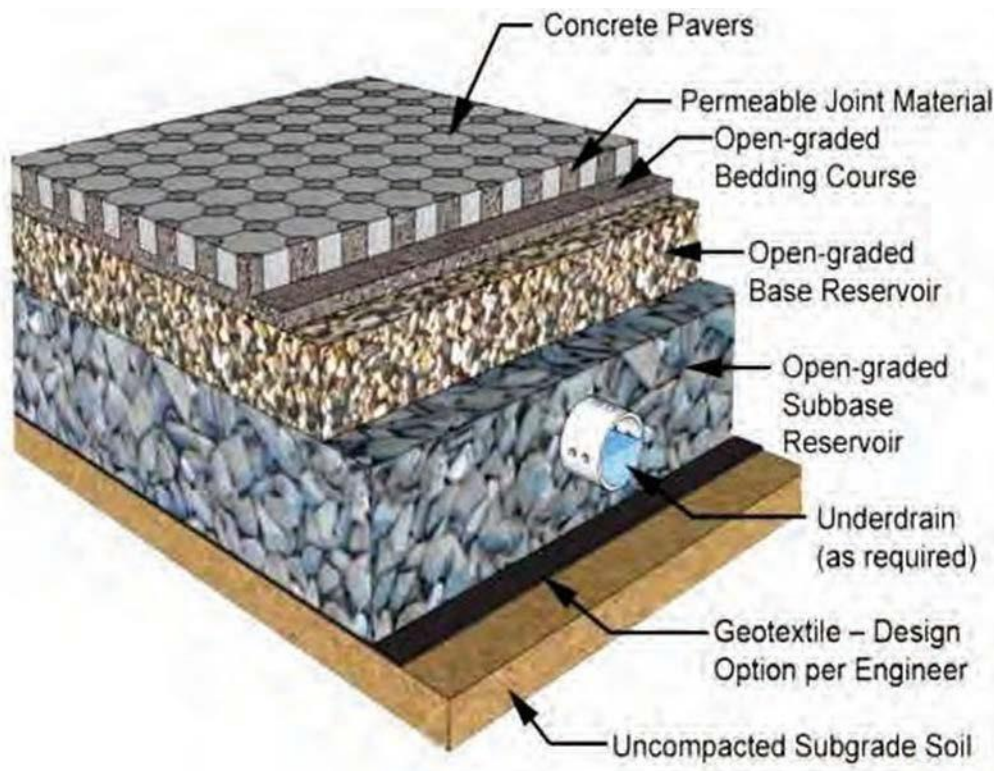


Figure 4.11. Cross-section of permeable pavement (source: ICPI).

### **Definition**

This is a paving system that captures and temporarily stores the SWRV by filtering runoff through voids in an alternative pavement surface into an underlying stone reservoir. Filtered runoff may be collected and returned to the conveyance system or allowed to infiltrate into the soil.

Design variants include the following:

- P-1 Porous asphalt (PA)
- P-2 Pervious concrete (PC)
- P-3 Permeable pavers (PP)

Other surface material variations of permeable pavement that can be part of a permeable pavement system, such as porous rubber, plastic grid pavers, and synthetic turf systems are also encompassed in this section.

### **Porous Asphalt**

Porous asphalt (also known as pervious asphalt) consists of a special open-graded surface course bound together by asphalt cement. The open-graded surface course in a typical porous asphalt installation is 3 to 7 inches thick and has a void ratio of between 15% and 20%. Porous asphalt is thought to have a limited ability to maintain its structure and permeability during hot summer months and, consequently,

is currently not recommended for use in coastal South Carolina. If it is used on a development site in the coastal region, it should be carefully monitored and maintained over time.

### **Pervious Concrete**

Pervious concrete (also known as porous concrete) is similar to conventional concrete in structure and form but consists of a special open-graded surface course, typically 4 to 8 inches thick, that is bound together with Portland cement. This open-graded surface course has a void ratio of 15% to 25% (conventional concrete pavement has a void ratio of between 3% and 5%), which gives it a high permeability that is often many times more than that of the underlying native soils, and allows rainwater and stormwater runoff to rapidly pass through it and into the underlying stone reservoir. Although this particular type of permeable pavement surface may not require an underlying base layer to support traffic loads, site planning and design teams may wish to provide it to increase the stormwater storage capacity provided by a pervious concrete system.

### **Permeable Pavers**

Permeable pavers (PP) are solid structural units (e.g., blocks, bricks) that are installed in a way that provides regularly spaced openings through which stormwater runoff can rapidly pass through the pavement surface and into the underlying stone reservoir. The regularly spaced openings, which generally make up between 8% and 20% of the total pavement surface, are typically filled with pea gravel (i.e., ASTM D 448 Size No. 8, 3/8 inch to 1/8 inch). Typical PP systems consist of the pavers, a 1.5- to 3-inch thick fine gravel bedding layer and an underlying stone reservoir.

### **Design Configurations**

There are two types of permeable pavement design configurations:

- **Standard Design**  
Practice with a standard underdrain design and no infiltration sump or water quality filter (see Figure 4.12).
- **Enhanced Design**  
Practice with underdrains that contain a water quality filter layer and an infiltration sump beneath the underdrain sized to drain the design storm in 48 hours (see Figure 4.13) or practices with no underdrains that can infiltrate the entire design storm volume in 48 hours (see Figure 4.14).

The particular design configuration to be implemented on a site is typically dependent on specific site conditions and the characteristics of the underlying soils. These criteria are further discussed below.

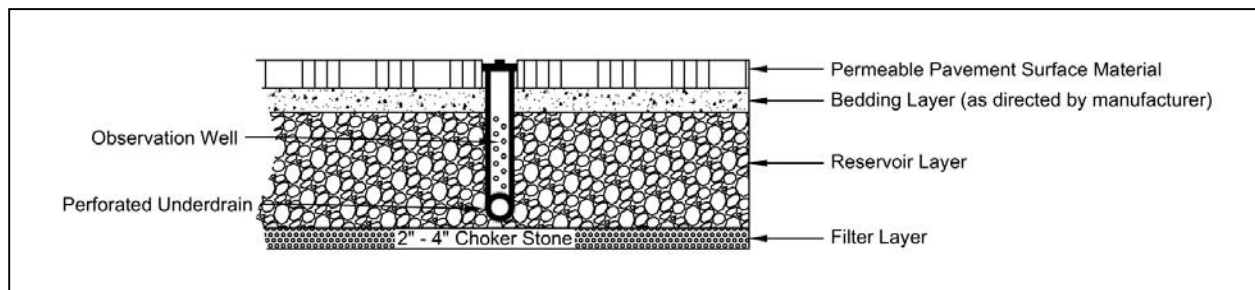


Figure 4.12. Cross-section of a standard permeable pavement design.



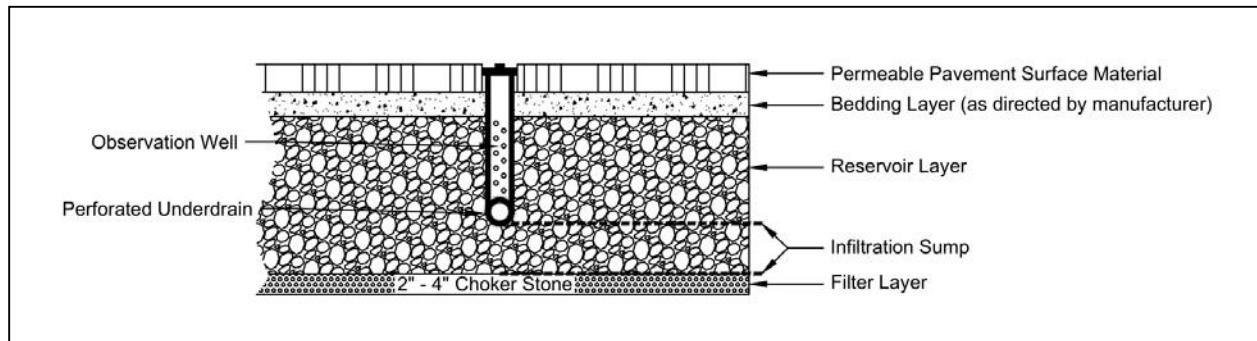


Figure 4.13. Cross-section of an enhanced permeable pavement design with an underdrain.

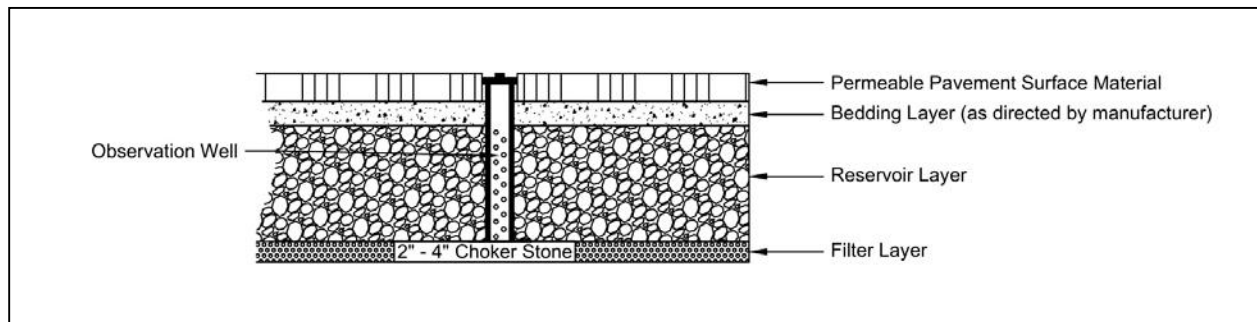


Figure 4.14. Cross-section of an enhanced permeable pavement design without an underdrain.

#### 4.4.1 Permeable Pavement Feasibility Criteria

Since permeable pavement has a very high retention capability, it should always be considered as an alternative to conventional pavement. Permeable pavement is subject to the same feasibility constraints as most infiltration practices, as described below.

##### Required Space

A prime advantage of permeable pavement is that it does not normally require additional space at a new development or redevelopment site, which can be important for tight sites or areas where land prices are high.

##### Soils

Soil conditions do not typically constrain the use of permeable pavement, although they do determine whether an underdrain is needed. Underdrains may be required if the measured permeability of the underlying soils is less than 0.5 inches per hour (although utilization of an infiltration sump may still be feasible). When designing an infiltrating permeable pavement practice, designers must verify soil

permeability by using the on-site soil investigation methods provided in Appendix B Geotechnical Information Requirements for Underground BMPs. Impermeable soils will require an underdrain.

In fill soil locations, geotechnical investigations are required to determine if the use of an impermeable liner and underdrain are necessary or if the use of an infiltration sump is permissible (see Section 4.4.4 Permeable Pavement Design Criteria).

### **Contributing Drainage Area**

The portion of the CDA that does not include the permeable pavement may not exceed 5 times the surface area of the permeable pavement (2 times is recommended) and it should be as close to 100% impervious as possible to reduce sediment loading.

### **Pavement Surface Slope**

Steep pavement surface slopes can reduce the stormwater storage capability of permeable pavement and may cause shifting of the pavement surface and base materials. The permeable pavement slope must be less than 5%. Designers may consider using a terraced design for permeable pavement in areas with steeper slopes (3%–5%). In all cases, designs must ensure that the slope of the pavement does not lead to flow occurring out of the stone reservoir layer onto lower portions of the pavement surface.

### **Minimum Hydraulic Head**

The elevation difference needed for permeable pavement to function properly is generally nominal, although 1 to 4 feet of head from the pavement surface to the underdrain outlet is typically necessary. This value may vary based on several design factors, such as required storage depth and underdrain location.

### **Minimum Depth to Water Table**

A high groundwater table may cause runoff to pond at the bottom of the permeable pavement system. Therefore, a minimum vertical distance of 0.5 feet (preferably 2 feet) must be provided between the bottom of the permeable pavement installation (i.e., the bottom invert of the reservoir layer) and the seasonal high water table.

### **Tidal Impacts**

For systems with an underdrain, the underdrain should be located above the tidal mean high water elevation. For entirely infiltration-based systems, the bottom of the stone reservoir should be located above the mean high water elevation. Where this is not possible, portions of the practice below the tidal mean high water elevation cannot be included in the volume calculations.

### **Setbacks**

To avoid the risk of seepage, stormwater cannot flow from the permeable pavement reservoir layer to the traditional pavement base layer, existing structure foundations, or future foundations which may be built on adjacent properties. Setbacks to structures and property lines must be at least 10 feet and adequate waterproofing protection must be provided for foundations and basements. Where the 10-foot setback is not possible, an impermeable liner may be used along the sides and bottom of the permeable pavement practice (extending from the surface to the bottom of the practice and outward to meet the 10-foot setback).

### **Proximity to Utilities**

Interference with underground utilities should be avoided if possible. When large site development is undertaken the expectation of achieving avoidance will be high. Conflicts may be commonplace on smaller sites and in the public right-of-way (PROW). Consult with each utility company on recommended offsets, which will allow utility maintenance work with minimal disturbance to the permeable pavement. Permeable pavement in the public right-of-way (PROW) must conform with the State of South Carolina Department of Transportation design specifications. Where conflicts cannot be avoided, follow these guidelines:

- ❑ Consider altering the location or sizing of the permeable pavement to avoid or minimize the utility conflict. Consider an alternate BMP type to avoid conflict.
- ❑ Use design features to mitigate the impacts of conflicts that may arise by allowing the permeable pavement and the utility to coexist. The permeable pavement design may need to incorporate impervious areas, through geotextiles or compaction, to protect utility crossings.
- ❑ Work with the utility company to evaluate the relocation of the existing utility and install the optimum placement and sizing of the permeable pavement.
- ❑ If utility functionality, longevity, and vehicular access to manholes can be assured, accept the permeable pavement design and location with the existing utility. Design sufficient soil coverage over the utility or general clearances or other features, such as an impermeable liner, to assure all entities that the conflict is limited to maintenance.

When accepting utility conflict into the permeable pavement location and design, it is understood the permeable pavement will be temporarily impacted during utility work, but the utility owner will replace the permeable pavement or, alternatively, install functionally comparable permeable pavement according to the specifications in the current version of this guidebook. Restoration of permeable pavement that is located in the PROW will also conform with the State of South Carolina Department of Transportation design specifications.

### **Pollutant Hotspot Land Uses**

Permeable pavement is not appropriate for certain pollutant-generating sites. In areas where higher pollutant loading is likely (i.e. oils and greases from fueling stations or vehicle storage areas, sediment from un-stabilized pervious areas, or other pollutants from industrial processes), appropriate pretreatment, such as an oil-water separator or filtering device must be provided, or the areas should be diverted from the permeable pavement.

On sites with existing contaminated soils, infiltration is not allowed. Permeable pavement areas must include an impermeable liner, and the Enhanced Design configuration cannot be used.

### **High Loading Situations**

Permeable pavement is not intended to treat sites with high sediment or trash/debris loads, since such loads will cause the practice to clog and fail. Sites with considerable pervious area (e.g., newly established turf and landscaping) can be considered high loading sites and the pervious areas should be diverted if possible, from the permeable pavement area. If unavoidable, pretreatment measures, such as a gravel or a sod filter strip should be employed (see Section 4.4.3 Permeable Pavement Pretreatment Criteria).

## **High Speed Roads**

Permeable pavement should not be used for high speed roads, although it has been successfully applied for low speed residential streets, parking lanes, and roadway shoulders.

## **Economic Considerations**

Permeable pavement tends to be expensive relative to other practices, but when the cost of land and traditional paving are included in the calculations, permeable pavement becomes much more competitive. Permeable pavement is very space-efficient, since it combines a useful pavement surface with stormwater management for runoff and, in standard design configurations, water quality treatment.

### **4.4.2 Permeable Pavement Conveyance Criteria**

Permeable pavement designs must include methods to convey larger storms (e.g., 2- to 25-year) to the storm drain system. Conveyance methods include the following:

- Place an overdrain—a horizontal perforated pipe near the top of the reservoir layer—to pass excess flows after water has filled the base.
- Increase the thickness of the top of the reservoir layer by as much as 6 inches to increase storage (i.e., create freeboard). The design computations used to size the reservoir layer often assume that no freeboard is present.
- Create underground detention within the reservoir layer of the permeable pavement system. Reservoir storage may be augmented by corrugated metal pipes, plastic or concrete arch structures, etc.
- Route overflows to another detention or conveyance system.
- Set the storm drain inlets flush with the elevation of the permeable pavement surface to effectively convey excess stormwater runoff past the system. The design should also make allowances for relief of unacceptable ponding depths during larger rainfall events.

### **4.4.3 Permeable Pavement Pretreatment Criteria**

Pretreatment for most permeable pavement applications is not necessary. Additional pretreatment is recommended if the pavement receives runoff from adjacent pervious areas. For example, a gravel or sod filter strip can be placed adjacent to pervious (landscaped) areas to trap coarse sediment particles before they reach the pavement surface in order to reduce clogging.

### **4.4.4 Permeable Pavement Design Criteria**

## **Type of Surface Pavement**

The type of pavement should be selected based on a review of the pavement specifications and properties and designed according to the product manufacturer's recommendations.

## **Pavement Bottom Slope**

For unlined designs, the bottom slope of a permeable pavement installation should be as flat as possible (i.e., 0% longitudinal and lateral slopes) to enable even distribution and infiltration of stormwater. On sloped sites, internal check dams or barriers, as shown in Figure 4.15 can be incorporated into the subsurface to encourage infiltration. Barriers may be constructed of concrete, earthen berms, impermeable membranes, or low permeability geotextile. In this type of design, the depth of the infiltration sump would be the depth behind the check dams. The depth and spacing of the barriers are

dependent upon the underlying slope and the saturated hydraulic conductivity, as any water retained by the flow barriers must infiltrate within 48 hours. If an underdrain will be used in conjunction with the flow barriers, it can be installed over the top of the barriers, or parallel to the barriers with an underdrain in each cell.

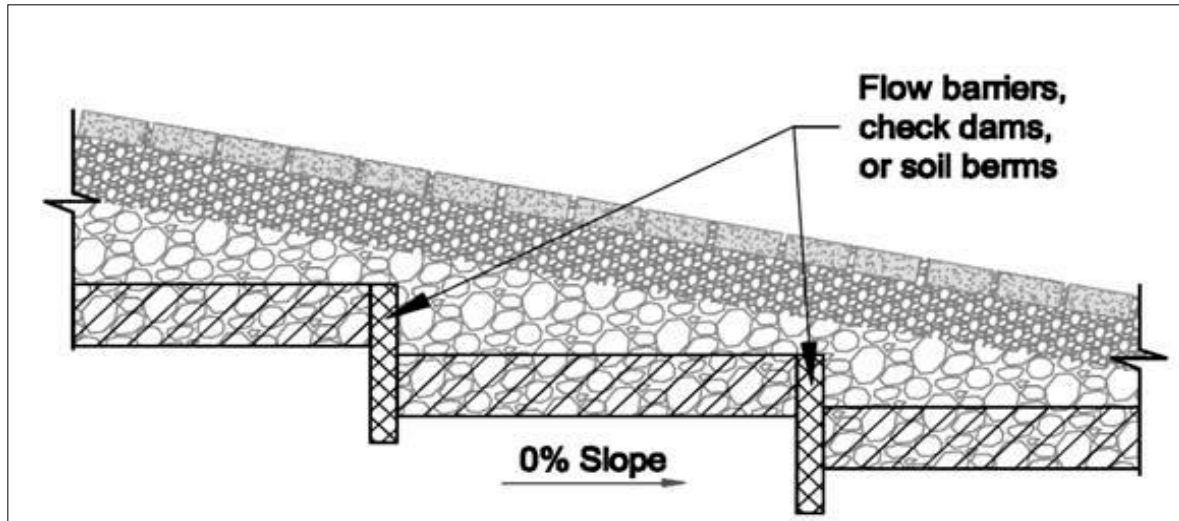


Figure 4.15. Use of flow barriers to encourage infiltration on sloped sites.

#### **Internal Geometry and Drawdowns**

##### ▪ **Rapid Drawdown**

Permeable pavement must be designed so that the target storage volume is detained in the reservoir for as long as possible, 36 to 48 hours, before completely discharging through an underdrain. A minimum orifice size of 1 inch is recommended regardless of the calculated drawdown time.

Note: A 48-hour maximum drawdown time is utilized for permeable pavement rather than the 72-hour value used for other BMPs. This shorter drawdown time, in accordance with industry standards, is intended to ensure that the subgrade does not stay saturated for too long and cause problems with the pavement.

##### ▪ **Infiltration Sump**

To promote greater retention for permeable pavement located on marginal soils, an infiltration sump can be installed to create a storage layer below the underdrain invert. This design configuration is discussed further below.

#### **Reservoir Layer**

The reservoir layer consists of the stone underneath the pavement section and above the bottom filter layer or underlying soils, including the optional infiltration sump. The total thickness of the reservoir layer is determined by runoff storage needs, the saturated hydraulic conductivity of in-situ soils, structural requirements of the pavement sub-base, depth to water table, and frost depth conditions (see Section 4.4.1 Permeable Pavement Feasibility Criteria). A geotechnical engineer should be consulted regarding the suitability of the soil subgrade.

- The reservoir below the permeable pavement surface should be composed of clean, double-washed stone aggregate and sized for both the storm event to be treated and the structural requirements of

the expected traffic loading. Additional chamber structures may also be used to create larger storage volumes.

- The storage layer may consist of clean, double-washed No. 57 stone, although No. 2 stone is preferred because it provides additional structural stability. Other appropriate materials may be used if accepted by the Beaufort County Public Works Department.
- The bottom of the reservoir layer should be completely flat so that runoff will be able to infiltrate evenly through the entire surface. The use of terracing and check dams is permissible.

### **Underdrains**

Most permeable pavement designs will require an underdrain (see Section 4.4.1 Permeable Pavement Feasibility Criteria). Underdrains can also be used to keep detained stormwater from flooding permeable pavement during extreme rain events. Multiple underdrains are typically necessary for permeable pavement wider than 40 feet, and each underdrain is recommended to be located 20 feet or less from the next pipe or the edge of the permeable pavement. For long and narrow applications, a single underdrain running the length of the permeable pavement is sufficient. The underdrain should be perforated schedule 40 PVC pipe (corrugated HDPE may be used for smaller load-bearing applications), with three or four rows of 3/8-inch perforations at 6 inches on center. The underdrain must be encased in a layer of clean, double-washed No. 57 stone, with a minimum 2-inch cover over the top of the underdrain. The underdrain system must include a flow control to ensure that the reservoir layer drains slowly (within 36 to 48 hours).

- The underdrain outlet can be fitted with a flow-reduction orifice within a weir or other easily inspected and maintained configuration in the downstream manhole as a means of regulating the stormwater detention time. The minimum diameter of any orifice is 1 inch. The designer should verify that the volume will draw down completely within 36 to 48 hours.
- On infiltration designs, an underdrain(s) can be installed and capped at the downstream structure as an option for future use if maintenance observations indicate a reduction in the soil permeability.

### **Observation Wells**

All permeable pavement practices must include observation wells. The observation well is used to observe the rate of drawdown within the reservoir layer following a storm event and to facilitate periodic inspection and maintenance. The observation well should consist of a well-anchored, perforated 4- to 6-inch diameter PVC pipe. There should be no perforation within 1 foot of the surface. If the permeable pavement has an underdrain, tie the observation well into any Ts or Ys in the underdrain system. The observation well should extend vertically to the bottom of the reservoir layer and extend upwards to be flush with the surface (or just under pavers) with a lockable cap.

### **Infiltration Sump (optional, required for enhanced designs with an underdrain)**

For unlined permeable pavement systems, an optional upturned elbow or elevated underdrain configuration can be used to promote greater retention for permeable pavement located on marginal soils. The infiltration sump must be installed to create a storage layer below the underdrain or upturned elbow invert. The depth of this layer must be sized so that the design storm can infiltrate into the subsoils in a 48-hour period. The bottom of the infiltration sump must be at least 0.5 feet above the seasonally high water table. The inclusion of an infiltration sump is not permitted for designs with an impermeable liner. In fill soil locations, geotechnical investigations are required to determine if the use of an infiltration sump is permissible.

**Filter Layer (optional)**

To protect the bottom of the reservoir layer from intrusion by underlying soils, a filter layer can be used. The underlying native soils should be separated from the stone reservoir by a 2- to 4-inch layer of choker stone (e.g., No. 8).

**Geotextile (optional)**

Geotextile fabric is another option to protect the bottom of the reservoir layer from intrusion by underlying soils, although some practitioners recommend avoiding the use of fabric beneath permeable pavements since it may become a future plane of clogging within the system. Geotextile fabric is still recommended to protect the excavated sides of the reservoir layer, in order to prevent soil piping. An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude higher (10 times) than the soil subgrade permeability must be used.

**Impermeable Liner**

An impermeable liner is not typically required, although it may be utilized in fill applications where deemed necessary by a geotechnical investigation, on sites with contaminated soils, or on the sides of the practice to protect adjacent structures from seepage. Use a PVC geomembrane liner or equivalent of an appropriate thickness (follow manufacturer's instructions for installation). Field seams must be sealed according to the liner manufacturer's specifications. A minimum 6-inch overlap of material is required at all seams.

**Material Specifications**

Permeable pavement material specifications vary according to the specific pavement product selected. A general comparison of different permeable pavements is provided in Table 4.13, but designers should consult manufacturer's technical specifications for specific criteria and guidance. Table 4.14 provides general material specifications for the component structures installed beneath the permeable pavement. Note that the size of stone materials used in the reservoir and filter layers may differ depending on the type of surface material.

Table 4.13. Permeable pavement specifications for a variety of typical surface materials.

Material	Specification	Notes
Permeable Pavers (PP)	Void content, thickness, and compressive strength vary based on type and manufacturer Open void fill media: aggregate, topsoil and grass, coarse sand, etc.	Reservoir layer required to support the structural load.
Pervious Concrete (PC)	Void content: 15–20% Thickness: Typically 4–8 inches Compressive strength: 2.8–28 MPa Open void fill media: None	May not require a reservoir layer to support the structural load, but a layer may be included to increase the storage or infiltration. Requires certified supplier and installer.
Porous Asphalt (PA)	Void content: 15–20% Thickness: Typically 3–7 inches (depending on traffic load) Open void fill media: None	Reservoir layer required to support the structural load. Requires certified supplier and installer.

Table 4.14. Material specifications for typical layers beneath the surface of permeable pavements.

Material	Specification	Notes
Bedding Layer	PC: 3–4 inches of No. 57 stone if No. 2 stone is used for Reservoir Layer PA: 3–4 inches of No. 57 stone PP: Follow manufacturer specifications	ASTM D448 size No. 57 stone (i.e., 1/2 to 1 1/2 inches in size). Must be double-washed and clean and free of all fines.
Reservoir Layer	PC: No. 57 stone or No. 2 stone PA: No. 2 stone PP: Follow manufacturer specifications	ASTM D448 size No. 57 stone (i.e., 1/2 to 1 1/2 inches in size); No. 2 Stone (i.e., 3/4 to 3 inches in size). Depth is based on the pavement structural and hydraulic requirements. Must be double-washed and clean and free of all fines. Other appropriate materials may be used if accepted by Beaufort County Public Works Department.
Underdrain	Use 4- to 6-inch diameter perforated PVC pipe (or equivalent corrugated HDPE may be used for smaller load-bearing applications), with 3 or 4 rows of 3/8-inch perforations at 6 inches on center. Perforated pipe installed for the full length of the permeable pavement cell, and non-perforated pipe, as needed, is used to connect with the storm drain system. T's and Y's should be installed as needed, depending on the underdrain configuration. Extend cleanout pipes to the surface.	
Infiltration Sump (optional)	An aggregate storage layer below the underdrain invert. The material specifications are the same as Reservoir Layer.	
Filter Layer (optional)	The underlying native soils should be separated from the stone reservoir by a 2- to 4-inch layer of choker stone (e.g., No. 8).	
Geotextile (optional)	Use an appropriate geotextile fabric for both sides and/or bottom that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude higher than (10 times) the soil subgrade permeability. Low-permeability geotextile fabric may be used as a check dam material.	
Impermeable Liner (optional)	Where appropriate, use PVC geomembrane liner or equivalent.	
Observation Well	Use a perforated 4- to 6-inch vertical PVC pipe (AASHTO M-252) with a lockable cap, installed flush with the surface.	

### **Permeable Pavement Sizing**

The thickness of the reservoir layer is determined by both a structural and hydraulic design analysis. The reservoir layer serves to retain stormwater and to support the design traffic loads for the pavement. Permeable pavement structural and hydraulic sizing criteria are discussed below.



### Structural Design

If permeable pavement will be used in a parking lot or other setting that involves vehicles, the pavement surface must be able to support the maximum anticipated traffic load. The structural design process will vary according to the type of pavement selected, and the manufacturer's specific recommendations should be consulted. The thickness of the permeable pavement and reservoir layer must be sized to support structural loads and to temporarily store the design storm volume (i.e., the water quality, channel protection, and/or flood control volumes). On most new development and redevelopment sites, the structural support requirements will dictate the depth of the underlying stone reservoir.

The structural design of permeable pavements involves consideration of four main site elements:

- ❑ Total traffic
- ❑ In situ soil strength
- ❑ Environmental elements
- ❑ Bedding and reservoir layer design

The resulting structural requirements may include the thickness of the pavement, filter, and reservoir layer. Designers should note that if the underlying soils have a low California Bearing Ratio (less than 4%), they may need to be compacted to at least 95% of the Standard Proctor Density, which may limit their use for infiltration.

Designers should determine structural design requirements by consulting transportation design guidance sources, such as the following:

- ❑ ASCE/T&DI/ICPI 68-18 Permeable Interlocking Concrete Pavement (2018)
- ❑ AASHTO Guide for Design of Pavement Structures (1993)
- ❑ AASHTO Supplement to the Guide for Design of Pavement Structures (1998)

**Hydraulic Design.** Permeable pavement is typically sized to store the SWRV or larger design storm volumes in the reservoir layer. The storage volume in the pavements must account for the underlying saturated hydraulic conductivity and outflow through any underdrains. The design storm should be routed through the pavement to accurately determine the required reservoir depth. The depth of the reservoir layer or infiltration sump needed to store the design storm can be determined by using Equation 4.3.

Equation 4.3. Reservoir layer or infiltration sump depth.

$$d_p = \frac{\left( \frac{P \times R_{v1} \times CDA}{A_p} \right) - (K_{sat} \times t_f)}{r}$$

Where:

- $d_p$  = Depth of the reservoir layer, or depth of the infiltration sump for enhanced designs with underdrains (ft)
- $P$  = Rainfall depth for the SWRV or other design storm (ft)
- $R_{v1}$  = 0.95 (runoff coefficient for impervious cover)

- CDA = Total contributing drainage area, including permeable pavement surface area (square feet)
- $A_p$  = Permeable pavement surface area (square feet)
- $K_{sat}$  = Field-verified saturated hydraulic conductivity for subgrade soils (ft/day). If an impermeable liner is used in the design, then this value is 0
- $t_f$  = Time to fill the reservoir layer (days; assume 2 hours or 0.083 day)
- $\eta_r$  = 0.4 (effective porosity for the reservoir layer)

This equation makes the following design assumptions:

- ② The CDA does not contain pervious areas.
- ② If the subgrade will be compacted to meet structural design requirements of the pavement section, the measured saturated hydraulic conductivity shall be based on measurement of the subgrade soil subjected to the compaction requirements.

The depth of the reservoir layer cannot be less than the depth required to meet the pavement structural requirement. The depth of the reservoir layer may need to be increased to meet structural or larger storage requirements.

For infiltration designs without underdrains or designs with infiltration sumps, the captured volume must drain from the practice within 48 hours. Equation 4.4 can be used to determine the drawdown time in the reservoir layer or infiltration sump.

Equation 4.4. Drawdown time.

$$t_d = \frac{d_p \times \eta_r}{K_{sat}}$$

Where:

- $t_d$  = Drawdown time (days)
- $d_p$  = Depth of the reservoir layer, or depth of the infiltration sump for enhanced designs with underdrains (ft)
- $\eta_r$  = 0.4 (effective porosity for the reservoir layer)
- $K_{sat}$  = Field-verified saturated hydraulic conductivity for subgrade soils (ft/day). If an impermeable liner is used in the design, then this value is 0

For designs with underdrains, the captured volume must drain in 36-48 hours. The drawdown time should be determined using the hydrologic routing or modeling procedures used for detention systems with the depth and head adjusted for the porosity of the aggregate.

The total storage volume provided by the practice,  $S_v$ , should be determined using Equation 4.5.

Equation 4.5. Permeable pavement storage volume.

$$S_v = A_p[(d_p \times \eta_r) + K_{sat} \times t_f]$$

Where:

- $S_v$  = Storage volume (cubic feet)
- $d_p$  = Depth of the reservoir layer, or depth of the infiltration sump for enhanced designs with underdrains (ft)
- $n_r$  = 0.4 (effective porosity for the reservoir layer)
- $A_p$  = Permeable pavement surface area (square feet)
- $K_{sat}$  = Field-verified saturated hydraulic conductivity for subgrade soils (ft/day). If an impermeable liner is used in the design, then this value is 0
- $t_f$  = Time to fill the reservoir layer (days; assume 2 hours or 0.083 day)

### **Detention Storage Design**

Permeable pavement can also be designed to address, in whole or in part, the detention storage for larger storm events. The designer can model various approaches by factoring in storage within the stone aggregate layer (including chamber structures that increase the available storage volume), expected infiltration, and any outlet structures used as part of the design. Routing calculations can also be used to provide a more accurate solution of the peak discharge and required storage volume.

Once runoff passes through the surface of the permeable pavement system, designers should calculate outflow pathways to handle subsurface flows. Subsurface flows can be regulated using underdrains, the volume of storage in the reservoir layer, the bed slope of the reservoir layer, and/or a control structure at the outlet (see Section 4.4.2 Permeable Pavement Conveyance Criteria).

#### **4.4.5 Permeable Pavement Landscaping Criteria**

Permeable pavement does not have any landscaping needs. However, large-scale permeable pavement applications should be carefully planned to integrate the typical landscaping features of a parking lot, such as trees and islands, in a manner that maximizes runoff treatment and minimizes the risk that sediment, mulch, grass clippings, leaves, and other plant matter will inadvertently clog the paving surface. Bioretention areas (see Section 4.3 Bioretention) may be a good design option to meet these landscaping goals.

#### **4.4.6 Permeable Pavement Construction Sequence**

Experience has shown that proper installation is critical to the effective operation of a permeable pavement system.

### **Soil Erosion and Sediment Controls**

The following soil erosion and sediment control guidelines must be followed during construction:

- ② All permeable pavement areas must be fully protected from sediment intrusion by silt fence or construction fencing, particularly if they are intended to infiltrate runoff.
- ② Permeable pavement areas intended to infiltrate runoff must remain outside the limits of disturbance during construction to prevent soil compaction by heavy equipment and loss of design infiltration rate (unless the area has been determined to have a low California Bearing Ratio and will require compaction during the permeable pavement construction phase). Where it is infeasible to keep the proposed permeable pavement areas outside of the limits of disturbance, there are several possible remedies for the impacted area.
  - If excavation in the proposed permeable pavement areas can be restricted, then remediation can be achieved with deep tilling practices. This is only possible if in situ soils

- are not disturbed any deeper than 2 feet above the final design elevation of the bottom of the aggregate reservoir course. In this case, when heavy equipment activity has ceased, the area is excavated to grade, and the impacted area must be tilled to a depth of 12 inches below the bottom of the reservoir layer.
- Alternatively, if it is infeasible to keep the proposed permeable pavement areas outside of the limits of disturbance, and excavation of the area cannot be restricted, then infiltration tests will be required prior to installation of the permeable pavement to ensure that the design infiltration rate is still present. If tests reveal the loss of design infiltration rates, then deep tilling practices may be used in an effort to restore those rates. In this case, further testing must be done before the permeable pavement can be installed to establish that design rates have been achieved.
  - Finally, if it is infeasible to keep the proposed permeable pavement areas outside of the limits of disturbance, excavation of the area cannot be restricted, and infiltration tests reveal design rates cannot be restored, then a resubmission of the SWMP will be required.
- ⑦ Permeable pavement areas must be clearly marked on all construction documents and grading plans.
  - ⑦ During construction, care should be taken to avoid tracking sediments onto any permeable pavement surface to avoid post-construction clogging and long-term maintenance issues.
  - ⑦ Any area of the site intended ultimately to be a permeable pavement area with an infiltration component should not be used as the site of a temporary sediment trap or basin. If locating a temporary sediment trap or basin on an area intended for permeable pavement is unavoidable, the remedies are similar to those discussed for heavy equipment compaction.
  - ⑦ If it is possible, restrict the invert of the sediment trap or basin to at least 1 foot above the final design elevation of the bottom of the aggregate reservoir course of the proposed permeable pavement. Then remediation can be achieved with proper removal of trapped sediments and deep tilling practices.
  - ⑦ An alternate approach to deep tilling is to use an impermeable liner to protect the in situ soils from sedimentation while the sediment trap or basin is in use.
  - ⑦ In each case, all sediment deposits in the excavated area must be carefully removed prior to installing the sub-base, base, and surface materials. The plan must also show the proper procedures for converting the temporary sediment control practice to a permeable pavement BMP, including dewatering, cleanout, and stabilization.

### **Permeable Pavement Installation**

The following is a typical construction sequence to properly install permeable pavement, which may need to be modified depending on the particular type of permeable pavement that is being installed.

#### **1. Stabilize Contributing Drainage Area**

Construction of the permeable pavement should only begin after the entire CDA has been stabilized. The proposed site should be checked for existing utilities prior to any excavation. Do not install the system in rain.

#### **2. Install Soil Erosion and Sediment Control Measures for the Permeable Pavement**

As noted above, temporary soil erosion and sediment controls are needed during installation to divert stormwater away from the permeable pavement area until it is completed. Special protection measures,

such as erosion control fabrics, may be needed to protect vulnerable side slopes from erosion during the excavation process. The proposed permeable pavement area must be kept free from sediment during the entire construction process. Construction materials contaminated by sediment must be removed and replaced with clean material.

### **3. Minimize Impact of Heavy Installation Equipment**

Where possible, excavators or backhoes should work from the sides to excavate the reservoir layer to its appropriate design depth and dimensions. For small pavement applications, excavating equipment should have arms with adequate extension so they do not have to work inside the footprint of the permeable pavement area (to avoid compaction). Contractors can utilize a cell construction approach, whereby the proposed permeable pavement area is split into 500- to 1,000-square foot temporary cells with a 10- to 15-foot-wide earth bridge in between, so cells can be excavated from the side. Excavated material should be placed away from the open excavation so as to not jeopardize the stability of the side walls.

### **4. Promote Infiltration Rate**

The native soils along the bottom of the permeable pavement system should be scarified or tilled to a depth of 3 to 4 inches prior to the placement of the filter layer or geotextile fabric. In large-scale paving applications with weak soils, the soil subgrade may need to be compacted to 95% of the Standard Proctor Density to achieve the desired load-bearing capacity.

Note: This may reduce or eliminate the infiltration function of the installation, and it must be addressed during hydrologic design.

### **5. Order of Materials**

Geotextile fabric should be installed on the sides of the reservoir layer (and the bottom if the design calls for it). Geotextile fabric strips should overlap down-slope by a minimum of 2 feet and be secured a minimum of 4 feet beyond the edge of the excavation. Where the filter layer extends beyond the edge of the pavement (to convey runoff to the reservoir layer), install an additional layer of geotextile fabric 1 foot below the surface to prevent sediment from entering into the reservoir layer. Excess geotextile fabric should not be trimmed until the site is fully stabilized.

### **6. Install Base Material Components**

Provide a minimum of 2 inches of aggregate above and below the underdrains. The up-gradient end of underdrains in the reservoir layer should be capped. Where an underdrain pipe is connected to a structure, there shall be no perforations within 1 foot of the structure. Ensure there are no perforations in clean-outs and observation wells within 1 foot of the surface.

### **7. Stone Media**

Spread 6-inch lifts of the appropriate clean, double-washed stone aggregate (usually No. 2 or No. 57 stone). Place at least 4 inches of additional aggregate above the underdrain, and then compact it using a vibratory roller in static mode until there is no visible movement of the aggregate. Do not crush the aggregate with the roller.

### **8. Reservoir Media**

Install the desired depth of the bedding layer, depending on the type of pavement, as indicated in Table 4.14.

### **9. Paving Media**

Paving materials shall be installed in accordance with manufacturer or industry specifications for the particular type of pavement.

### **10. Installation of Porous Asphalt**

The following has been excerpted from various documents, most notably Jackson (2007):

- Install porous asphalt pavement similarly to regular asphalt pavement. The pavement should be laid in a single lift over the filter course. The laying temperature should be between 230°F and 260°F, with a minimum air temperature of 50°F, to ensure the surface does not stiffen before compaction.
- Complete compaction of the surface course when the surface is cool enough to resist a 10-ton roller. One or two passes of the roller are required for proper compaction. More rolling could cause a reduction in the porosity of the pavement.
- The mixing plant must provide certification of the aggregate mix, abrasion loss factor, and asphalt content in the mix. Test the asphalt mix for its resistance to stripping by water using ASTM D1664. If the estimated coating area is not above 95%, additional anti-stripping agents must be added to the mix.
- Transport the mix to the site in a clean vehicle with smooth dump beds sprayed with a non-petroleum release agent. The mix shall be covered during transportation to control cooling.
- Test the full permeability of the pavement surface by application of clean water at a rate of at least 5 gallons per minute over the entire surface. All water must infiltrate directly, without puddle formation or surface runoff.
- Inspect the facility 18 to 30 hours after a significant rainfall (0.5 inch or greater) or artificial flooding to determine if the facility is draining properly.

### **11. Pervious Concrete Installation**

The basic installation sequence for pervious concrete is outlined by the National Ready Mixed Concrete Association (NRMCA; NRMCA, 2004). Concrete installers are required to be certified by a recognized pervious concrete installers training program, such as the Pervious Concrete Contractor Certification Program offered by the NRMCA. The basic installation procedure is as follows:

- Drive the concrete truck as close to the project site as possible.
- Water the underlying aggregate (reservoir layer) before the concrete is placed, so the aggregate does not draw moisture from the freshly laid pervious concrete.
- After the concrete is placed, approximately 3/8 to 1/2 inches is struck off, using a vibratory screed. This is to allow for compaction of the concrete pavement.
- Compact the pavement with a steel pipe roller. Care should be taken to ensure over-compaction does not occur.
- Cut joints for the concrete to a depth of 1/4 inch.
- The curing process is very important for pervious concrete. Concrete installers should follow manufacturer specifications to the extent allowed by on-site conditions when curing pervious concrete. This typically requires covering the pavement with plastic sheeting within 20 minutes of the strike-off and may require keeping it covered for at least 7 days. Do not allow traffic on the pavement during the curing period.
- Remove the plastic sheeting only after the proper curing time. Inspect the facility 18 to 30 hours after a significant rainfall (0.5 inch or greater) or artificial flooding, to determine if the facility is draining properly.

## 12. Permeable Interlocking Concrete Paver Installation

The basic installation process is described in greater detail by Smith (2006):

- Place edge restraints for open-jointed pavement blocks before the bedding layer and pavement blocks are installed. Permeable interlocking concrete pavement systems require edge restraints to prevent vehicle loads from moving the paver blocks. Edge restraints may be standard curbs or gutter pans, or precast or cast-in-place reinforced concrete borders a minimum of 6 inches wide and 18 inches deep, constructed with Class A3 concrete. Edge restraints along the traffic side of a permeable pavement block system are recommended.
- Place the double-washed No. 57 stone in a single lift. Level the filter course and compact it into the reservoir course beneath with at least four passes of a 10-ton steel drum static roller until there is no visible movement. The first two passes are in vibratory mode, with the final two passes in static mode. The filter aggregate should be moist to facilitate movement into the reservoir course.
- Place and screed the bedding course material (typically No. 8 stone).
- Fill gaps at the edge of the paved areas with cut pavers or edge units. When cut pavers are needed, cut the pavers with a paver splitter or masonry saw. Cut pavers no smaller than 1/3 of the full unit size.
- Pavers may be placed by hand or with mechanical installers. Fill the joints and openings with stone. Joint openings must be filled with ASTM D448 No. 8 stone; although, No. 8P or No. 9 stone may be used where needed to fill narrower joints. Remove excess stones from the paver surface.
- Compact and seat the pavers into the bedding course with a minimum low-amplitude 5,000-pound-foot, 75- to 95-Hz plate compactor.
- Do not compact within 6 feet of the unrestrained edges of the pavers.
- The system must be thoroughly swept by a mechanical sweeper or vacuumed immediately after construction to remove any sediment or excess aggregate.
- Inspect the area for settlement. Any blocks that settle must be reset and re-inspected.
- Inspect the facility 18 to 30 hours after a significant rainfall (0.5 inch or greater) or artificial flooding to determine whether the facility is draining properly.

## 13. Construction Supervision

Supervision before, during, and after construction by a qualified professional is recommended to ensure permeable pavement is built in accordance with these specifications. ASTM test C1781 or C1701 must be performed to ensure initial pavement permeability of at least 6 inches per hour. Inspection checklists that require sign-offs by qualified individuals should be used at critical stages of construction to ensure the contractor's interpretation of the plan is consistent with the designer's intent.

Construction phase inspection checklist for permeable pavement practices can be found in Appendix E Construction Inspection Checklists.

Some common pitfalls can be avoided by careful construction supervision that focuses on the following key aspects of permeable pavement installation:

- Store materials in a protected area to keep them free from mud, dirt, and other foreign materials.
- The CDA should be stabilized prior to directing water to the permeable pavement area.
- Check the aggregate material to confirm it is clean and washed, meets specifications and is installed to the correct depth. Aggregate loads that do not meet the specifications or do not appear to be sufficiently washed may be rejected.
- Check elevations (i.e., the invert of the underdrain, inverts for the inflow, and outflow points) and the surface slope.
- Make sure the permeable pavement surface is even, runoff spreads evenly across it, and the storage bed drains within 48 hours.
- Ensure caps are placed on the upstream (but not the downstream) ends of the underdrains.
- Inspect the pretreatment structures (if applicable) to make sure they are properly installed and working effectively.
- Once the final construction inspection has been completed, log the GPS coordinates for each facility and submit them for entry into the BMP maintenance tracking database.

Runoff diversion structures are recommended to protect larger permeable pavement applications from early runoff-producing storms, particularly when up-gradient conventional asphalt areas drain to the permeable pavement. This can help reduce the input of fine particles often produced shortly after conventional asphalt is laid.

#### **4.4.7 Permeable Pavement Maintenance Criteria**

Maintenance is a required and crucial element to ensure the long-term performance of permeable pavement. The most frequently cited maintenance problem is surface clogging caused by organic matter and sediment. Periodic street sweeping will remove accumulated sediment and help prevent clogging; however, it is also critical to ensure that surrounding land areas remain stabilized.

The following tasks must be avoided on all permeable pavements:

- Sanding
- Resealing
- Resurfacing
- Power washing
- Storage of mulch or soil materials
- Construction staging on unprotected pavement

It is difficult to prescribe the specific types or frequency of maintenance tasks that are needed to maintain the hydrologic function of permeable pavement systems over time. The frequency of maintenance will depend largely on the pavement use, traffic loads, and the surrounding land use.

One preventative maintenance task for large-scale applications (e.g., parking lots) involves vacuum sweeping on a frequency consistent with the use and loadings encountered in the site. Many experts



consider an annual, dry-weather sweeping in the spring months to be important. The contract for sweeping should specify that a vacuum sweeper be used that does not use water spray, since spraying may lead to subsurface clogging. Typical maintenance tasks are outlined in Table 4.15.

Table 4.15. Typical maintenance tasks for permeable pavement practices.

Frequency	Maintenance Tasks
After installation	<ul style="list-style-type: none"> <li>For the first 6 months following construction, the practice and CDA should be inspected at least twice after storm events that exceed 0.5 inch of rainfall. Conduct any needed repairs or stabilization.</li> </ul>
Once every 1–2 months during the growing season	<ul style="list-style-type: none"> <li>Mow grass in grid paver applications (clippings should be removed from the pavement area).</li> </ul>
As needed	<ul style="list-style-type: none"> <li>Stabilize the CDA to prevent erosion.</li> <li>Remove any soil or sediment deposited on pavement.</li> <li>Replace or repair any pavement surfaces that are degenerating or spalling.</li> </ul>
2–4 times per year (depending on use)	<ul style="list-style-type: none"> <li>Mechanically sweep pavement with a standard street sweeper to prevent clogging.</li> </ul>
Annually	<ul style="list-style-type: none"> <li>Conduct a maintenance inspection</li> <li>Remove weeds as needed.</li> </ul>
Once every 2–3 years	<ul style="list-style-type: none"> <li>Remove any accumulated sediment in pretreatment cells and inflow points.</li> </ul>
If clogged	<ul style="list-style-type: none"> <li>Conduct maintenance using a regenerative street sweeper or a vacuum sweeper</li> <li>Replace any necessary joint material.</li> </ul>

When permeable pavements are installed on private residential lots, homeowners will need to (1) be educated about their routine maintenance needs and (2) understand the long-term maintenance plan.

It is recommended that a qualified professional conduct a spring maintenance inspection and cleanup at each permeable pavement site, particularly at large-scale applications. Maintenance inspection checklists for permeable pavements and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

### **Waste Material**

Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

### **4.4.8 Permeable Pavement Stormwater Compliance Calculations**

Permeable pavement retention credit varies depending on the design configuration of the system.

### **Enhanced Designs**

These permeable pavement applications have an infiltration sump and water-quality filter, but no underdrain. Enhanced designs are credited with 100% retention for the storage volume (Sv) provided by the practice as well as 100% TSS, TN, and bacteria removal (Table 4.16).

Table 4.16. Retention and pollutant removal for enhanced permeable pavement practices.

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

Note: If using an infiltration sump design, only the volume stored in the sump can be counted as the Enhanced Design Storage Volume (Sv). Any volume stored in the practice above the sump is counted as a standard design. When using the SoLoCo Compliance Calculator, the Sv of the infiltration sump should be entered into the cell "Storage Volume Provided by BMP" in the Permeable Pavement – Enhanced row. Permeable Pavement – Standard should then be selected as the downstream practice. Next, in the Permeable Pavement - Standard row, the Sv provided above the infiltration sump should be entered into the cell "Storage Volume Provided by BMP."

#### **Standard Designs**

These permeable pavement applications have an underdrain, but no infiltration sump or water quality filter. Standard designs are credited with 30% retention for the storage volume (Sv) provided as well as 80% TSS, 45% TN, and 30% bacteria removal. (Table 4.17).

Table 4.17. Retention and pollutant removal for standard permeable pavement practices.

Retention	= 30%
TSS Removal	= 80%
TN Removal	= 45%
Bacteria Removal	= 30%

The practice must be sized using the guidance detailed in Section 4.2.4 Permeable Pavement Design Criteria.

Permeable pavement also contributes to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume (Sv) achieved by the practice from the total runoff volumes for the 2-year through the 100-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.



#### 4.5 Infiltration Practices

Infiltration				
<b>Definition:</b> Practices that capture and temporarily store the design storm volume before allowing it to infiltrate into the soil over a three-day period.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		100%	100%	100%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
Moderate	Moderate	High		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	Basin	Trench	
Quarterly	Every 5-10 years	100%	100%	
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Excellent in impervious CDAs</li><li>▪ Helps restore pre-development hydrologic conditions through groundwater recharge</li><li>▪ Reduces runoff rates, volumes, and pollutant loads</li><li>▪ Attractive landscaping features</li><li>▪ Good for small sites with porous soils</li></ul>		<ul style="list-style-type: none"><li>▪ CDA should be less than 2 acres.</li><li>▪ Potential for groundwater contamination</li><li>▪ High clogging potential;</li><li>▪ Not for sites with fine soils (clays/silts) in CDA</li><li>▪ Geotechnical testing required</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Pretreatment</li><li>▪ Conveyance system</li><li>▪ Ponding area</li><li>▪ Soils/Filter Media/Mulch</li><li>▪ Observation Well/Monitoring Port</li><li>▪ Plants</li></ul>		<ul style="list-style-type: none"><li>▪ Depth to seasonal high water table must be at least 6 inches below bottom of practice</li><li>▪ Must infiltrate within 72 hours</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Inspect for clogging</li></ul>		<ul style="list-style-type: none"><li>▪ Replace soil/stone if it becomes clogged</li><li>▪ Clean conveyance system(s)</li></ul>		

<sup>1</sup>Credited pollutant load removal

Infiltration practices are suitable for use in residential and other urban areas where field measured soil infiltration rates are sufficient. To prevent possible groundwater contamination, infiltration must not be utilized at sites designated as stormwater hotspots. If properly designed, they can provide significant reductions in post-construction stormwater runoff rates, volumes, and pollutant loads on development sites (Figure 4.16)



Figure 4.16. Infiltration practice in median strip.

**Definition**

Practices that capture and temporarily store the design storm volume before allowing it to infiltrate into the soil over a three-day period. Infiltration practices use temporary surface or underground storage to allow incoming stormwater runoff to exfiltrate into underlying soils. Runoff first passes through multiple pretreatment mechanisms to trap sediment and organic matter before it reaches the practice. As the stormwater penetrates the underlying soil, chemical and physical adsorption processes remove pollutants. Infiltration practices are suitable for use in residential and other urban areas where field-verified saturated hydraulic conductivity is sufficient.

Design variants include the following:

- I-1 Infiltration trench
- I-2 Infiltration basin

### **Infiltration Trenches**

Infiltration trenches are excavated trenches filled with stone. Stormwater runoff is captured and temporarily stored in the stone reservoir, where it is allowed to infiltrate into the surrounding and underlying native soils. Infiltration trenches can be used to “receive” stormwater runoff from contributing drainage areas of up to 2 acres in size and should only be used on development sites where sediment loads can be kept relatively low (see Figure 4.17 and Figure 4.18).

### **Infiltration Basins**

Infiltration basins are shallow, landscaped excavations filled with an engineered soil mix. They are designed to capture and temporarily store stormwater runoff in the engineered soil mix, where it is subjected to the hydrologic processes of evaporation and transpiration, before being allowed to infiltrate into the surrounding soils. They are essentially non-underdrained bioretention areas and should also only be used on drainage areas up to 5 acres where sediment loads can be kept relatively low (Figure 4.19).

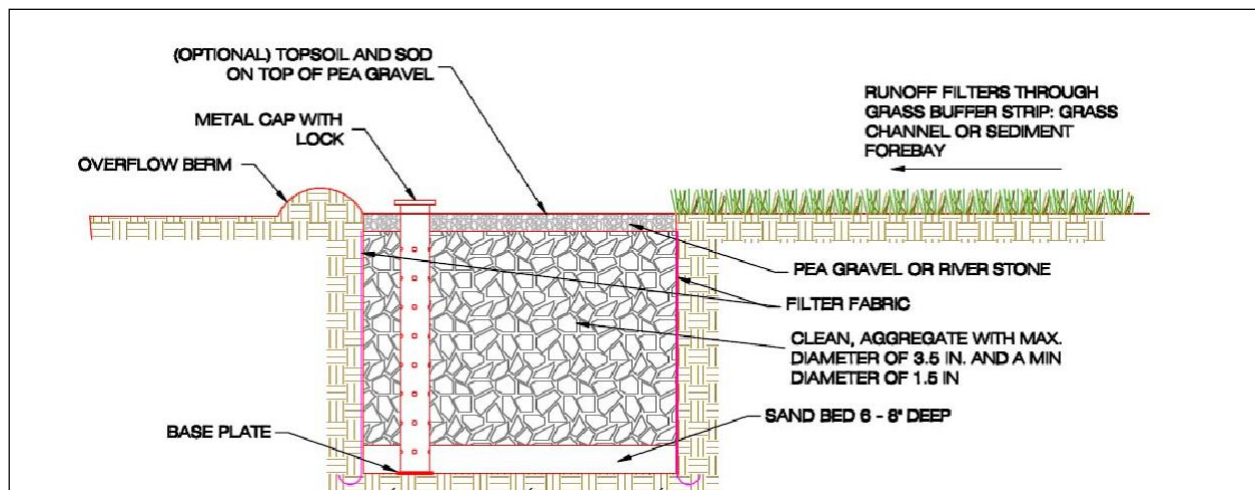


Figure 4.17. Example design of an infiltration trench.

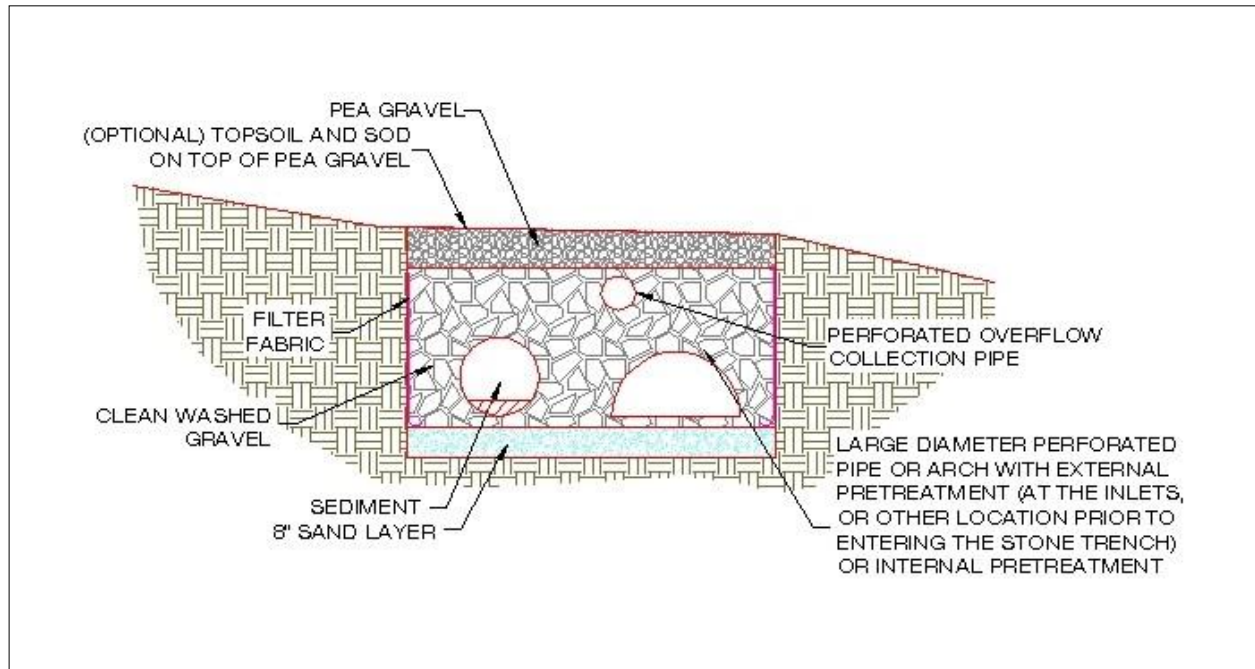


Figure 4.18. Example design of an infiltration practice with supplemental pipe storage.

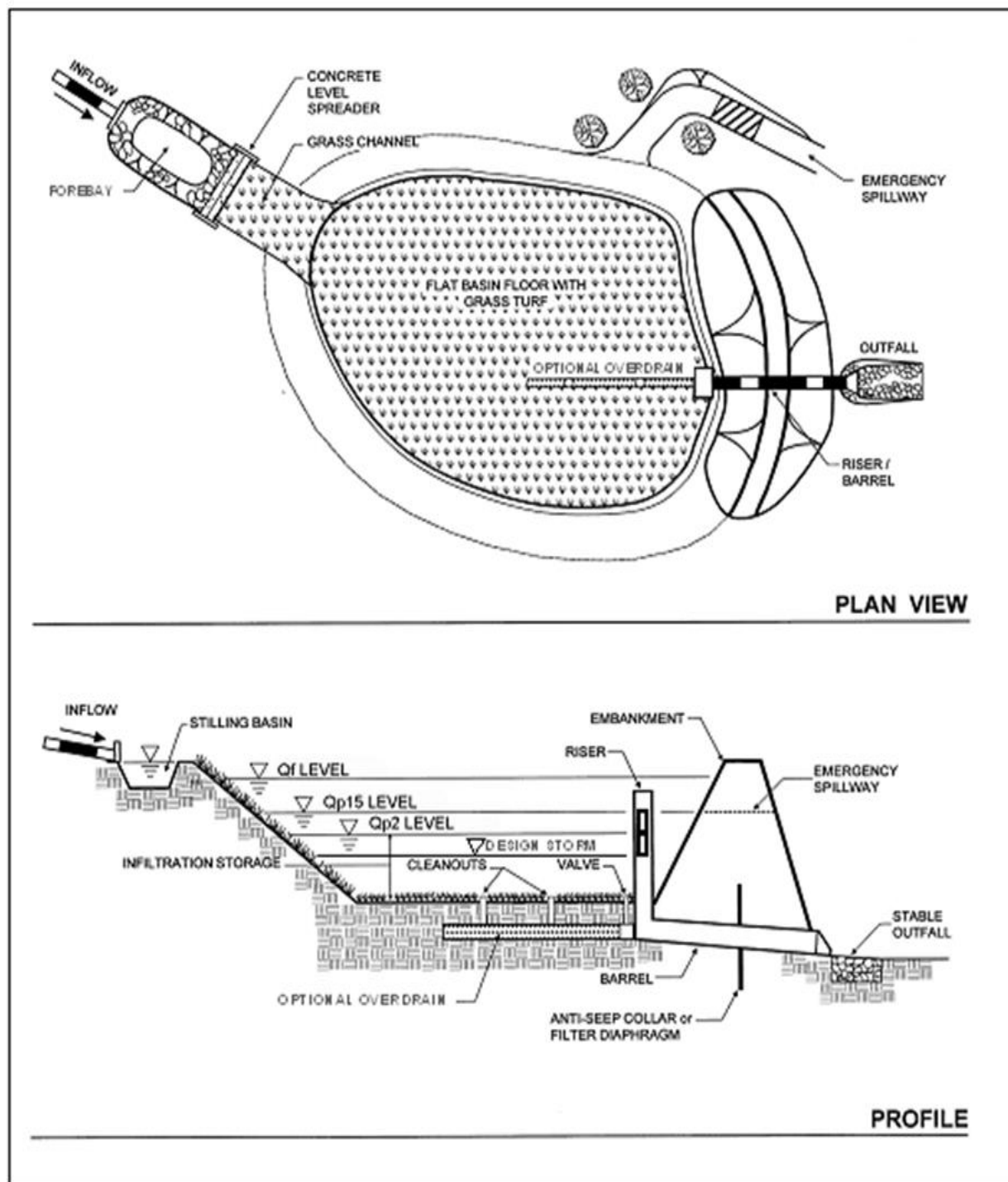


Figure 4.19. Example design of an infiltration basin.



#### **4.5.1 Infiltration Feasibility Criteria**

Infiltration practices have very high storage and retention capabilities when sited and designed appropriately. Designers should evaluate the range of soil properties during initial site layout and seek to configure the site to conserve and protect the soils with the greatest recharge and infiltration rates. In particular, areas of HSG A or B soils, shown on the U.S. Department of Agriculture's NRCS soil surveys, should be considered as primary locations for infiltration practices. Additional information about soil and infiltration are described in more detail later in this section. During initial design phases, designers should carefully identify and evaluate constraints on infiltration, as follows:

##### **Underground Injection Control for Class V Wells**

In order for an infiltration practice to avoid classification as a Class V well, which is subject to regulation under the Federal Underground Injection Control program, the practice must be wider than the practice is deep. If an infiltration practice is "deeper than its widest surface dimension" or if it includes an underground distribution system, then it will likely be considered a Class V injection well. Class V injection wells are subject to permit approval by the U.S. Environmental Protection Agency (EPA).

##### **Contributing Drainage Area**

The maximum CDA to an individual infiltration practice should be less than 2 acres and as close to 100% impervious as possible. The design, pretreatment, and maintenance requirements will differ depending on the size of the infiltration practice.

##### **Site Topography**

The infiltration practice shall not be located on slopes greater than 6%, although check dams or other devices may be employed to reduce the effective slope of the practice. Further, unless slope stability calculations demonstrate otherwise, infiltration practices should be located a minimum horizontal distance of 200 feet from down-gradient slopes greater than 20%.

##### **Minimum Hydraulic Head**

Two or more feet of head may be needed to promote flow through infiltration practices.

##### **Minimum Depth to Water Table**

A minimum vertical distance of 0.5 feet must be provided between the bottom of the infiltration practice.

##### **Tidal Impacts**

The bottom of an infiltration practice should be located above the tidal mean high water elevation. Where this is not possible, portions of the practice below the tidal mean high water elevation cannot be included in the volume calculations.

##### **Soils**

Initially, soil infiltration rates can be estimated from NRCS soil data for feasibility purposes, but designers must verify soil permeability by using the on-site soil investigation methods provided in Appendix B Geotechnical Information Requirements for Underground BMPs for their design.

### **Use on Urban Fill Soils/Redevelopment Sites**

Sites that have been previously graded or disturbed do not typically retain their original soil permeability due to compaction. Therefore, such sites are often not good candidates for infiltration practices unless the geotechnical investigation shows that a sufficient saturated hydraulic conductivity exists.

### **Dry Weather Flows**

Infiltration practices should not be used on sites receiving regular dry-weather flows from sump pumps, irrigation water, chlorinated wash-water, or flows other than stormwater.

### **Setbacks**

To avoid the risk of seepage, stormwater cannot flow from infiltration practices to traditional pavement base layer, existing structure foundations, or future foundations which may be built on adjacent properties. Setbacks to structures and property lines must be at least 10 feet and adequate waterproofing protection must be provided for foundations and basements. Where the 10-foot setback is not possible, an impermeable liner may be used along the sides and bottom of the infiltration area (extending from the surface to the bottom of the practice and outward to meet the 10-foot setback). Areas where the liner blocks infiltration should be excluded from surface area calculations for the practice. In locations where the surface soil consists of highly permeable soils with little separation of the infiltration trench or basin bottom, the extent of ground water mounding should be considered. Mounding can occur in areas where infiltrating water intersects a groundwater table and the rate of water entering the subsurface is greater than the rate at which water is conveyed away from the infiltration system (MPCA, 2019). Ground water mounding may impact building foundations, soil stability, underground utilities and potentially on-site treatment systems (septic leach beds).

All setbacks must be verified by a professional geotechnical engineer registered in the State of South Carolina.

### **Proximity to Utilities**

Interference with underground utilities should be avoided, if possible. When large site development is undertaken the expectation of achieving avoidance will be high. Conflicts may be commonplace on smaller sites and in the PROW. Consult with each utility company on recommended offsets, which will allow utility maintenance work with minimal disturbance to the infiltration BMP. Infiltration BMPs in the PROW will also conform with the State of South Carolina Department of Transportation design specifications. Where conflicts cannot be avoided, follow these guidelines:

- Consider altering the location or sizing of the infiltration BMP to avoid or minimize the utility conflict. Consider an alternate BMP type to avoid conflict.
- Use design features to mitigate the impacts of conflicts that may arise by allowing the infiltration BMP and the utility to coexist. The infiltration BMP design may need to incorporate impervious areas, through geotextiles or compaction, to protect utility crossings. Other key design features may need to be moved, added, or deleted.
- Evaluate the relocation of the existing utility and install an optimally placed and sized infiltration BMP.
- If utility functionality, longevity and vehicular access to manholes can be assured, accept the infiltration BMP design and location with the existing utility. Incorporate into the infiltration BMP design sufficient soil coverage over the utility or general clearances or other features such as an impermeable linear to assure all entities the conflict is limited to maintenance.

Note: When accepting utility conflict into the infiltration BMP location and design, it is understood the infiltration BMP will be temporarily impacted during utility work. At the conclusion of this work, the utility owner will replace the infiltration BMP or, alternatively, install a functionally comparable infiltration BMP according to the specifications in the current version of this guidebook. If the infiltration BMP is located in the PROW the infiltration BMP restoration will also conform with the State of South Carolina Department of Transportation design specification.

### **Pollutant Hotspots and High Loading Situations**

Infiltration practices are not intended to treat sites with high sediment or trash or debris loads, because such loads will cause the practice to clog and fail. Infiltration practices must be avoided at potential stormwater hotspots that pose a risk of groundwater contamination. In areas where higher pollutant loading is likely (i.e. oils and greases from fueling stations or vehicle storage areas, sediment from un-stabilized pervious areas, or other pollutants from industrial processes), appropriate pretreatment, such as an oil-water separator or filtering device must be provided. These pretreatment facilities should be monitored and maintained frequently to avoid negative impacts to the infiltration area and groundwater.

On sites with existing contaminated soils, infiltration is not allowed.

### **Economic Considerations**

Infiltration practices do require a designated space on the site, which in space-constrained areas, may reduce available building space. However, infiltration practices have a relatively low construction cost, and high space efficiency. In some cases, they can even be incorporated into the detention design or landscaped areas

#### **4.5.2 Infiltration Conveyance Criteria**

The nature of the conveyance and overflow to an infiltration practice depends on the scale of infiltration and whether the facility is on-line or off-line. Where possible, conventional infiltration practices should be designed off-line to avoid damage from the erosive velocities of larger design storms. If runoff is delivered by a storm drain pipe or along the main conveyance system, the infiltration practice shall be designed as an off-line practice. Pretreatment shall be provided for storm drain pipes and conveyance systems discharging directly to infiltration systems.

### **Off-line Infiltration**

Overflows can either be diverted from entering the infiltration practice or dealt with via an overflow inlet. Optional overflow methods include the following:

- Utilize a low-flow diversion or flow splitter at the inlet to allow only the design SWRV to enter the facility. This may be achieved with a weir or curb opening sized for the target flow, in combination with a bypass channel. Using a weir or curb opening helps minimize clogging and reduces the maintenance frequency (further guidance on determining the peak flow rate will be necessary in order to ensure proper design of the diversion structure).
- Use landscaping type inlets or standpipes with trash guards as overflow devices.

### **On-line Infiltration**

An overflow structure must be incorporated into on-line designs to safely convey the 25-year storm through the infiltration area. Mechanisms such as elevated drop inlets and overflow weirs are examples of how to direct high flows to a non-erosive down-slope overflow channel, stabilized water course, or storm sewer system designed to convey the 25-year design storm.

#### 4.5.3 Infiltration Pretreatment Criteria

Every infiltration system shall have pretreatment mechanisms to protect the long-term integrity of the infiltration rate. One of the following techniques must be installed to pretreat 100% of the inflow in every facility:

- Grass channel
- Grass filter strip (minimum 20 feet and only if sheet flow is established and maintained)
- Forebay or sump pit (must accommodate a minimum 15% of the design storm volume)
- Gravel diaphragm (minimum 1 foot deep and 2 feet wide and only if sheet flow is established and maintained)
- Filter system (see Section 4.10 Filtering Systems) If using a filter system as a pretreatment facility, the sand filter will not require its own separate pretreatment facility.
- A proprietary structure with demonstrated capability of reducing sediment and hydrocarbons may be used to provide pretreatment. Refer to Section 0 Proprietary Practices.

If the basin serves a CDA greater than 20,000 square feet, a forebay, sump pit, filter system, or proprietary practice must be used for pretreatment.

Exit velocities from the pretreatment chamber shall not be erosive (above 6 fps) during the 25-year design storm and flow from the pretreatment chamber should be evenly distributed across the width of the practice (e.g., using a level spreader).

#### 4.5.4 Infiltration Design Criteria Geometry

Where possible, an infiltration practice should be designed to be wider than it is deep, to avoid classification as a Class V injection well.

##### Practice Slope

The bottom of an infiltration practice should be flat (i.e., 0% longitudinal and lateral slopes) to enable even distribution and infiltration of stormwater.

##### Infiltration Basin Geometry

The maximum vertical depth to which runoff may be ponded over an infiltration basin is 24 inches. The side-slopes should be no steeper than 4H:1V.

##### Surface Cover (optional)

Designers may choose to install a layer of topsoil and grass above the infiltration practice.

##### Surface Stone

A 3-inch layer of clean, washed river stone or No. 8 or 89 stone should be installed over the stone layer.

##### Stone Layer

Stone layers must consist of clean, washed aggregate with a maximum diameter of 3.5 inches and a minimum diameter of 1.5 inches.

##### Observation Wells

All infiltration practices must include at least one observation well. The observation well is used to observe the rate of drawdown within the infiltration practice following a storm event and to facilitate periodic inspection and maintenance. The observation well should consist of a well-anchored, perforated 4- to 6-inch diameter PVC pipe. There should be no perforation within 1 foot of the surface. The observation well should extend vertically to the bottom of the stone layer and extend upward to the top of ponding.

#### **Underground Storage (optional)**

In the underground mode, runoff is stored in the voids of the stones and infiltrates into the underlying soil matrix. Perforated corrugated metal pipe, plastic pipe, concrete arch pipe, or comparable materials can be used in conjunction with the stone to increase the available temporary underground storage. In some instances, a combination of filtration and infiltration cells can be installed in the floor of a dry extended detention (ED) pond.

#### **Overflow Collection Pipe (Overdrain)**

An optional overflow collection pipe can be installed in the stone layer to convey collected runoff from larger storm events to a downstream conveyance system.

#### **Trench Bottom**

To protect the bottom of an infiltration trench from intrusion by underlying soils, a sand layer must be used. The underlying native soils must be separated from the stone layer by a 6- to 8-inch layer of coarse sand (e.g., ASTM C-33, 0.02–0.04 inches in diameter).

#### **Geotextile Fabric**

An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability must be used. This layer should be applied only to the sides of the practice.

#### **Material Specifications**

Recommended material specifications for infiltration areas are shown in Table 4.18.

Table 4.18. Infiltration practice material specifications.

Material	Specification	Notes
Surface Layer (optional)	Topsoil and grass layer	
Surface Stone	Install a 3-inch layer of river stone or pea gravel.	Provides an attractive surface cover that can suppress weed growth.
Stone Layer	Clean, double-washed aggregate with a maximum diameter of 3.5 inches and a minimum diameter of 1.5 inches.	
Observation Well	Install a vertical 6-inch Schedule 40 PVC perforated pipe, with a lockable cap and anchor plate.	Install one per 50 feet of length of infiltration practice.
Overflow Collection Pipe (optional)	Use 4- or 6-inch rigid schedule 40 PVC pipe, with three or four rows of 3/8-inch perforations at 6 inches on center.	
Trench Bottom	Install a 6- to 8-inch sand layer (e.g., ASTM C-33, 0.02–0.04 inches in diameter)	
Geotextile Fabric (sides only)	An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability must be used.	

**Practice Sizing**

The proper approach for designing infiltration practices is to avoid forcing a large amount of infiltration into a small area. Therefore, individual infiltration practices that are limited in size due to soil permeability and available space need not be sized to achieve the full design storm volume (SWR<sub>v</sub>) for the CDA, as long as other stormwater treatment practices are applied at the site to meet the remainder of the design storm volume.

Several equations (see following page) are needed to size infiltration practices. The first equations establish the maximum depth of the infiltration practice, depending on whether it is a surface basin (Equation 4.6) or trench with an underground reservoir (Equation 4.7)

Equation 4.6. Maximum surface basin depth for infiltration basins.

$$d_{\max} = K_{\text{sat}} \times t_d$$

Equation 4.7. Maximum underground reservoir depth for infiltration trenches.

$$d_{\max} = \frac{(K_{\text{sat}} \times t_d)}{\eta_r}$$

Where:

- $d_{\max}$  = Maximum depth of the infiltration practice (ft)
- $K_{\text{sat}}$  = Field-verified saturated hydraulic conductivity for the native soils (ft/day)
- $t_d$  = Maximum drawdown time (days, normally 3 days)
- $\eta_r$  = Available porosity of the stone reservoir (assume 0.4)

These equations make the following design assumptions:

▪ **Stone Layer Porosity**

A porosity value of 0.4 shall be used in the design of stone reservoirs, although a larger value may be used if perforated corrugated metal pipe, plastic pipe, concrete arch pipe, or comparable materials are installed within the reservoir.

▪ **Rapid Drawdown**

Infiltration practices must be sized so that the design volume infiltrates within 72 hours, to prevent nuisance ponding conditions.

Designers should compare these results to the maximum allowable depths in Table 4.19 and use whichever value is less for the subsequent design.

Table 4.19. Maximum facility depth for infiltration practices.

Mode of Entry	Scale of Infiltration		
	Micro Infiltration (250–2,500 ft <sup>2</sup> )	Small Scale Infiltration (2,500–20,000 ft <sup>2</sup> )	Conventional Infiltration (20,000–100,000 ft <sup>2</sup> )
Surface Basin	1.0	1.5	2.0
Underground Reservoir	3.0	5.0	varies

Once the maximum depth is known, calculate the surface area needed for an infiltration practice using Equation 4.8 or Equation 4.9.

Equation 4.8. Surface basin surface area for infiltration basins.

$$SA = \frac{\text{DesignStorm}}{d + (K_{\text{sat}} \times t_f)}$$

Equation 4.9. Underground reservoir surface area for infiltration trenches.

$$SSSS = \frac{\text{DesignStorm}}{(\eta_r \times d) + (0.5 \times K_{\text{sat}} \times t_f)}$$

Where:

SA = Surface area (square feet)

DesignStorm = SWRV or other design storm volume (e.g., portion of the SWRV; cubic feet)

$\eta_r$  = Available porosity of the stone reservoir (assume 0.4)

d = Infiltration depth (feet; maximum depends on the scale of infiltration and the results of Equation 4.6 or Equation 4.7)

$K_{\text{sat}}$  = Field-verified saturated hydraulic conductivity for the native soils (ft/day)

$t_f$  = Time to fill the infiltration facility (days; typically 2 hours or 0.083 days)

The storage volume (Sv) captured by the infiltration practice is defined as the volume of water that is fully infiltrated through the practice (i.e., no overflow). Designers may choose to infiltrate less than the full design storm (SWRV). In this case, the design volume captured must be treated as the Sv of the

practice (see Section 4.5.4 Infiltration Design Criteria).  $S_v$  can be determined by rearranging Equation 4.8 and Equation 4.9 to yield Equation 4.10 and Equation 4.11.

Equation 4.10. Storage volume for surface basin area for infiltration basins.

$$S_v = SA \times [d + (K_{sat} \times t_f)]$$

Equation 4.11. Storage volume for underground reservoir surface area for infiltration trenches.

$$S_v = SA \times [(\eta_r \times d) + (K_{sat} \times t_f)]$$

Infiltration practices can also be designed to address, in whole or in part, the detention storage needed to comply with channel protection and/or flood control requirements. The designer can model various approaches by factoring in storage within the stone aggregate layer, any perforated corrugated metal pipe, plastic pipe, concrete arch pipe, or comparable materials installed within the reservoir, expected infiltration, and any outlet structures used as part of the design. Routing calculations can also be used to provide a more accurate solution of the peak discharge and required storage volume.

#### 4.5.5 Infiltration Landscaping Criteria

Infiltration trenches can be effectively integrated into the site plan and aesthetically designed with adjacent native landscaping or turf cover, subject to the following additional design considerations:

- ② Infiltration practices should not be installed until all up-gradient construction is completed and pervious areas are stabilized with dense and healthy vegetation, unless the practice can be kept off-line so it receives no runoff until construction and stabilization is complete.
- ② Vegetation associated with the infiltration practice buffers should be regularly maintained to limit organic matter in the infiltration device and maintain enough vegetation to prevent soil erosion from occurring.

#### 4.5.6 Infiltration Construction Sequence

Infiltration practices are particularly vulnerable to failure during the construction phase for two reasons. First, if the construction sequence is not followed correctly, construction sediment can clog the practice. Second, loading from heavy construction equipment can result in compaction of the soil, which can then reduce the soil's infiltration rate. For this reason, a careful construction sequence needs to be followed.

During site construction, the following protective measures are absolutely critical:

- ② All areas proposed for infiltration practices should be fully protected from sediment intrusion by silt fence or construction fencing, particularly if they are intended to infiltrate runoff.
- ② Avoid excessive compaction by preventing construction equipment and vehicles from traveling over the proposed location of the infiltration practice. To accomplish this, areas intended to infiltrate runoff must remain outside the limits of disturbance during construction.
- ② When this is unavoidable, there are several possible remedies for the impacted area.
  - If excavation at the impacted area can be restricted then remediation can be achieved with deep tilling practices. This is only possible if in situ soils are not disturbed below 2 feet above the final design elevation of the bottom of the infiltration practice. In this case, when heavy equipment activity has ceased, the area is excavated to grade, and the impacted area must be tilled a minimum of 12 inches below the bottom of the infiltration practice.



- Alternatively, if it is infeasible to keep the proposed infiltration practice outside of the limits of disturbance, and excavation of the area cannot be restricted, then infiltration tests will be required prior to installation of the infiltration practice to ensure that the design infiltration rate is still present. If tests reveal the loss of design infiltration rates then deep tilling practices may be used in an effort to restore those rates. In this case further testing must be done to establish design rates exist before the infiltration practice can be installed.
  - Finally, if it is infeasible to keep the proposed permeable pavement areas outside of the limits of disturbance, excavation of the area cannot be restricted, and infiltration tests reveal design rates cannot be restored, then a resubmission of the SWMP will be required.
- ⑦ Any area of the site intended ultimately to be an infiltration practice should not be used as the site of a temporary sediment trap or basin. If locating a sediment trap or basin on an area intended for infiltration is unavoidable, the remedies are similar to those discussed for heavy equipment compaction. If it is possible, restrict the invert of the sediment trap or basin to at least 2 feet above the final design elevation of the bottom of the proposed infiltration practice. Then remediation can be achieved with proper removal of trapped sediments and deep tilling practices. An alternate approach to deep tilling is to use an impermeable linear to protect the in situ soils from sedimentation while the sediment trap or basin is in use. In each case, all sediment deposits must be carefully removed prior to installing the infiltration practice.
  - ⑦ Keep the infiltration practice off-line until construction is complete. Prevent sediment from entering the infiltration site by using super silt fence, diversion berms, or other means. In the soil erosion and sediment control plan, indicate the earliest time at which stormwater runoff may be directed to a conventional infiltration basin. The soil erosion and sediment control plan must also indicate the specific methods to be used to temporarily keep runoff from the infiltration site.
  - ⑦ Upland CDAs need to be completely stabilized with a well-established layer of vegetation prior to commencing excavation for an infiltration practice.

### **Infiltration Installation**

The actual installation of an infiltration practice is done using the following steps:

#### **1. Avoid Impact of Heavy Installation Equipment**

Excavate the infiltration practice to the design dimensions from the side using a backhoe or excavator. The floor of the pit should be completely level, but equipment should be kept off the floor area to prevent soil compaction.

#### **2. Hang Geotextile Walls**

Install geotextile fabric on the trench sides. Large tree roots should be trimmed flush with the sides of infiltration trenches to prevent puncturing or tearing of the geotextile fabric during subsequent installation procedures. When laying out the geotextile, the width should include sufficient material to compensate for perimeter irregularities in the trench and for a 6-inch minimum overlap at the top of the trench. The geotextile fabric itself should be tucked under the sand layer on the bottom of the infiltration trench. Stones or other anchoring objects should be placed on the fabric at the trench sides, to keep the trench open during windy periods. Voids may occur between the fabric and the excavated sides of a trench. Natural soils should be placed in all voids, to ensure the fabric conforms smoothly to the sides of excavation.

### **3. Promote Infiltration Rate**

Scarify the bottom of the infiltration practice and spread 6 inches of sand on the bottom as a filter layer.

### **4. Observation Wells**

Anchor the observation well(s) and add stone to the practice in 1-foot lifts.

### **5. Stabilize Surrounding Area**

Use sod, where applicable, to establish a dense turf cover for at least 10 feet around the sides of the infiltration practice, to reduce erosion and sloughing.

### **Construction Supervision**

Supervision during construction is recommended to ensure that the infiltration practice is built in accordance with the approved design and this specification. Qualified individuals should use detailed inspection checklists to include sign-offs at critical stages of construction, to ensure that the contractor's interpretation of the plan is consistent with the designer's intentions.

### **4.5.7 Infiltration Maintenance Criteria**

Maintenance is a crucial and required element that ensures the long-term performance of infiltration practices. The most frequently cited maintenance problem for infiltration practices is clogging of the stone layer by organic matter and sediment. The following design features can minimize the risk of clogging:

#### **Stabilized CDA**

Infiltration systems may not receive runoff until the entire CDA has been completely stabilized.

#### **Observation Well**

Infiltration practices must include an observation well to facilitate periodic inspection and maintenance. Design criteria must include an anchored 6-inch diameter perforated PVC pipe fitted with a lockable cap installed flush with the ground surface.

#### **No Geotextile Fabric on Bottom**

Avoid installing geotextile fabric along the bottom of infiltration practices. Experience has shown that geotextile fabric is prone to clogging. However, permeable geotextile fabric should be installed on the trench sides to prevent soil piping.

#### **Direct Maintenance Access**

Access must be provided to allow personnel and heavy equipment to perform atypical maintenance tasks, such as practice reconstruction or rehabilitation. While a turf cover is permissible for small-scale infiltration practices, the surface must never be covered by an impermeable material, such as asphalt or concrete.

#### **Maintenance Inspections**

Effective long-term operation of infiltration practices requires a dedicated and routine maintenance inspection schedule with clear guidelines and schedules, as shown in Table 4.20. Where possible, facility maintenance should be integrated into routine landscaping maintenance tasks.

Table 4.20. Typical maintenance activities for infiltration practices.

Schedule	Maintenance Activity
Quarterly	<ul style="list-style-type: none"> <li>Ensure that the CDA, inlets, and facility surface are clear of debris.</li> <li>Ensure that the CDA is stabilized. Perform spot-reseeding if where needed.</li> <li>Remove sediment and oil/grease from inlets, pretreatment devices, flow diversion structures, and overflow structures.</li> <li>Repair undercut and eroded areas at inflow and outflow structures.</li> </ul>
Semi-annual inspection	<ul style="list-style-type: none"> <li>Check observation wells 3 days after a storm event in excess of 0.5 inch in depth. Standing water observed in the well after 3 days is a clear indication of clogging.</li> <li>Inspect pretreatment devices and diversion structures for sediment build-up and structural damage.</li> </ul>
Annually	<ul style="list-style-type: none"> <li>Clean out accumulated sediment from the pretreatment cell.</li> </ul>
As needed	<ul style="list-style-type: none"> <li>Replace pea gravel/topsoil and top surface geotextile fabric (when clogged).</li> <li>Mow vegetated filter strips as necessary and remove the clippings.</li> </ul>

It is highly recommended that a qualified professional conduct annual site inspections for infiltration practices to ensure the practice performance and longevity of infiltration practices.

Beaufort County Public Works Departments's maintenance inspection checklist for infiltration systems and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### 4.5.8 Infiltration Stormwater Compliance Calculations

Infiltration practices are credited with 100% retention for the storage volume (Sv) provided by the practice as well as 100% TSS, TN, and bacteria removal (Table 4.21).

Table 4.21. Retention and pollutant removal for infiltration practices.

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

The practice must be sized using the guidance detailed in Section 4.3.4 Infiltration Design Criteria.

Infiltration practices also contribute to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume (Sv) from the total runoff volume for the 2-year through the 100-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate

peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

#### 4.6 Green Roofs

Green Roofs				
<b>Definition:</b> Practices that capture and store rainfall in an engineered growing media installed over a waterproof membrane that is designed to support plant growth on the roof of a building or other structure.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		100%	100%	100%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
High	Low	High		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	100% of Sv		
Semi-annually	As needed			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Reduces runoff volume and pollutant loads</li><li>▪ Energy savings: keep buildings cool, prolongs roof life</li><li>▪ Possible amenity space for public or users</li><li>▪ Sound absorption</li><li>▪ Life cycle costs comparable to traditional roof</li></ul>		<ul style="list-style-type: none"><li>▪ For retrofits, strengthening structure may be required</li><li>▪ If roof leaks occur, may be harder to trace</li><li>▪ Design and installation require specialized knowledge</li><li>▪ Typically applied on flat roofs (1%–2% pitch)</li><li>▪ Installation costs higher than for traditional roof</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Vegetation that thrives in rooftop climate.</li><li>▪ Engineered planting medium (not soil).</li><li>▪ Containment (Modular systems - plant containers; Non-modular systems - barriers at roof perimeter/drainage structures).</li><li>▪ Drainage layer, sometimes with built-in water reservoirs.</li><li>▪ Water proofing layer or roof membrane with root repellant.</li></ul>		<ul style="list-style-type: none"><li>▪ Good waterproofing material and installation are essential.</li><li>▪ Materials used must be lightweight.</li><li>▪ Building structure must be able to support saturated weight.</li><li>▪ Roofs with moderate to flat slopes are most appropriate. Maximum roof slope of 30%.</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Watering and fertilization until well-established</li><li>▪ Occasional weeding</li></ul>		<ul style="list-style-type: none"><li>▪ Inspection for proper drainage and plant health</li><li>▪ Ordinary life cycle roof replacement</li></ul>		

<sup>1</sup>Credited pollutant load removal

Green roofs are practices that capture and store rainfall in an engineered growing media that is designed to support plant growth (see Figure 4.20). A portion of the captured rainfall evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on development sites. Green roofs typically contain a layered system of roofing, which is designed to support plant growth and retain water for plant uptake while preventing ponding on the roof surface. The roofs are designed so that water drains vertically through the media and then horizontally along a waterproofing layer towards the outlet. Extensive green roofs are designed to have minimal maintenance requirements. Plant species are selected so that the roof does not need supplemental irrigation or fertilization after vegetation is initially established.

Green roofs are typically not designed to provide stormwater detention of larger storms (e.g., 2 - 25-year) although some intensive green roof systems may be designed to meet these criteria. Green roof designs should generally be combined with a separate facility to provide large storm controls.



Figure 4.20. Green roof (photo: Center for Watershed Protection, Inc.)

### **Definition**

Practices that capture and store rainfall in an engineered growing media installed over a waterproof membrane that is designed to support plant growth on the roof of a building or other structure. A portion of the captured rainfall evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on development sites. Green roofs typically contain a layered system of roofing, which is designed to support plant growth and retain water for plant uptake while preventing ponding on the roof surface. The roofs are designed so that water drains vertically through the media and then horizontally along a waterproofing layer towards the outlet. Plant species are selected so that the roof does not need supplemental irrigation and requires minimal, infrequent fertilization after vegetation is initially established.

Design variants include extensive and intensive green roofs.

- G-1 Extensive green roofs have a much shallower growing media layer that typically ranges from 3 to 8 inches thick and are designed to have minimal maintenance requirements.
- G-2 Intensive green roofs have a growing media layer that typically ranges from 8 to 48 inches thick.

Green roofs are typically not designed to provide stormwater detention of larger storms (e.g., 2 - 25-year) although some intensive green roof systems may be designed to meet these criteria. Most green roof designs shall generally be combined with a separate facility to provide large storm controls.

This specification is intended for situations where the primary design objective of the green roof is stormwater management and, unless specified otherwise, addresses the design of extensive roof systems. While rooftop practices such as urban agriculture may provide some retention, their primary design objective is not stormwater management and is not addressed in this specification.

#### **4.6.1 Green Roof Feasibility Criteria**

Green roofs are ideal for use on commercial, institutional, municipal, and multi-family residential buildings. They are particularly well-suited for use on ultra-urban development and redevelopment sites. Key constraints with green roofs include the following:

##### **Structural Capacity of the Roof**

When designing a green roof, designers must not only consider the stormwater storage capacity of the green roof but also its structural capacity to support the weight of the additional water. A conventional rooftop should typically be designed to support an additional 15 to 30 pounds per square foot (psf) for an extensive green roof. As a result, a structural engineer, architect, or other qualified professional should be involved with all green roof designs to ensure that the building has enough structural capacity to support a green roof. See Section 4.6.4 Green Roof Design Criteria for more information on structural design considerations.

##### **Hurricane-Prone Areas**

**As South Carolina is subject to hurricanes, some may be concerned about the durability of green roofs in high winds. Having good vegetative cover and root growth in the growing media is the most effective way to reduce wind erosion of the media during high winds. New green roofs where the plants have not yet deeply rooted are the most susceptible to plant damage and media blow-off in a hurricane. Therefore, it is best to install a green roof three or more months prior to hurricane season, to allow enough time for the plants to be established.**

##### **Roof Pitch**

Green roof storage volume is maximized on relatively flat roofs (a pitch of 1% to 2%). Some pitch is needed to promote positive drainage and prevent ponding and/or saturation of the growing media. Green roofs can be installed on rooftops with slopes up to 30% if baffles, grids, or strips are used to prevent slippage of the media. These baffles must be designed to ensure the roof provides adequate storage for the design storm. Slopes greater than 30% would be considered a green wall, which is not specifically identified as a stormwater BMP. Green walls can be used to receive cistern discharge (calculations are necessary to determine demand).

### **Roof Access**

Adequate, permanent access to the roof must be available to deliver construction materials and perform routine maintenance. A temporary ladder is not sufficient for access to the roof. Roof access can be achieved either by an interior stairway through a penthouse or by an alternating tread device with a roof hatch or trap door not less than 16 square feet in area and with a minimum dimension of 24 inches (NVRC, 2007). Designers should also consider how they will get construction materials up to the roof (e.g., by elevator or crane) and how the roof structure can accommodate material stockpiles and equipment loads. If material and equipment storage is required, rooftop storage areas must be identified and clearly marked based on structural load capacity of the roof.

### **Roof Type**

Green roofs can be applied to most roof surfaces. Certain roof materials, such as exposed treated wood and uncoated galvanized metal, may not be appropriate for green rooftops due to pollutant leaching through the media (Clark et al., 2008).

### **Setbacks**

Green roofs should not be located near rooftop electrical and HVAC systems. A 2-foot-wide vegetation-free zone is recommended along the perimeter of the roof with a 1-foot vegetation-free zone around all roof penetrations, to act as a firebreak. The 2-foot setback may be relaxed for small or low green roof applications where parapets have been properly designed.

### **Contributing Drainage Area**

It is recommended that the contributing drainage area (CDA) to a green roof be limited to the green roof itself. In cases where there will be additional CDA, the designer must provide sufficient design detail showing distribution of this additional runoff throughout the green roof area to prevent erosion or overloading of the roof growing media with the use of level spreaders, splash pads, perforated piping, or other flow dissipation techniques. The absolute maximum CDA to a green roof shall be no more than 100% larger than the area of the green roof (e.g., a 1,000-square-foot green roof can have no more than 1,000 square feet of additional impervious cover draining to it).

### **Local Building Codes**

The green roof design must comply with the local building codes with respect to roof drains and emergency overflow devices. Additionally, a structural engineer should certify that the design complies with structural building codes. For green roofs installed on historic buildings or in historic districts, consult local building codes and architectural review criteria to determine if any special requirements exist for green roof design or maintenance.

Additionally, a State of South Carolina registered structural engineer must certify that the design complies with State building structural codes. This is true for new construction as well as retrofit projects.

### **Economic Considerations**

Green roofs tend to be one of the most expensive BMPs on a per cubic foot captured basis. However, a green roof allows stormwater management to be achieved in otherwise unused space, a major benefit in space-constrained locations. Further, green roofs provide many other non-stormwater services with economic benefits, including increased insulation and roof life expectancy



#### **4.6.2 Green Roof Conveyance Criteria**

The green roof drainage layer (refer to Section 4.6.4 Green Roof Design Criteria) must convey flow from under the growing media directly to an outlet or overflow system such as a traditional rooftop downspout drainage system. The green roof drainage layer must be adequate to convey the volume of stormwater equal to the flow capacity of the overflow or downspout system without backing water up onto the rooftop or into the green roof media. Roof drains immediately adjacent to the growing media should be boxed and protected by flashing extending at least 3 inches above the growing media to prevent clogging. However, an adequate number of roof drains that are not immediately adjacent to the growing media must be provided so as to allow the roof to drain without 3 inches of ponding above the growing media.

#### **4.6.3 Green Roof Pretreatment Criteria**

Pretreatment is not necessary for green roofs.

#### **4.6.4 Green Roof Design Criteria Structural**

##### **Capacity of the Roof**

Green roofs can be limited by the additional weight of the fully saturated soil and plants, in terms of the physical capacity of the roof to bear structural loads. The designer shall consult with a licensed structural engineer to ensure that the building will be able to support the additional live and dead structural load and to determine the maximum depth of the green roof system and any needed structural reinforcement. Typically, the green roof manufacturer can provide specific background specifications and information on their product for planning and design.

In most cases, fully saturated extensive green roofs have loads of about 15 to 30 pounds per square foot, which is fairly similar to traditional new rooftops (12 to 15 pounds per square foot) that have a waterproofing layer anchored with stone ballast.

##### **Functional Elements of a Green Roof System**

A green roof is composed of up to nine different systems or layers that combine to protect the roof and maintain a vigorous cover (see Figure 4.21).

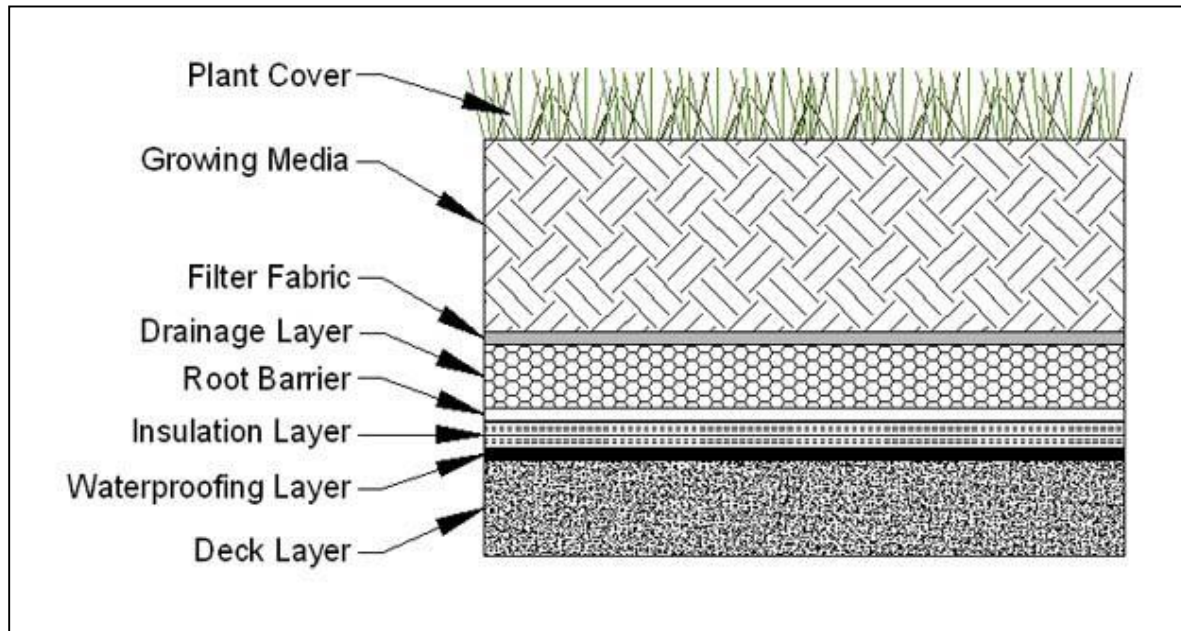


Figure 4.21. Green roof layers (note: the relative placement of various layers may vary depending on the type and design of the green roof system).

The design layers include the following:

1. **Deck Layer.** The roof deck layer is the foundation of a green roof. It may be composed of concrete, wood, metal, plastic, gypsum, or a composite material. The type of deck material determines the strength, load bearing capacity, longevity, and potential need for insulation in the green roof system.
2. **Leak Detection System (optional).** Leak detection systems are often installed above the deck layer to identify leaks, minimize leak damage through timely detection, and locate leak locations. Electric Field Vector Mapping (EFVM®) or other leak detection techniques are strongly recommended as part of the green roof installation process. In the case of EFVM, the deck material must be conductive. If it is not, an additional conductive medium may need to be added on top of the deck. Other leak detection systems may require additional materials between the deck layer and the waterproofing layer.
3. **Waterproofing Layer.** All green roof systems must include an effective and reliable waterproofing layer to prevent water damage through the deck layer. A wide range of waterproofing materials can be used, including hot applied rubberized asphalt, built up bitumen, modified bitumen, thermoplastic membranes, polyvinyl chloride (PVC), thermoplastic olefin membrane (TPO), and elastomeric membranes (EPDM) (see Weiler and Scholz-Barth, 2009, and Snodgrass and Snodgrass, 2006). The waterproofing layer must be 100% waterproof and have an expected life span as long as any other element of the green roof system. The waterproofing material may be loose laid or bonded (recommended). If loose laid, overlapping and additional construction techniques should be used to avoid water migration.
4. **Insulation Layer.** Many green rooftops contain an insulation layer, usually located above, but sometimes below, the waterproofing layer. The insulation increases the energy efficiency of the building and/or protects the roof deck (particularly for metal roofs). According to Snodgrass and Snodgrass (2006), the trend is to install insulation on the outside of the building, in part to avoid

mildew problems. The designer should consider the use of open or closed cell insulation depending on whether the insulation layer is above or below the waterproofing layer (and thus exposed to wetness), with closed cell insulation recommended for use above the waterproofing layer.

5. **Root Barrier.** Another layer of a green roof system, which can be either above or below the insulation layer depending on the system, is a root barrier that protects the waterproofing membrane from root penetration. Chemical root barriers or physical root barriers that have been impregnated with pesticides, metals, or other chemicals that could leach into stormwater runoff must be avoided in systems where the root barrier layer will come in contact with water or allow water to pass through the barrier.
6. **Drainage Layer and Drainage System.** A drainage layer is placed between the root barrier and the growing media to quickly remove excess water from the vegetation root zone. The selection and thickness of the drainage layer type is an important design decision that is governed by the desired stormwater storage capacity, the required conveyance capacity, and the structural capacity of the rooftop. The effective depth of the drainage layer is generally 0.25–1.5 inches thick for extensive green roof system and increases for intensive designs. The drainage layer should consist of synthetic or inorganic materials (e.g., 1–2-inch layer of clean, washed granular material (ASTM D448 size No. 8 stone or lightweight granular mix), high density polyethylene (HDPE)) that are capable of retaining water and providing efficient drainage (ASTM, 2017). A wide range of prefabricated water cups or plastic modules can be used, as well as a traditional system of protected roof drains, conductors, and roof leaders. ASTM E2396 and E2398 can be used to evaluate alternative material specifications (ASTM E2396, 2015 and ASTM E2398, 2015).
7. **Root-Permeable Filter Fabric.** A semi-permeable needled polypropylene filter fabric is normally placed between the drainage layer and the growing media to prevent the media from migrating into the drainage layer and clogging it. The filter fabric must not impede the downward migration of water into the drainage layer.
8. **Growing Media.** The next layer in an extensive green roof is the growing media, which is typically 3–8 inches deep. The recommended growing media for extensive green roofs is typically composed of approximately 70%–80% lightweight inorganic materials, such as expanded slates, shales or clays; pumice; scoria; or other similar materials. The media must contain no more than 30% organic matter, normally well-aged compost (see Appendix C Soil Compost Amendment Requirements). The percentage of organic matter should be limited, since it can leach nutrients into the runoff from the roof and clog the permeable filter fabric. It is advisable to mix the media in a batch facility prior to delivery to the roof. Manufacturer's specifications should be followed for all proprietary roof systems.

The composition of growing media for intensive green roofs may be different (although the organic material limit still applies), and it is often much greater in depth (e.g., 8–48 inches). If trees are included in the green roof planting plan, the growing media must be sufficient to provide enough soil volume for the root structure of mature trees.

9. **Plant Cover.** The top layer of an extensive green roof typically consists of plants that are slow-growing, shallow-rooted, perennial, and succulent. These plants are chosen for their ability to withstand harsh conditions at the roof surface. Guidance on selecting the appropriate green roof plants can often be provided by green roof manufacturers and can also be found in Snodgrass and Snodgrass (2006). A mix of base ground covers (usually *Sedum* species) and accent plants can be used to enhance the visual amenity value of a green roof. See Section 4.6.4 Green Roof Design Criteria for additional plant information. The design must provide for temporary, manual, and/or

permanent irrigation or watering systems, depending on the green roof system and types of plants. For most applications, some type of watering system should be accessible for initial establishment or drought periods. The use of water efficient designs and/or use of non-potable sources are strongly encouraged.

### **Material Specifications**

Standard specifications for North American green roofs continue to evolve, and no universal material specifications exist that cover the wide range of roof types and system components currently available. The ASTM has recently issued several overarching green roof standards, which are described and referenced in Table 4.22 below.

Designers and reviewers should also fully understand manufacturer specifications for each system component, particularly if they choose to install proprietary “complete” green roof systems or modules.

Table 4.22. Extensive Green Roof Material Specifications

Material	Specification
Roof	Structural capacity must conform to ASTM E2397, <i>Standard Practice for Determination of Dead Loads and Live Loads Associated with Vegetative (Green) Roof Systems</i> . In addition, use standard test methods ASTM E2398, <i>Standard Test Method for Water Capture and Media Retention of Geocomposite Drain Layers for Vegetated (Green) Roof Systems</i> and ASTM E2399, <i>Standard Test Method for Maximum Media Density for Dead Load Analysis of Vegetative (Green) Roof Systems</i> .
Leak Detection System	Optional system to detect and locate leaks in the waterproof membrane.
Waterproof Membrane	See Chapter 6 of Weiler and Scholz-Barth (2009) for waterproofing options that are designed to convey water horizontally across the roof surface to drains or gutter. This layer may sometimes act as a root barrier.
Root Barrier	Impermeable liner that impedes root penetration of the membrane.
Drainage Layer	Depth of the drainage layer is generally 0.25–1.5 inches thick for extensive designs. The drainage layer should consist of synthetic or inorganic materials (e.g., gravel, HDPE, etc.) that are capable of retaining water and providing efficient drainage. A wide range of prefabricated water cups or plastic modules can be used, as well as a traditional system of protected roof drains, conductors, and roof leaders. Designers should consult the material specifications as outlined in ASTM E2396 and E2398. Roof drains and emergency overflow must be designed in accordance with the local construction codes.

Material	Specification
Filter Fabric	<p>Generally, needle-punched, non-woven, polypropylene geotextile, with the following qualities:</p> <ul style="list-style-type: none"> <li>▪ Strong enough and adequate puncture resistance to withstand stresses of installing other layers of the green roof. Density as per ASTM D3776 <math>\geq 8</math> oz/yd<sup>2</sup>. Puncture resistance as per ASTM D4833 <math>\geq 130</math> lb. These values can be reduced with submission of a Product Data Sheet and other documentation that demonstrates applicability for the intended use.</li> <li>▪ Adequate tensile strength and tear resistance for long-term performance.</li> <li>▪ Allows a good flow of water to the drainage layer. Apparent Opening Size, as per ASTM D4751, of <math>\geq 0.06\text{mm} \leq 0.2\text{mm}</math>, with other values based on Product Data Sheet and other documentation as noted above.</li> <li>▪ Allows at least fine roots to penetrate.</li> <li>▪ Adequate resistance to soil borne chemicals or microbial growth both during construction and after completion since the fabric will be in contact with moisture and possibly fertilizer compounds.</li> </ul>
Growth Media	<p>70%–80% lightweight inorganic materials and a maximum of 30% organic matter (e.g., well-aged compost). Material makeup of the growing media must be provided. Media must provide sufficient nutrient and water holding capacity to support the proposed plant materials. Determine acceptable saturated water permeability using ASTM E2396. An acceptable emerging industry practice combines the drainage layer with the growing media layer.</p>
Plant Materials	<p><i>Sedum</i>, herbaceous plants, and perennial grasses that are shallow-rooted, low maintenance, and tolerant of full and direct sunlight, drought, wind, and frost. See ASTM E2400, <i>Standard Guide for Selection, Installation, and Maintenance of Plants for Green Roof Systems</i>.</p>

### **Solar Panels and Other Structures**

Occasionally, structures such as solar panels or HVAC systems must be installed above a green roof. These structures can be incorporated into a green roof design with no adverse effects to the retention credit assigned to the green roof if specific design requirements for runoff disbursement, maintenance access, and sun/wind exposure are incorporated, including the following:

- Structures above the green roof must be no more than 6.5 feet wide.
- Structures must have a minimum 3-foot separation between them.
- The lower edge of the structure must be at least 1 foot above the top of the green roof, and the upper edge must be at least 2.5 feet above the top of the green roof. This allows for at least a 15-degree tilt. For flatter installations, the lower edge would need to be raised to ensure that the 2.5-foot minimum for the upper edge is met.

These design requirements are illustrated in Figure 4.22.

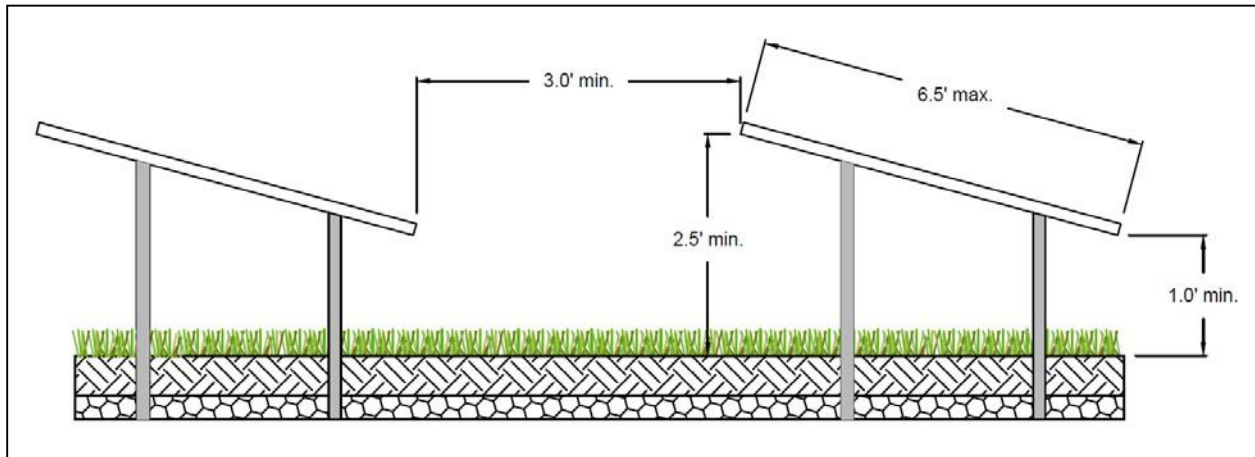


Figure 4.22. Design requirements for structures constructed above green roofs.

### **Green Roof Sizing**

Green roof areas can be designed to capture the entire Stormwater Retention Volume (SWR<sub>v</sub>). In some cases, they could be designed to capture larger design storm volumes as well. The required size of a green roof will depend on several factors, including maximum water retention of the growing media and the underlying drainage and storage layer materials, if present (e.g., prefabricated water cups or plastic modules). As maximum water retention can vary significantly between green roof products, verification of this value must be included with the Stormwater Management Plan (SWMP). Verification shall be provided by an ASTM-certified lab using the methods described by ASTM tests E2396, E2397, E2398, or E2399, as appropriate. In the absence of laboratory test results, the baseline default values must be used. Equation 4.12 below shall be used to determine the storage volume retained by a green roof.

Equation 4.12. Storage Volume for Green Roofs

$$S_v = \frac{SA \times [(d \times MWR_1) + (DL \times MWR_2)]}{12} \times IF$$

Where:

- $S_v$  = green roof storage volume (ft<sup>3</sup>)
- $SA$  = green roof area (ft<sup>2</sup>)
- $d$  = media depth (in.) (minimum 3 in.)
- $MWR_1$  = verified media maximum water retention (use 0.10 as a baseline default in the absence of verification data)
- $DL$  = drainage layer depth (in.) (if the drainage layer is combined with the media layer, then this value is 0)
- $MWR_2$  = verified drainage layer maximum water retention (use 0.0 as a baseline default in the absence of verification data)
- $IF$  = irrigation factor (0.5 for irrigated green roofs, 1.0 for unirrigated green roofs)

The appropriate  $S_v$  can then be compared to the required SWR<sub>v</sub> for the entire rooftop area (including all conventional roof areas) to determine the portion of the design storm captured.

Green roofs can have dramatic rate attenuation effects on larger storm events and may be used, in part, to manage a portion of the 2- to 25-year events. Designers can model various approaches by factoring in storage within the drainage layer. Routing calculations can also be used to provide a more accurate solution of the peak discharge and required storage volume.

#### 4.6.5 Green Roof Landscaping Criteria

Plant selection, landscaping, and maintenance are critical to the performance and function of green roofs. Therefore, a landscaping plan shall be provided for green roofs.

A planting plan must be prepared for a green roof by a landscape architect, botanist, or other professional experienced with green roofs and submitted with the SWMP.

Plant selection for green roofs is an integral design consideration, which is governed by local climate and design objectives. The primary ground cover for most green roof installations is a hardy, low-growing succulent, such as *Sedum*, *Delosperma*, *Talinum*, *Semperivum*, or *Hieracium* that is matched to the local climate conditions and can tolerate the difficult growing conditions found on building rooftops (Snodgrass and Snodgrass, 2006).

A list of some common green roof plant species that work well in the can South Lowcountry region be found in Table 4.23 below.

Table 4.23. Ground Covers Appropriate for Green Roofs in the State of South Carolina

Plant	Light	Moisture Requirement	Notes
<i>Delosperma cooperii</i>	Full Sun	Dry	Pink flowers; grows rapidly
<i>Delosperma 'Kelaidis'</i>	Full Sun	Dry	Salmon flowers; grows rapidly
<i>Delosperma nubigenum 'Basutoland'</i>	Full Sun	Moist-Dry	Yellow flowers; very hardy
<i>Sedum album</i>	Full Sun	Dry	White flowers; hardy
<i>Sedum lanceolatum</i>	Full Sun	Dry	Yellow flowers; native to U.S.
<i>Sedum oreganum</i>	Part Shade	Moist	Yellow flowers; native to U.S.
<i>Sedum stoloniferum</i>	Sun	Moist	Pink flowers; drought tolerant
<i>Sedum telephiodes</i>	Sun	Dry	Blue green foliage; native to region
<i>Sedum ternatum</i>	Part Shade	Dry-Moist	White flowers; grows in shade
<i>Talinum calycinum</i>	Sun	Dry	Pink flowers; self-sows

*Note: Designers should choose species based on shade tolerance, ability to sow or not, foliage height, and spreading rate. See Snodgrass and Snodgrass (2006) for a definitive list of green roof plants, including accent plants.*

- Plant choices can be much more diverse for deeper intensive green roof systems. Herbs, forbs, grasses, shrubs, and even trees can be used, but designers should understand they may have higher watering, weeding, and landscape maintenance requirements.
- The species and layout of the planting plan must reflect the location of the building, in terms of its height, exposure to wind, heat stress, orientation to the sun, and impacts from surrounding buildings. Wind scour and solar burning have been observed on green roof installations that failed to adequately account for neighboring building heights and surrounding window reflectivity. In addition, plants must be selected that are fire resistant and able to withstand heat, cold, and high winds.
- Designers should also match species to the expected rooting depth of the growing media, which can also provide enough lateral growth to stabilize the growing media surface. The planting plan should usually include several accent plants to provide diversity and seasonal color. For a comprehensive resource on green roof plant selection, consult Snodgrass and Snodgrass (2006).
- It is also important to note that most green roof plant species will not be native to the Chesapeake Bay watershed (which contrasts with native plant recommendations for other stormwater practices, such as bioretention and constructed wetlands).
- Given the limited number of green roof plant nurseries in the region, it may be necessary for designers to order plants 6 to 12 months prior to the expected planting date. It is also advisable to have plant materials contract grown.
- Plants can be established using cuttings, plugs, mats, and, more rarely, containers. Several vendors also sell mats, rolls, or proprietary green roof planting modules. For the pros and cons of each method, see Snodgrass and Snodgrass (2006). To achieve 50% coverage after 1 year and 80% coverage after 2 years, the recommended minimum spacing for succulent plantings is 2 plugs per square foot and 10 pounds per 100 square feet.
- When planting cuttings, plugs, and mats, the planting window extends from the spring to early fall; although, it is important to allow plants to root thoroughly before the first killing frost. Green roof manufacturers and plant suppliers may provide guidance on planting windows as well as winter care. Proper planting and care may also be required for plant warranty eligibility.
- When appropriate species are selected, most green roofs will not require supplemental irrigation, except for temporary irrigation during drought or initial establishment. The use of water-efficient designs and/or use of non-potable sources is strongly encouraged. Permanent irrigation of extensive roof designs is prohibited. For intensive roofs, permanent irrigation may be included. However, permanent irrigation can adversely impact the rainfall retention capacity of the green roof. For this reason, soil moisture monitors are a required part of the irrigation system for all irrigated green roofs, and the calculated storage volume for green roofs with permanent irrigation must be reduced by 50%.
- The goal for green roof systems designed for stormwater management is to establish a full and vigorous cover of low-maintenance vegetation that is self-sustaining (not requiring fertilizer inputs) and requires minimal mowing, trimming, and weeding.

The green roof design should include non-vegetated walkways (e.g., paver blocks) to allow for easy access to the roof for weeding and making spot repairs (see Section 4.6.4 Green Roof Design Criteria).



#### 4.6.6 Green Roof Construction Sequence Green

##### Roof Installation

Given the diversity of extensive vegetated roof designs, there is no typical step-by-step construction sequence for proper installation. The following general construction considerations are noted:

- Construct the roof deck with the appropriate slope and material.
- Install the waterproofing method, according to manufacturer's specifications.
- Conduct electric field vector mapping (EVFM®) or flood testing to ensure the system is watertight. Where possible, EVFM® is strongly recommended over the flood test, but not all impermeable membranes and deck systems are compatible with this method. Problems have been noted with the use of EFVM on black ethylene propylene diene terpolymer (EPDM) and with aluminized protective coatings commonly used in conjunction with modified bituminous membranes. If EVFM® or other leak detection systems are not possible, a flood test should be performed instead. The flood test is done by placing at least 2 inches of water over the membrane for 48 hours to confirm the integrity of the waterproofing system.
- Add additional system components (e.g., insulation, root barrier, drainage layer and interior drainage system, and filter fabric) per the manufacturer's specifications, taking care not to damage the waterproofing. Any damage occurring must be reported immediately. Drain collars and protective flashing should be installed to ensure free flow of excess stormwater.
- The growing media should be mixed prior to delivery to the site. Media must be spread evenly over the filter fabric surface as required by the manufacturer. If a delay between the installation of the growing media and the plants is required, adequate efforts must be taken to secure the growing media from erosion and the seeding of weeds. The growing media must be covered and anchored in place until planting. Sheets of exterior grade plywood can also be laid over the growing media to accommodate foot or wheelbarrow traffic. Foot traffic and equipment traffic should be limited over the growing media to reduce compaction beyond manufacturer's recommendations.
- The growing media should be moistened prior to planting, and then planted with the ground cover and other plant materials, per the planting plan or in accordance with ASTM E2400 (2015). Plants should be watered immediately after installation and routinely during establishment.
- It generally takes 2 to 3 growing seasons to fully establish the vegetated roof. The growing medium should contain enough organic matter to support plants for the first growing season, so initial fertilization is not required. Extensive green roofs may require supplemental irrigation during the first few months of establishment. Hand weeding is also critical in the first 2 years (see Table 10.1 of Weiler & Scholz-Barth (2009) for a photo guide of common rooftop weeds).
- Most construction contracts should contain a care and replacement warranty that specifies at least 50% coverage after 1 year and 80% coverage after 2 years for plugs and cuttings, and 90% coverage after 1 year for *Sedum* carpet/tile.

##### Construction Supervision

Supervision during construction is recommended to ensure that the vegetated roof is built in accordance with these specifications. Inspection checklists should be used that include sign-offs by qualified individuals at critical stages of construction and confirm that the contractor's interpretation of the plan is consistent with the intent of the designer and/or manufacturer.

An experienced installer should be retained to construct the vegetated roof system. The vegetated roof should be constructed in sections for easier inspection and maintenance access to the membrane and roof drains. Careful construction supervision/inspection is needed throughout the installation of a vegetated roof, as follows:

- During placement of the waterproofing layer, to ensure that it is properly installed and watertight.
- During placement of the drainage layer and drainage system.
- During placement of the growing media, to confirm that it meets the specifications and is applied to the correct depth (certification for vendor or source should be provided).
- Upon installation of plants, to ensure they conform to the planting plan (certification from vendor or source should be provided).
- Before issuing use and occupancy approvals.
- At the end of the first or second growing season to ensure desired surface cover specified in the Care and Replacement Warranty has been achieved.

Construction phase inspection checklist for green roof practices can be found in Appendix E Construction Inspection Checklists.

#### **4.6.7 Green Roof Maintenance Criteria**

##### **Maintenance Inspections**

A green roof should be inspected by a qualified professional twice a year during the growing season to assess vegetative cover and to look for leaks, drainage problems, and any rooftop structural concerns (see Table 4.24). In addition, the green roof should be hand weeded to remove invasive or volunteer plants, and plants and/or media should be added to repair bare areas (refer to ASTM E2400; ASTM, 2015).

If a roof leak is suspected, it is advisable to perform an electric leak survey (e.g., EVFM®), if applicable, to pinpoint the exact location, make localized repairs, and then reestablish system components and ground cover.

The use of herbicides, insecticides, and fungicides should be avoided, since their presence could hasten degradation of some waterproofing membranes. Check with the membrane manufacturer for approval and warranty information. Also, power washing and other exterior maintenance operations should be avoided so that cleaning agents and other chemicals do not harm the green roof plant communities.

Fertilization is generally not recommended due to the potential for leaching of nutrients from the green roof. Supplemental fertilization may be required following the first growing season, but only if plants show signs of nutrient deficiencies and a media test indicates a specific deficiency. Addressing this issue with the holder of the vegetation warranty is recommended. If fertilizer is to be applied, it must be a slow-release type, rather than liquid or gaseous form.

Maintenance inspection checklist for green roofs and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Table 4.24. Typical Maintenance Activities Associated with Green Roofs

Schedule (following construction)	Activity
As needed or As required by manufacturer	<ul style="list-style-type: none"> <li>Water to promote plant growth and survival.</li> <li>Inspect the green roof and replace any dead or dying vegetation.</li> </ul>
Semi-annually	<ul style="list-style-type: none"> <li>Inspect the waterproof membrane for leaks and cracks.</li> <li>Weed to remove invasive plants and tree seedlings (do not dig or use pointed tools where there is potential to harm the root barrier or waterproof membrane).</li> <li>Inspect roof drains, scuppers, and gutters to ensure they are not overgrown and have not accumulated organic matter deposits. Remove any accumulated organic matter or debris.</li> <li>Inspect the green roof for dead, dying, or invasive vegetation. Plant replacement vegetation as needed.</li> </ul>

**Waste Material**

Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

**4.6.8 Green Roof Stormwater Compliance Calculations**

Green roofs are credited with 100% retention for the storage volume (Sv) provided by the practice as well as 100% TSS, TN, and bacteria removal (see Table 4.25).

Table 4.25. Retention and pollutant removal of green roofs.

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

The practice must be designed using the guidance detailed in Section 4.6.4 Green Roof Design Criteria.

Green roofs also contribute to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume (Sv) from the total runoff volume for the design storms. The resulting reduced runoff volumes can then be used to calculate a reduced Natural Resource Conservation Service (NRCS) curve number (CN) for the site or site drainage area (SDA). The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

#### 4.7 Rainwater Harvesting

Rainwater Harvesting				
<b>Definition:</b> Rainwater harvesting systems store rainfall and release it for future use. Rainwater that falls on a rooftop or other impervious surface is collected and conveyed into an above- or below-ground tank (also referred to as a cistern) or settling pond, where it is stored for non-potable uses.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		Varies*	Varies*	Varies*
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
Low to Moderate	Moderate	Varies*		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	100% of Available Storage Volume		
Quarterly	Every 3 years			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Reduces runoff rates and volume</li><li>▪ Can provide for/supplement irrigation needs</li></ul>		<ul style="list-style-type: none"><li>▪ Stored water must be used on regular basis to maintain capacity</li><li>▪ Stagnant water can breed mosquitos</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Pretreatment</li><li>▪ Conveyance</li><li>▪ First flush diverter</li><li>▪ Cistern (storage tank)</li><li>▪ Overflow</li><li>▪ Low water cutoff</li></ul>		<ul style="list-style-type: none"><li>▪ Plumbing codes (for indoor tanks)</li><li>▪ Size based on CDA, local rainfall patterns, and projected harvest rainwater demand</li><li>▪ Location and elevation of cistern</li><li>▪ Tank manufacturer’s specifications</li><li>▪ Irrigation system and application rates</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Inspect/clean pretreatment devices and first flush diverts</li><li>▪ Clear gutter/downspouts</li></ul>		<ul style="list-style-type: none"><li>▪ Inspect and clean storage tank</li><li>▪ Maintenance log required</li></ul>		

<sup>1</sup>Credited pollutant load removal

\*Varies according to rainwater harvesting storage capacity and demand

Rainwater harvesting systems store rainfall for future, non-potable water uses and on-site stormwater disposal/infiltration. By providing a reliable and renewable source of water to end users, rainwater harvesting systems can also have environmental and economic benefits beyond stormwater management (e.g. increased water conservation, water supply during drought and mandatory municipal water supply restrictions, decreased demand on municipal or groundwater supply, decreased water costs for the end-user, potential for increased groundwater recharge, supply of water post storm/hurricane in case of failed municipal infrastructure etc.).

### **Definition**

Rainwater harvesting systems store rainfall and release it for future use. Rainwater that falls on a rooftop or other impervious surface is collected and conveyed into an above- or below-ground tank (also referred to as a cistern) or settling pond where it is stored for non-potable uses or for on-site disposal or infiltration as stormwater. Cisterns can be sized for commercial as well as residential purposes (see Figure 4.23). Residential cisterns are commonly called rain barrels.



Figure 4.23. Example cistern application (photo: Marty Morganello).

The design includes the following:

#### R-1 Rainwater harvesting for non-potable uses

Non-potable uses of harvested rainwater may include the following:

- Landscape irrigation,
- Exterior washing (e.g., car washes, building facades, sidewalks, street sweepers, and fire trucks),
- Flushing of toilets and urinals,
- Fire suppression (e.g., sprinkler systems),
- Supply for cooling towers, evaporative coolers, fluid coolers, and chillers,
- Supplemental water for closed loop systems and steam boilers,
- Replenishment of water features and water fountains,
- Distribution to a green wall or living wall system, and
- Laundry.

Rainwater stored in a settling pond may only be used for landscape irrigation. Pond design criteria in Section 4.10 and landscaping criteria of Section 4.5.5 shall be followed.

The seven primary components of an enclosed rainwater harvesting system are discussed in detail in Section 4.5.4 Rainwater Harvesting Design Criteria. Some are depicted in Figure 4.25 . The components include the following:

- CDA surface,
- Collection and conveyance system (e.g., gutter and downspouts; number 1 in Figure 4.24)
- Pretreatment, including prescreening and first flush diverters (number 2 in Figure 4.24)
- Cistern (no number, but depicted in Figure 4.24)
- Water quality treatment (as required by Appendix J Rainwater Harvesting Treatment and Management Requirements)
- Distribution system
- Overflow, filter path, or secondary stormwater retention practice (number 8 in Figure 4.24)

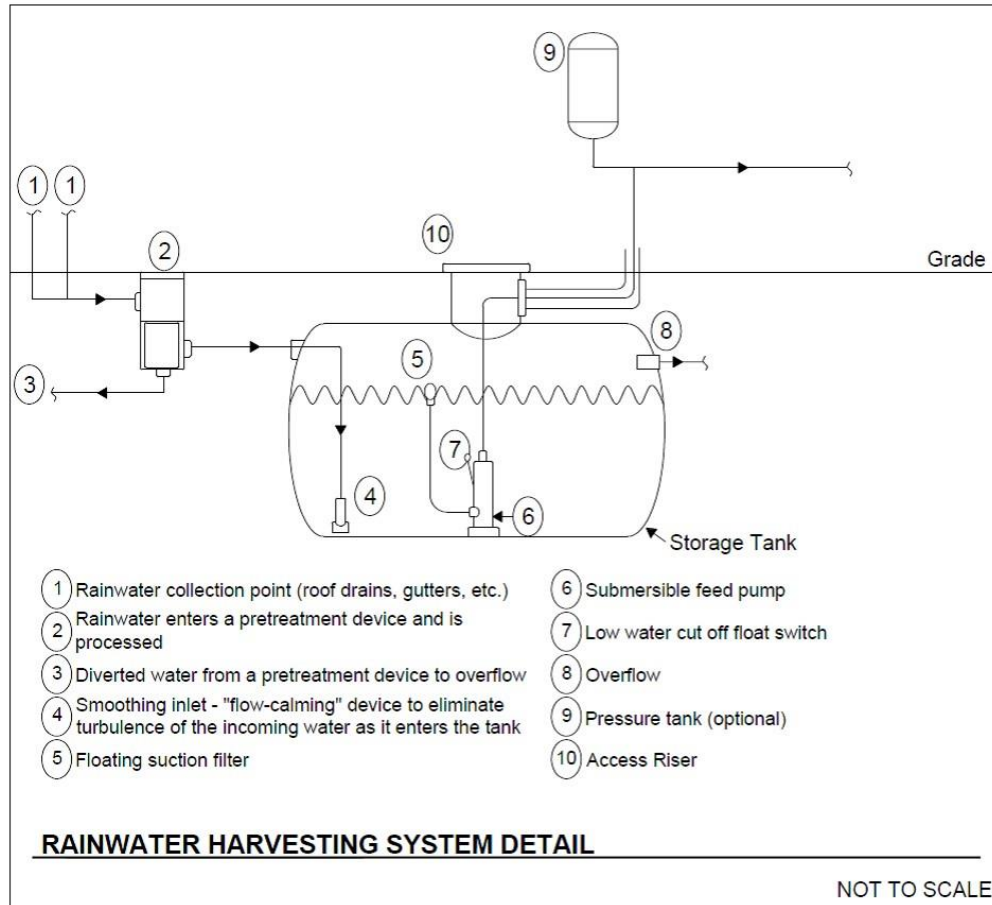


Figure 4.24. Example of a rainwater harvesting system detail.

#### 4.7.1 Rainwater Harvesting Feasibility Criteria

Several site-specific features influence how rainwater harvesting systems are designed and/or utilized. The following are key considerations for rainwater harvesting feasibility. They are not comprehensive or conclusive; rather, they are recommendations to consider during the planning process to incorporate rainwater harvesting systems into the site design.

##### **Plumbing Code**

Designers and plan reviewers should consult with local construction codes to determine the allowable indoor uses and required treatment for harvested rainwater. This specification does not address indoor plumbing or disinfection issues. Designers and plan reviewers should refer to the 2012 Uniform Plumbing Code - Chapter 17 Non-potable Rainwater Catchment Systems, or local plumbing codes, as applicable.

##### **Mechanical, Electrical, Plumbing**

For systems that call for indoor use of harvested rainwater, the seal of a mechanical, electrical, and plumbing engineer is required.

##### **Water Use**

When rainwater harvesting will be used, the requirements in Appendix J Rainwater Harvesting Treatment and Management Requirements must be followed. This will outline the design assumptions and provide water quality end use standards.

### **Available Space**

Adequate space is needed to house the cistern and any overflow. Space limitations are rarely a concern with rainwater harvesting systems if they are considered during the initial building design and site layout of a residential or commercial development. Cisterns can be placed underground, indoors, adjacent to buildings, and on rooftops that are structurally designed to support the added weight. Designers can work with architects and landscape architects to creatively site the cisterns. Underground utilities or other obstructions should always be identified prior to final determination of the cistern location.

### **Site Topography**

Site topography and cistern location should be considered as they relate to every inlet and outlet invert elevation in the rainwater harvesting system.

The final invert of the cistern outlet pipe at the discharge point must match the invert of the receiving mechanism (e.g., natural channel, storm drain system) and be sufficiently sloped to adequately convey this overflow. The elevation drops associated with the various components of a rainwater harvesting system and the resulting invert elevations should be considered early in the design, to ensure that the rainwater harvesting system is feasible for the particular site.

Site topography and cistern location will also affect pumping requirements. Locating cisterns in low areas will make it easier to get water into the cisterns; however, it will increase the amount of pumping needed to distribute the harvested rainwater back into the building or to irrigated areas situated on higher ground. Conversely, placing cisterns at higher elevations may require larger diameter pipes with smaller slopes but will generally reduce the amount of pumping needed for distribution. It is often best to locate a cistern close to the building or SDA, to limit the amount of pipe needed.

### **Available Hydraulic Head**

The required hydraulic head depends on the intended use of the water. For residential landscaping uses, the cistern may be sited up-gradient of the landscaping areas or on a raised stand. Pumps are commonly used to convey stored rainwater to the end use to provide the required head. When the water is being routed from the cistern to the inside of a building for non-potable use, often a pump is used to feed a much smaller pressure tank inside the building, which then serves the internal water demands. Cisterns can also use gravity to accomplish indoor residential uses (e.g., laundry) that do not require high water pressure.

### **Water Table**

Underground storage tanks are most appropriate in areas where the tank can be buried above the water table. The tank should be located in a manner that does not subject it to flooding. In areas where the tank is to be buried partially below the water table, special design features must be employed, such as sufficiently securing the tank (to keep it from floating) and conducting buoyancy calculations when the tank is empty. The tank may need to be secured appropriately with fasteners or weighted to avoid uplift buoyancy. The combined weight of the tank and hold-down ballast must meet or exceed the buoyancy force of the cistern. The cistern must also be installed according to the cistern manufacturer's specifications.

### **Soils**

Cisterns should only be placed on native soils or on fill in accordance with the manufacturer's guidelines. The bearing capacity of the soil upon which the cistern will be placed must be considered, as full cisterns can be very heavy. This is particularly important for above-ground cisterns, as significant settling could



cause the cistern to lean or in some cases to potentially topple. A sufficient aggregate, or concrete foundation, may be appropriate depending on the soils and cistern characteristics. Where the installation requires a foundation, the foundation must be designed to support the cistern's weight when the cistern is full, consistent with the bearing capacity of the soil and good engineering practice. The pH of the soil should also be considered in relation to its interaction with the cistern material.

### **Proximity of Underground Utilities**

All underground utilities must be taken into consideration during the design of underground rainwater harvesting systems, treating all of the rainwater harvesting system components and storm drains as typical stormwater facilities and pipes. The underground utilities must be marked and avoided during the installation of underground cisterns and piping associated with the system.

### **Contributing Drainage Area**

The CDA to the cistern is the area draining to the cistern. Rooftop surfaces are what typically make up the CDA, but paved areas can be used with appropriate treatment (oil/water separators and/or debris excluders).

### **Contributing Drainage Area Material**

The quality of the harvested rainwater will vary according to the roof material or CDA over which it flows. Water harvested from certain types of rooftops and CDAs, such as asphalt sealcoats, tar and gravel, painted roofs, galvanized metal roofs, sheet metal, or any material that may contain asbestos may leach trace metals and other toxic compounds. In general, harvesting rainwater from such surfaces should be avoided. If harvesting from a sealed or painted roof surface is desired, it is recommended that the sealant or paint be certified for such purposes to the NSF International NSF Protocol P151 standard.

### **Water Quality of Rainwater**

Designers should also note that the pH of rainfall in the State tends to be acidic (ranging from 4.5 to 5.0), which may result in leaching of metals from roof surfaces, cistern lining, or water laterals, to interior connections. Once rainfall leaves rooftop surfaces, pH levels tend to be slightly higher, ranging from 5.5 to 6.0. Limestone or other materials may be added in the cistern to buffer acidity, if desired.

### **Pollutant Hotspot Land Uses**

Harvesting rainwater can be an effective method to prevent contamination of rooftop runoff that would result from its mixing with ground-level runoff from a stormwater hotspot operation.

### **Setbacks from Buildings**

Cistern overflow devices must be designed to avoid causing ponding or soil saturation within 10 feet of building foundations. While most systems are generally sited underground and more than 10 feet laterally from the building foundation wall, some cisterns are incorporated into the basement of a building or underground parking areas. In any case, cisterns must be designed to be watertight to prevent water damage when placed near building foundations.

### **Vehicle Loading**

Whenever possible, underground rainwater harvesting systems should be placed in areas without vehicle traffic or other heavy loading, such as deep earth fill. If site constraints dictate otherwise, systems must be designed to support the loads to which they will be subjected.

### **Feasibility**

Rainwater harvesting systems are very well suited to the warm environment of South Carolina and may help to relieve some of the pressure on drinking water aquifers, if applied on a wide scale. In areas with a high-water table, above ground installations will often be more appropriate.

### **Economic Considerations**

Rainwater harvesting systems can provide cost savings by replacing or augmenting municipal water supply needs.

#### **4.7.2 Rainwater Harvesting Conveyance Criteria Collection and Conveyance**

The collection and conveyance systems consist of the gutters, downspouts, and pipes that channel rainfall into cisterns. Gutters and downspouts should be designed as they would for a building without a rainwater harvesting system.

Pipes, which connect downspouts to the cistern, should be at a minimum slope of 1.5% and sized/ designed to convey the intended design storm, as specified above. In some cases, a steeper slope and larger sizes may be recommended and/or necessary to convey the required runoff, depending on the design objective and design storm intensity. Gutters and downspouts should be kept clean and free of debris and rust.

### **Overflow**

An overflow mechanism must be included in the rainwater harvesting system design in order to handle an individual storm event or multiple storms in succession that exceed the capacity of the cistern. The overflow pipe(s) must have a capacity greater than or equal to the inflow pipe(s) and have a diameter and slope sufficient to drain the cistern while maintaining an adequate freeboard height. The overflow pipe(s) must be screened to prevent access to the cistern by small mammals and birds and must include a backflow preventer if it connects directly to the combined sewer or storm sewer. All overflow from the system must be directed to an acceptable flow path that will not cause erosion during a 2-year storm event.

#### **4.7.3 Rainwater Harvesting Pretreatment Criteria**

Prefiltration is required to keep sediment, leaves, contaminants, and other debris from the system. Leaf screens and gutter guards meet the minimal requirement for prefiltration of small systems, although direct water filtration is preferred. The purpose of prefiltration is to significantly cut down on maintenance by preventing organic buildup in the cistern, thereby decreasing microbial food sources.

Various pretreatment devices are described below. In addition to the initial first flush diversion, filters have an associated efficiency curve that estimates the percentage of rooftop runoff that will be conveyed through the filter to the cistern. If filters are not sized properly, a large portion of the rooftop runoff may be diverted and not conveyed to the cistern at all. A design intensity of 1 inch per hour (for design storm = SWRV) must be used for the purposes of sizing pre-cistern conveyance and filter components. This design intensity captures a significant portion of the total rainfall during a large majority of rainfall events (NOAA, 2004). If the system will be used for channel and flood protection, the 2- to 25-year storm intensities must be used for the design of the conveyance and pretreatment portion of the system. The Appendix K Rainwater Harvesting Storage Volume Calculator, discussed in Section 4.7.4-Rainwater Harvesting Design Criteria, allows for input of variable filter efficiency rates for the

design storm. To meet the requirements to manage the 2- to 25-year storms, a minimum filter efficiency of 90% must be met.

- **First Flush Diverters.** First flush diverters (see Figure 4.25) direct the initial pulse of rainfall away from the cistern. While leaf screens effectively remove larger debris such as leaves, twigs, and blooms from harvested rainwater, first flush diverters can be used to remove smaller contaminants such as dust, pollen, and bird and rodent feces.
- **Leaf Screens.** Leaf screens are mesh screens installed over either the gutter or downspout to separate leaves and other large debris from rooftop runoff. Leaf screens must be regularly cleaned to be effective; if not maintained, they can become clogged and prevent rainwater from flowing into the cisterns. Built-up debris can also harbor bacterial growth within gutters or downspouts (Texas Water Development Board, 2005).
- **Roof Washers.** Roof washers are placed just ahead of cisterns and are used to filter small debris from harvested rainwater (see Figure 4.26). Roof washers consist of a cistern, usually between 25 and 50 gallons in size, with leaf strainers and a filter with openings as small as 30 microns. The filter functions to remove very small particulate matter from harvested rainwater. All roof washers must be cleaned on a regular basis.
- **Hydrodynamic Separator.** For large-scale applications, hydrodynamic separators and other devices can be used to filter rainwater from larger CDAs.

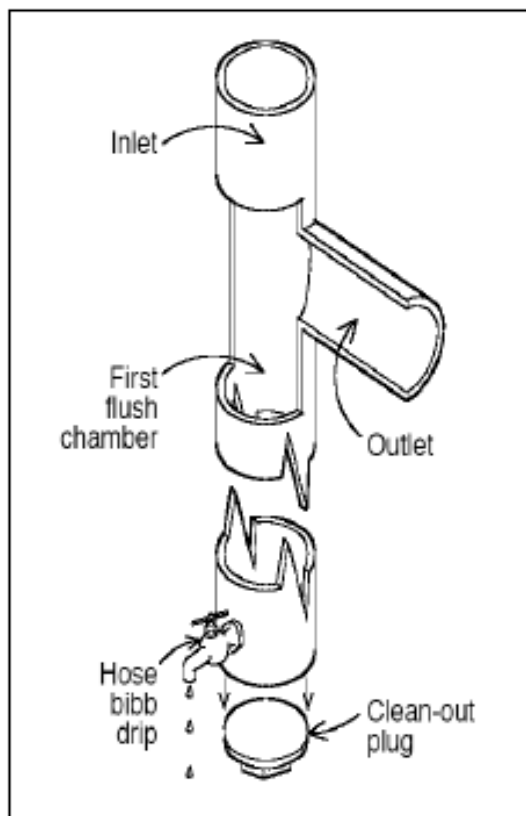


Figure 4.25. Diagram of a first flush diverter (photo: Texas Water Development Board, 2005).

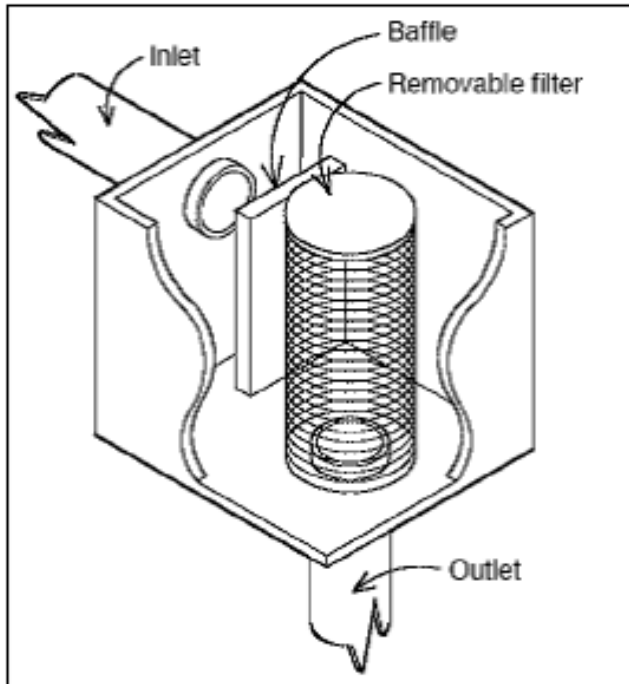


Figure 4.26. Diagram of a roof washer (photo: Texas Water Development Board, 2005).

#### 4.7.4 Rainwater Harvesting Design Criteria

System Components: Seven primary components of a rainwater harvesting system require special considerations:

- ❑ CDA or CDA surface
- ❑ Collection and conveyance system (i.e., gutter and downspouts)
- ❑ Cisterns (Storage Tank)
- ❑ Pretreatment, including prescreening and first flush diverters
- ❑ Water quality treatment (as described in Appendix J Rainwater Harvesting Treatment and Management Requirements)
- ❑ Distribution systems
- ❑ Overflow, filter path, or secondary stormwater retention practice

The system components are discussed below:

##### **CDA Surface**

When considering CDA surfaces, smooth, non-porous materials will drain more efficiently. Slow drainage of the CDA leads to poor rinsing and a prolonged first flush, which can decrease water quality.

Rainwater can also be harvested from other impervious surfaces, such as parking lots and driveways; however, this practice requires more extensive pretreatment and treatment prior to use.

### **Collection and Conveyance System**

See Section 1544.7.2 Rainwater Harvesting Conveyance Criteria.

### **Pretreatment**

See Section 4.7.3 Rainwater Harvesting Pretreatment Criteria.

### **Cisterns (Storage Tank)**

Also known as the storage tank, the cistern is the most important and typically the most expensive component of a rainwater harvesting system. Cistern capacities generally range from 250 to 30,000 gallons, but they can be as large as 100,000 gallons or more for larger projects. Multiple cisterns can be placed adjacent to each other and connected with pipes to balance water levels and to tailor the storage volume needed. Typical rainwater harvesting system capacities for residential use range from 1,500 to 5,000 gallons. Cistern volumes are calculated to meet the water demand and stormwater storage volume retention objectives, as described further below in this specification.

While many of the graphics and photos in this specification depict cisterns with a cylindrical shape, the cisterns can be made of many materials and configured in various shapes, depending on the type used and the site conditions where the cisterns will be installed. For example, configurations can be rectangular, L-shaped, or step vertically to match the topography of a site. The following factors should be considered when designing a rainwater harvesting system and selecting a cistern:

- Aboveground cisterns should be ultraviolet and impact resistant.
- Underground cisterns must be designed to support the overlying sediment and any other anticipated loads (e.g., vehicles, pedestrian traffic).
- Underground rainwater harvesting systems must have a standard size manhole or equivalent opening to allow access for cleaning, inspection, and maintenance purposes. The access opening must be installed in such a way as to prevent surface- or groundwater from entering through the top of any fittings, and it must be secured/locked to prevent unwanted entry. Confined space safety precautions/requirements should be observed during cleaning, inspection, and maintenance.
- All rainwater harvesting systems must be sealed using a water-safe, non-toxic substance.
- Rainwater harvesting systems may be ordered from a manufacturer or can be constructed on site from a variety of materials. Table 4. 26 compares the advantages and disadvantages of different cistern materials.
- Cisterns must be opaque or otherwise protected from direct sunlight to inhibit growth of algae, and they must be screened to discourage mosquito breeding.
- Dead storage below the outlet to the distribution system and an air gap at the top of the cistern must be included in the total cistern volume. For gravity-fed systems, a minimum of 6 inches of dead storage must be provided. For systems using a pump, the dead storage depth will be based on the pump specifications.
- Any hookup to a municipal backup water supply must have a backflow prevention device to keep municipal water separate from stored rainwater; this may include incorporating an air gap to separate the two supplies.

Table 4. 26. Advantages and Disadvantages of Typical Cistern Materials

Cistern Material	Advantages	Disadvantages
Fiberglass	Commercially available, alterable and moveable; durable with little maintenance; light weight; integral fittings (no leaks); broad application	Must be installed on smooth, solid, level footing; pressure proof for below-ground installation; expensive in smaller sizes
Polyethylene	Commercially available, alterable, moveable, affordable; available in wide range of sizes; can install above or below ground; little maintenance; broad application	Can be UV-degradable; must be painted or tinted for above-ground installations; pressure-proof for below-ground installation
Modular Storage	Can modify to topography; can alter footprint and create various shapes to fit site; relatively inexpensive	Longevity may be less than other materials; higher risk of puncturing of watertight membrane during construction
Plastic Barrels	Commercially available; inexpensive	Low storage capacity (20–50 gallons); limited application
Galvanized Steel	Commercially available, alterable, and moveable; available in a range of sizes; film develops inside to prevent corrosion	Possible external corrosion and rust; must be lined for potable use; can only install above ground; soil pH may limit underground applications
Steel Drums	Commercially available, alterable, and moveable	Small storage capacity; prone to corrosion, and rust can lead to leaching of metals; verify prior to reuse for toxics; water pH and soil pH may also limit applications
FerroConcrete	Durable and immovable; suitable for above or below ground installations; neutralizes acid rain	Potential to crack and leak; expensive
Cast-in-Place Concrete	Durable, immovable, and versatile; suitable for above or below ground installations; neutralizes acid rain	Potential to crack and leak; permanent; will need to provide adequate platform and design for placement in clay soils
Stone or Concrete Block	Durable and immovable; keeps water cool in summer months	Difficult to maintain; expensive to build

Source: Cabell Brand Center, 2007; Cabell Brand Center, 2009

#### ? Water Quality Treatment

Depending upon the collection surface, method of dispersal, and proposed use for the harvested rainwater, a water quality treatment device may be required. Treatment requirements are described in Appendix J Rainwater Harvesting Treatment and Management Requirements.

#### ? Distribution Systems

Most distribution systems require a pump to convey harvested rainwater from the cistern to its final destination, whether inside the building, an automated irrigation system, or gradually discharged to a secondary stormwater treatment practice. The rainwater harvesting system should be equipped with an appropriately sized pump that produces sufficient pressure for all end-uses.

The typical pump and pressure tank arrangement consists of a multi-stage, centrifugal pump, which draws water out of the cistern and sends it into the pressure tank, where it is stored for distribution. Some systems will not require this two-tank arrangement (e.g., low-pressure and gravel systems). When water is drawn out of the pressure tank, the pump activates to supply additional water to the distribution system. The backflow preventer is required to separate harvested rainwater from the main potable water distribution lines.

A drain plug or cleanout sump must be installed to allow the system to be completely emptied, if needed. Above-ground outdoor pipes must be insulated or heat-wrapped to prevent freezing and ensure uninterrupted operation during winter if winter use is planned.

#### **❓ Overflow**

See Section 4.7.2 Rainwater Harvesting Conveyance Criteria.

### **Rainwater Harvesting Material Specifications**

The basic material specifications for rainwater harvesting systems are presented in Table 4.27. Designers should consult with experienced rainwater harvesting system and irrigation installers on the choice of recommended manufacturers of prefabricated cisterns and other system components.

Table 4.27. Design Specifications for Rainwater Harvesting Systems

Item	Specification
Gutters and Downspouts	<p>Materials commonly used for gutters and downspouts include polyvinylchloride (PVC) pipe, vinyl, aluminum, and galvanized steel. Lead must not be used as gutter and downspout solder, since rainwater can dissolve the lead and contaminate the water supply.</p> <ul style="list-style-type: none"> <li>▪ The length of gutters and downspouts is determined by the size and layout of the catchment and the location of the cisterns.</li> <li>▪ Include needed bends and tees.</li> </ul>
Pretreatment	<p>At least one of the following (all rainwater to pass through pretreatment):</p> <ul style="list-style-type: none"> <li>▪ First flush diverter</li> <li>▪ Hydrodynamic separator</li> <li>▪ Roof washer</li> <li>▪ Leaf and mosquito screen (1 mm mesh size)</li> </ul>
Cisterns	<ul style="list-style-type: none"> <li>▪ Materials used to construct cisterns must be structurally sound.</li> <li>▪ Cisterns should be constructed in areas of the site where soils can support the load associated with stored water.</li> <li>▪ Cisterns must be watertight and sealed using a water-safe, non-toxic substance.</li> <li>▪ Cisterns must be opaque or otherwise shielded to prevent the growth of algae.</li> <li>▪ The size of the rainwater harvesting system(s) is determined through design calculations.</li> </ul>

Note: This table does not address indoor systems or pumps.

### **Design Objectives and System Configuration**

Rainwater harvesting systems can have many design variations that meet user demand and stormwater objectives. This specification provides a design framework to achieve the SWRv objectives that are required to comply with the regulations, and it adheres to the following concepts:

- ② Give preference to use of rainwater as a resource to meet on-site demand or in conjunction with other stormwater retention practices.
- ② Reduce peak flow by achieving volume reduction and temporary storage of runoff.

Based on these concepts, this specification focuses on system design configurations that harvest rainwater for internal building uses, seasonal irrigation, and other activities, such as cooling tower use and vehicle washing. While harvested rainwater will be in year-round demand for many internal building uses, some other uses will have varied demand depending on the time of year (e.g., cooling towers and seasonal irrigation). Thus, a lower retention volume is assigned to a type of use that has reduced demand.

### **Design Objectives & Cistern Design Set-Ups**

Prefabricated rainwater harvesting cisterns typically range in size from 250 to over 30,000 gallons. Three basic cistern designs meet the various rainwater harvesting system configurations in this section.

**Cistern Design 1.** The first cistern set-up (Figure 4.27) maximizes the available storage volume to meet the desired level of stormwater retention. This layout also maximizes the storage that can be used to meet a demand. An emergency overflow exists near the top of the cistern as the only gravity release outlet device (not including the pump, manway, or inlets). It should be noted that it is possible to address 2- to 25-year storm volumes with this cistern configuration, but the primary purpose is to address the smaller SWRv design storm.

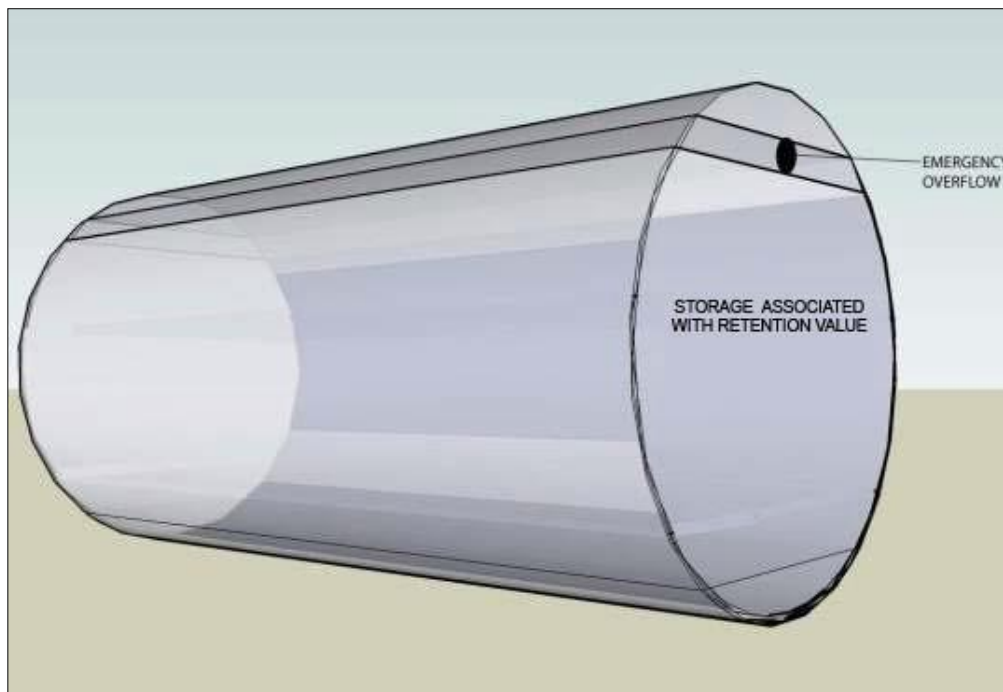


Figure 4.27. Cistern Design 1: Storage associated with the design storm volume only.



**Cistern Design 2.** The second cistern set-up (Figure 4.28) uses cistern storage to meet the SWRv retention objectives and also uses additional detention volume to meet some or all of the 2- to 25-year storm volume requirements. An orifice outlet is provided at the top of the design storage for the SWRv level, and an emergency overflow is located at the top of the detention volume level.

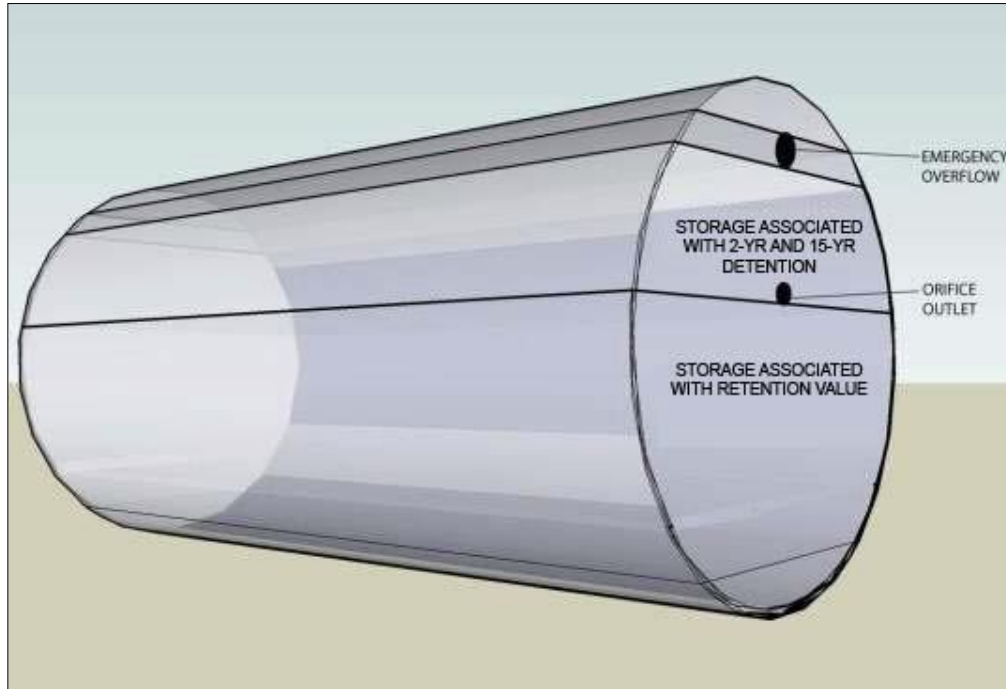


Figure 4.28. Cistern Design 2: Storage associated with design storm, channel protection, and flood volume.

**Cistern Design 3.** The third cistern set-up (Figure 4.29) creates a constant drawdown within the system. The small orifice at the bottom of the cistern needs to be routed to an appropriately designed secondary practice (i.e., bioretention, stormwater infiltration) that will allow the rainwater to be treated and allow for groundwater recharge over time. The release must not be discharged to a receiving channel or storm drain without treatment, and maximum specified drawdown rates from this constant drawdown should be adhered to, since the primary function of the system is not intended to be detention.

While a small orifice is shown at the bottom of the cistern in Figure 4.29, the orifice could be replaced with a pump that would serve the same purpose, conveying a limited amount of water to a secondary practice on a routine basis.

For this design, the secondary practice must be considered a component of the rainwater harvesting system with regard to the storage volume calculated in the General Retention Compliance Calculator in Appendix H. In other words, the storage volume associated with the secondary practice must not be included as a separate BMP because the secondary practice is an integral part of a rainwater harvesting system with a constant drawdown.

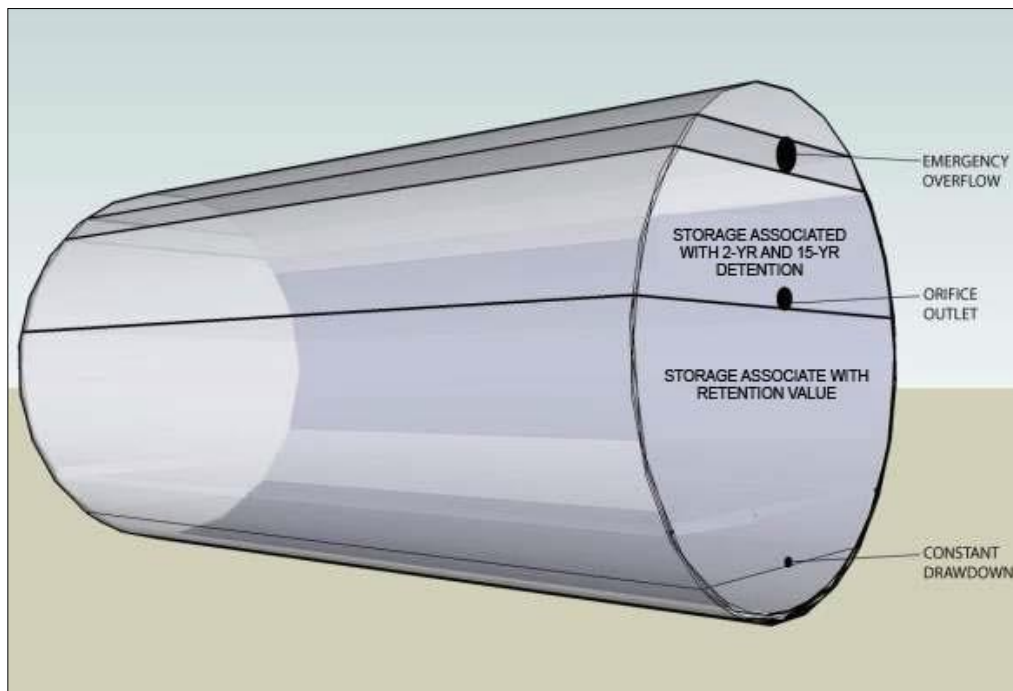


Figure 4.29. Cistern Design 3: Constant drawdown version where storage is associated with design storm, channel protection, and flood volume.

### **Sizing of Rainwater Harvesting Systems**

The rainwater harvesting cistern sizing criteria presented in this section were developed using a spreadsheet model that used best estimates of indoor and outdoor water demand, long-term rainfall data, and CDA capture area data (Forasté 2011). The Rainwater Harvesting Storage Volume Calculator in Appendix J1 is used for cistern sizing guidance and to quantify the available storage volume achieved. This storage volume value is required for input into the General Retention Compliance Calculator and is part of the submission of a SWMP using rainwater harvesting systems for compliance. A secondary objective of the spreadsheet is to increase the beneficial uses of the stored stormwater, treating it as a valuable natural resource.

### **Rainwater Harvesting Storage Volume Calculator**

The design specification provided in this section is follows the Rainwater Harvesting Storage Volume Calculator Appendix J1. The spreadsheet uses daily rainfall data from January 1, 2007 to December 31, 2019 to model performance parameters of the cistern under varying CDAs, demands on the system and cistern size.

The size of ponds used for irrigation, their irrigation area and characteristics of soil and land use can be entered in the calculator to determine stormwater volume retained. The runoff that reaches the cistern each day is added to the water level that existed in the cistern the previous day, with all of the total demands subtracted on a daily basis. If any overflow is realized, the volume is quantified and recorded. If the cistern runs dry (reaches the cut-off volume level), then the volume in the cistern is fixed at the low level. A summary of the water balance for the system is provided below.

### **Incremental Design Volumes within Cistern**

Rainwater cistern sizing is determined by accounting for varying precipitation levels, captured CDA runoff, first flush diversion (through filters) and filter efficiency, low water cut-off volume, dynamic water levels at the beginning of various storms, storage needed for the design storm (permanent storage), storage needed for 2- to 25-year volume (temporary detention storage), seasonal and year-round demand use and objectives, overflow volume, and freeboard volumes above high water levels during very large storms. See Figure 4. 30 for a graphical representation of these various incremental design volumes.

The design specification described in this section does not provide guidance for sizing larger storms, but rather provides guidance on sizing for the 85<sup>th</sup> and 95<sup>th</sup> percentile design storms.

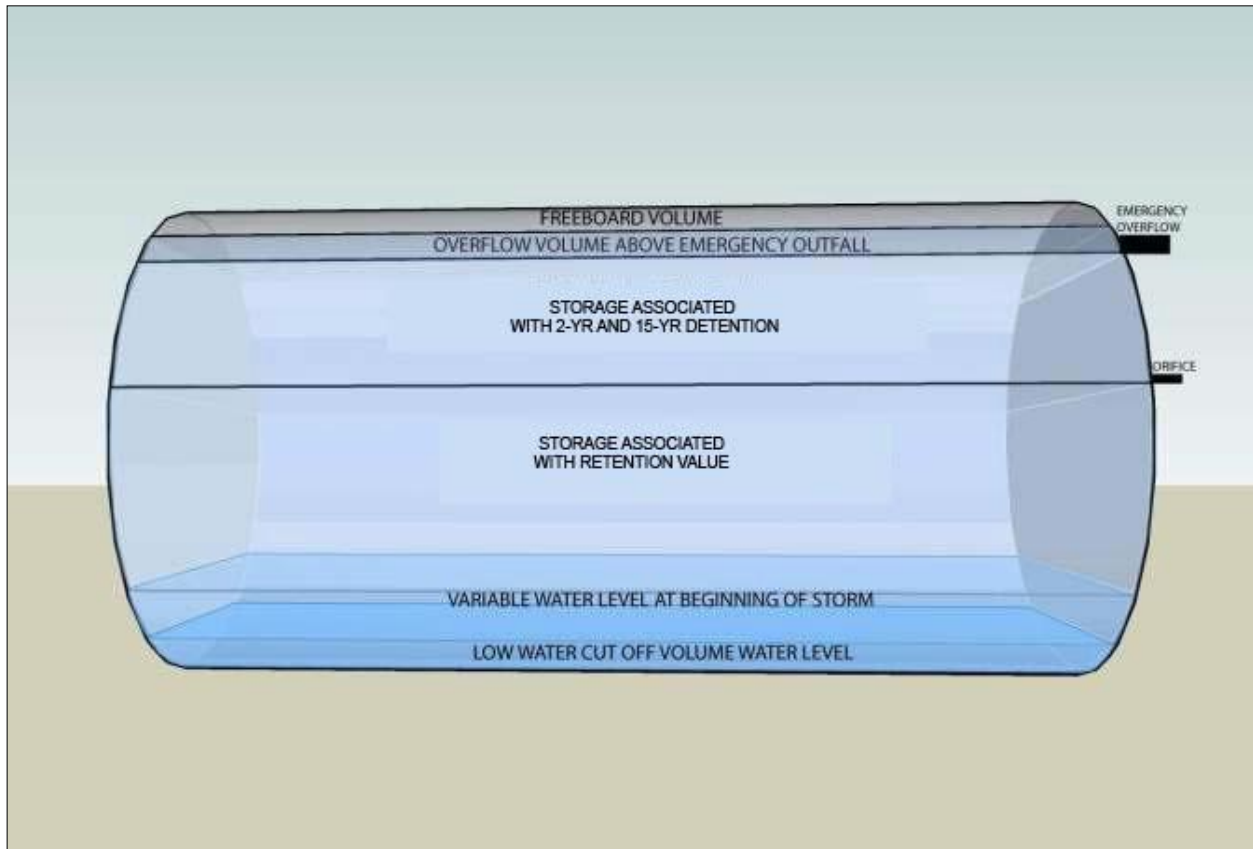


Figure 4.30. Incremental design volumes associated with cistern sizing.

The “Average Available Storage Volume” is the average storage within the cistern that is modeled and available to retain rainfall. While the SWRV will remain the same for a specific CDA, the “Average Available Storage Volume” is dependent on demand and cistern volume. It is the available space in the cistern between the average level at the beginning of a storm and the orifice outflow.

### Water Contribution

#### ❓ **Precipitation**

The volume of water contributing to the rainwater harvesting system is a function of the rainfall and CDA, as defined by the designer.

#### ❓ **Municipal Backup (optional)**

In some cases, the designer may choose to install a municipal backup water supply to supplement cistern levels. Note that municipal backups may also be connected post-cistern (i.e., a connection is made to the non-potable water line that is used for pumping water from the cistern for reuse), thereby not contributing any additional volume to the cistern. Municipal backup designs that supply water directly to the cistern are not accounted for in the Rainwater Harvesting Storage Volume Calculator.

## **Water Losses**

### **? Contributing Drainage Area Runoff Coefficient**

The CDA is assumed to convey 95% of the rainfall that lands on its surface (i.e.,  $RRRR = 0.95$ ).

### **? First Flush Diversion**

The first 0.02 to 0.06 inches of rainfall that is directed to filters is diverted from the system in order to prevent clogging it with debris. This value is assumed to be contained within the filter efficiency rate.

### **? Filter Efficiency**

It is assumed that, after the first flush diversion and loss of water due to filter inefficiencies, the remainder of the design storm will be captured successfully. For the 85<sup>th</sup> or 95<sup>th</sup> percentile storms, a minimum of 95% of the runoff should be conveyed into the cistern. The minimum values are included as the filter efficiencies in the Rainwater Harvesting Storage Volume Calculator, although they can be altered (increased) if appropriate. The Rainwater Harvesting Storage Volume Calculator applies these filter efficiencies, or interpolated values, to the daily rainfall record to determine the volume of runoff that reaches the cistern. For the purposes of selecting an appropriately sized filter, a rainfall intensity of 1 inch per hour shall be used when the design storm is the SWRV. The appropriate rainfall intensity values for the 2- to 25-year storms shall be used when designing for larger storm events.

### **? Drawdown (Storage Volume)**

This is the stored water within the cistern that is reused or directed to a secondary stormwater practice. It is the volume of runoff that is reduced from the CDA. This is the water loss that translates into the achievable storage volume retention.

## **Overflow**

For the purposes of addressing the SWRV (not for addressing larger storm volumes), orifice outlets for both detention and emergency overflows are treated the same. This is the volume of water that may be lost during large storm events or successive precipitation events.

## **Storage Volume Results**

The Rainwater Harvesting Storage Volume Calculator determines the average daily volume of water in the cistern for a range of cistern sizes. From this value, the available storage volume for the 85th and 95th percentile storm can be calculated; it is simply the difference between the cistern size and the average daily volume. The available storage volume for the selected cistern size should be used as an input to the General Retention Compliance Calculator. Similarly, the pond used for irrigation stormwater volume is entered in the General Retention Compliance Calculator in the rainwater harvesting row rather than the stormwater pond row to produce runoff reduction and pollutant removal credit with the other BMPs for the stormwater plan.

### **? Available Storage Volume (Sv)**

The volume available for storage of the 85th and 95th percentile storm is calculated for multiple sizes of cisterns. A trade-off curve plots these results, which allows for a comparison of the retention achieved versus cistern size. While larger cisterns yield more retention, they are more expensive. The curve helps the user to choose the appropriate cistern size, based on the design objectives and site needs.

## ❓ Overflow Volume

The volume of the overflows resulting from the 85<sup>th</sup> or 95<sup>th</sup> percentile precipitation event is also reported in this sheet. The overflow volume is also plotted to illustrate the effects of cistern size on overflow volume. An example chart is shown in Figure 4.31. The effect of diminishing returns is clear. Beyond a cistern size of 9,000 gallons, the overflow volume drops to zero. So, while the available storage continues to increase, the 85<sup>th</sup> or 95<sup>th</sup> percentile storm is entirely retained, and no additional retention will be possible.

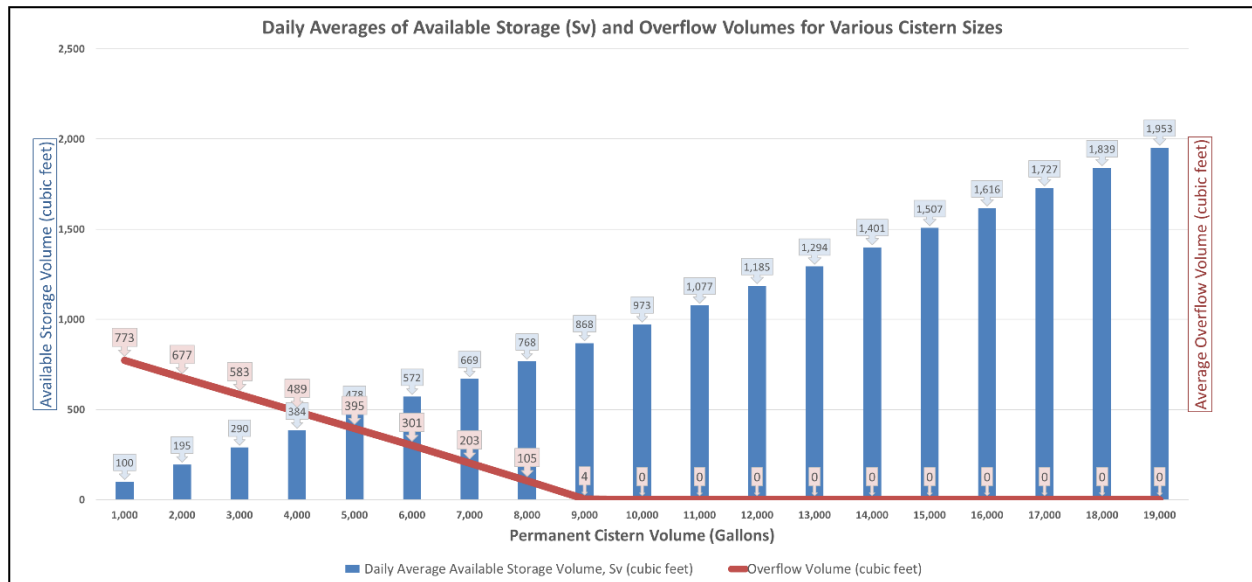


Figure 4.31. Example of graph showing Average Available Storage Volume and Overflow Volume for an example cistern design.

## Results from the Rainwater Harvesting Storage Volume Calculator to be Transferred to the Compliance Calculator

There are two results from the Rainwater Harvesting Storage Volume Calculator that are to be transferred to the Compliance Calculator as follows:

### ❓ Contributing Drainage Area

Enter the CDA that was used in the Rainwater Harvesting Storage Volume Calculator into the appropriate columns in the “Rainwater Harvesting” row of the Compliance Calculator BMP sheet.

### ❓ Available Storage Volume

Once a cistern has been selected, enter the Available Storage Volume (ft<sup>3</sup>) associated with that cistern into the Compliance Calculator column called “Storage Volume Provided by BMP” in the “Rainwater Harvesting” row of the BMP sheet.

## Completing the Sizing Design of the Cistern

The total size of the cistern is the sum of the following four volume components:

### ❓ Low Water Cutoff Volume (Included)

A dead storage area must be included so the pump will not run the cistern dry. This volume is included in the Rainwater Harvesting Storage Volume Calculator’s modeled volume.

❓ **Cistern Storage Associated with Design Volume (Included)**

This is the cistern design volume from the Rainwater Harvesting Storage Volume Calculator.

❓ **Adding Channel Protection and Flood Volumes (Optional)**

Additional detention volume may be added above and beyond the cistern storage associated with the design storm volumes for the 2- to 25-year events. Typical routing software programs may be used to design for this additional volume.

❓ **Adding Overflow and Freeboard Volumes (Required)**

An additional volume above the emergency overflow must be provided in order for the cistern to allow very large storms to pass. Above this overflow water level, there will be an associated freeboard volume that should account for at least 5% of the overall cistern size. Sufficient freeboard must be verified for large storms, and these volumes must be included in the overall size of the cistern.

#### **4.7.5 Rainwater Harvesting Landscaping Criteria**

If the harvested water is to be used for irrigation, the design plan elements must include the proposed delineation of planting areas to be irrigated, the planting plan, and quantification of the expected water demand. The default water demand for irrigation is 1.0 inches per week over the area to be irrigated during the months of May through October only. Justification must be provided if larger volumes are to be used.

#### **4.7.6 Rainwater Harvesting Construction Sequence Installation**

It is advisable to have a single contractor to install the rainwater harvesting system, outdoor irrigation system, and secondary retention practices. The contractor should be familiar with rainwater harvesting system sizing, installation, and placement. A licensed plumber is required to install the rainwater harvesting system components to the plumbing system.

A standard construction sequence for proper rainwater harvesting system installation is provided below. This can be modified to reflect different rainwater harvesting system applications or expected site conditions.

1. Choose the cistern location on the site.
2. Route all downspouts or pipes to prescreening devices and first flush diverters.
3. Properly install the cistern.
4. Install the pump (if needed) and piping to end uses (indoor, outdoor irrigation, or cistern dewatering release).
5. Route all pipes to the cistern.
6. Stormwater must not be diverted to the rainwater harvesting system until the overflow filter path has been stabilized with vegetation.

#### **Construction Supervision**

The following items should be inspected by a qualified professional in the mechanical, electrical, or plumbing fields prior to final sign-off and acceptance of a rainwater harvesting system:

- Rooftop area matches plans

- Diversion system is properly sized and installed
- Pretreatment system is installed
- Mosquito screens are installed on all openings
- Overflow device is directed as shown on plans
- Rainwater harvesting system foundation is constructed as shown on plans
- Catchment area and overflow area are stabilized
- Secondary stormwater treatment practice(s) is installed as shown on plans
- System commissioning

Construction phase inspection checklist for rainwater harvesting practices and the Stormwater Facility Leak Test form can be found in Appendix E Construction Inspection Checklists.

#### **4.7.7 Rainwater Harvesting Maintenance Criteria Maintenance**

##### **Inspections**

Periodic inspections and maintenance shall be conducted for each system by a qualified professional.

Maintenance inspection checklists for rainwater harvesting systems and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

##### **Maintenance Schedule**

Maintenance requirements for rainwater harvesting systems vary according to use. Systems that are used to provide supplemental irrigation water have relatively low maintenance requirements, while systems designed for indoor uses have much higher maintenance requirements. Table 4.28 describes routine maintenance tasks necessary to keep rainwater harvesting systems in working condition. It is recommended that maintenance tasks be performed by an “Inspector Specialist,” certified by the American Rainwater Catchment Association. Maintenance tasks must be documented and substantially comply with the maintenance responsibilities outlined in the maintenance agreement.

Table 4.28. Typical Maintenance Tasks for Rainwater Harvesting Systems

Responsible Person	Frequency	Activity
Owner	Four times a year	Inspect and clean prescreening devices and first flush diverters
	Twice a year	Keep gutters and downspouts free of leaves and other debris
	Once a year	<ul style="list-style-type: none"> <li>▪ Inspect and clean storage cistern lids, paying special attention to vents and screens on inflow and outflow spigots. Check mosquito screens and patch holes or gaps immediately</li> <li>▪ Inspect condition of overflow pipes, overflow filter path, and/or secondary stormwater treatment practices</li> </ul>
	Every third year	Clear overhanging vegetation and trees over roof surface
Qualified	According to Manufacturer	Inspect water quality devices



Responsible Person	Frequency	Activity
Third-Party Inspector	As indicated in Appendix J Rainwater Harvesting Treatment and Management Requirements	Field verification and data logs must be available at all times and annual reports should be sent to the Public Works Department.
	Every third year	<ul style="list-style-type: none"> <li>Inspect cistern for sediment buildup</li> <li>Check integrity of backflow preventer</li> <li>Inspect structural integrity of cistern, pump, pipe and electrical system</li> <li>Replace damaged or defective system components</li> </ul>

### **Mosquitoes**

In some situations, poorly designed rainwater harvesting systems can create habitat suitable for mosquito breeding. Designers must provide screens on above- and below-ground cisterns to prevent mosquitoes and other insects from entering the cisterns. If screening is not sufficient in deterring mosquitoes, dunks or pellets containing larvicide can be added to cisterns when water is intended for landscaping use.

### **Waste Material**

Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

### **4.7.8 Rainwater Harvesting Stormwater Compliance Calculations**

Rainwater harvesting practices are credited with 100% retention for the average available storage volume (Sv) available in the cistern as well as 100% TSS, TN, and bacteria removal (see Table 4.29). This average available storage volume is determined by using the Rainwater Harvesting Storage Volume Calculator, as described in Section 4.5.4 Rainwater Harvesting Design Criteria.

Table 4.29. Rainwater Harvesting Retention and Pollutant Removal

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

Rainwater harvesting practices also contribute to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume from the total runoff volume for the 2-year through the 100-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.



#### 4.8 Impervious Surface Disconnection

Impervious Surface Disconnection				
<b>Definition:</b> This strategy involves managing runoff close to its source by directing it from rooftops and other impervious surfaces to pervious areas.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		80%	40%	40%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
Low	Low	Low		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	40%		
At least annually	As needed			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Low cost construction and maintenance</li><li>▪ Reduces runoff volume</li><li>▪ Helps restore pre-development hydrologic conditions</li></ul>		<ul style="list-style-type: none"><li>▪ Only applicable to small drainage areas</li><li>▪ Difficult to apply to treatment trains</li><li>▪ Requires pervious receiving area</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Conveyance</li><li>▪ Receiving area</li><li>▪ Vegetation</li><li>▪ Receiving soils</li></ul>		<ul style="list-style-type: none"><li>▪ Maximum CDA of 1,000 ft<sup>2</sup> per disconnection</li><li>▪ Disconnection area should be at least 35 feet long and 10 feet wide.</li><li>▪ Slope of receiving area should be &lt; 2% (with turf reinforcement, &lt;5%)</li><li>▪ Building setback for areas with &lt; 1% slope</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Typical lawn/landscaping maintenance</li></ul>		<ul style="list-style-type: none"><li>▪ Ensure receiving area remains uncompacted and pervious</li></ul>		

<sup>1</sup>Credited pollutant load removal

In this practice, runoff from a rooftop or other small impervious surface is directed to a pervious surface or small practice to provide infiltration, filtering, or reuse (Figure 4.32)



Figure 4.32. Rooftop disconnection (photo: Center for Watershed Protection, Inc.)

#### **Definition**

This strategy involves managing runoff close to its source by directing it from rooftops and other impervious surfaces to pervious areas. Disconnection practices can be used to reduce the volume of runoff that enters the combined or separate sewer systems. Applicable practices include the following:

- D-1 Disconnection to pervious areas with the compacted cover designation
- D-2 Disconnection to conservation areas

**Disconnection practices reduce a portion of the SWRV. In order to fully meet retention requirements, , disconnection practices must be combined with additional practices.**

#### **4.8.1 Impervious Surface Disconnection Feasibility Criteria**

Impervious surface disconnections are ideal for use on commercial, institutional, municipal, multi-family residential, and single-family residential buildings. Key constraints with impervious surface disconnections include available space, soil permeability, and soil compaction. These and other feasibility criteria are described below and summarized in Table 4. 30.

- **Contributing Drainage Area.** For rooftop impervious areas, the maximum impervious area treated cannot exceed 1,000 square feet per disconnection. For impervious areas other than rooftop, the longest contributing impervious area flow path cannot exceed 75 feet.
- **Sizing.** The available disconnection area must be at least 10 feet wide and 35 feet long. For sheet flow from impervious areas, the disconnection area must be as wide as the area draining to it.
- **Site Topography.** Disconnection is best applied when the grade of the receiving pervious area is less than 2%, or less than 5% with turf reinforcement. The slope of the receiving areas must be graded away from any building foundations. Turf reinforcement may include erosion control matting or other appropriate reinforcing materials that are confirmed by the designer to be erosion resistant for the specific characteristics and flow rates anticipated at each individual application, and acceptable to the plan-approving authority.

- **Soils.** Impervious surface disconnection can be used on any post-construction hydrologic soil group (HSG). The disconnection area must be kept well-vegetated with minimal bare spots—at least 95% soil cover.
- **Building Setbacks.** If the grade of the receiving area is less than 1%, downspouts must be extended 5 feet away from building.

**Discharge Across Property Lines.** Disconnection areas must be designed such that runoff is not directed across property lines toward other sites.

**Economic Considerations.** Disconnection is one of the least expensive BMPs available.

**Table 4.30. Feasibility Criteria for Disconnection**

Design Factor	Disconnection Design
Contributing Drainage Area	1,000 square feet per rooftop disconnection. For impervious areas other than rooftop, the longest contributing impervious area flow path cannot exceed 75 feet.
Sizing	The available disconnection area must be at least 10 feet wide and 35 feet long. For sheet flow from impervious areas, the disconnection area must be as wide as the area draining to it.
Site Topography	Grade of the receiving pervious area is less than 2%, or less than 5% with turf reinforcement. The slope of the receiving areas must be graded away from any building foundations.
Soils	Impervious surface disconnection can be used on any post-construction HSG. The disconnection area must be kept well-vegetated with minimal bare spots.
Building Setbacks	5 feet away from building if the grade of the receiving area is less than 1%.

#### 4.8.2 Impervious Surface Disconnection Conveyance Criteria

Receiving areas in disconnection practices (D-1, D-2, and D-3) require a design that safely conveys the 2- to 25-year storm events over the receiving area without causing erosion. In some applications, erosion control matting or other appropriate reinforcing materials may be needed to control flow rates anticipated for these larger design storms.

#### 4.8.3 Impervious Surface Disconnection Pretreatment Criteria

Pretreatment is not needed for impervious surface disconnection.

#### 4.8.4 Impervious Surface Disconnection Design Criteria

If the feasibility criteria presented in Section 4.6.1 are met for a disconnection area, the storage volume is equal to the SWRV for the impervious area draining to it. The disconnection area itself should be considered Compacted Cover or Open Space rather than BMP area and should not be considered as part of the contributing drainage area to the impervious surface disconnection.

The following additional design criteria apply to Disconnection to Conservation Areas:

- **(D-2) Disconnection to a Conservation Area.** Disconnection area cannot include regulated wetlands and buffer areas.

- Inflow must be conveyed via sheet flow or via a level spreader.
- If inflow is conveyed via a level spreader, the maximum flow path is 150 feet, and the level spreader must be designed with an appropriate width as specified below.

**Level Spreaders.** A level spreader can be used to disperse or “spread” concentrated flow thinly over a vegetated or forested area to promote greater runoff infiltration in the receiving area. A level spreader consists of a permanent linear structure constructed at a 0% grade that transects the slope. The influent concentrated runoff must be spread over an area wide enough area so that erosion of the receiving area does not result. Detailed information on the design and function of level spreaders can be found in Hathaway and Hunt (2006) and NCDWQ (2010).

The minimum required width of the level spreader is

- 13 linear feet per each 1 cubic foot/second of inflow if the receiving conservation area has a minimum 90% ground cover
- 40 linear feet per 1 cubic foot/second of inflow if the receiving conservation area is forested

#### 4.8.5 Impervious Surface Disconnection Landscaping Criteria

All receiving disconnection areas must be stabilized to prevent erosion or transport of sediment to receiving practices or drainage systems according to the Erosion and Sediment Control seeding and vegetation requirements. Designers must ensure that the maximum flow velocities do not exceed the acceptable values for the selected grass species and the specific site slope.

#### 4.8.6 Impervious Surface Disconnection Construction Sequence

**Construction Sequence for Disconnection to Pervious Areas.** For disconnection to a pervious area, the pervious area can be within the limits of disturbance (LOD) during construction. The following procedures should be followed during construction:

- Before site work begins, the receiving pervious disconnection area boundaries should be clearly marked.
- Construction traffic in the disconnection area should be limited to avoid compaction. The material stockpile area shall not be located in the disconnection area.
- Construction runoff should be directed away from the proposed disconnection area, using perimeter silt fence, or, preferably, a diversion dike.
- If existing topsoil is stripped during grading, it shall be stockpiled for later use.
- The disconnection area may require light grading to achieve desired elevations and slopes. This should be done with tracked vehicles to prevent compaction.
- Topsoil and or compost amendments should be incorporated evenly across the disconnection area, stabilized with seed, and protected by biodegradable erosion control matting or blankets.
- Stormwater must not be diverted into any topsoil or compost amended areas until the area is stabilized (establishment of 95% or greater groundcover).

**Construction Sequence for Disconnection to Conservation Areas.** For disconnection to a conservation area, the conservation area must be fully protected during the construction stage of development and kept outside the LOD on the soil erosion and sediment control plan.

- No staging, parking, clearing, grading, or heavy equipment access is allowed in the conservation area except temporary disturbances associated with incidental utility construction, restoration operations, or management of nuisance vegetation. Incidental utility construction includes protecting existing utilities, removing abandoned utilities, rearranging service lines, temporarily rearranging utilities, and adjusting utility appurtenances.
- Any conservation areas shall be protected by super silt fence, chain link fence, orange safety fence, or other measures to prevent sediment discharge consistent with soil erosion and sediment control standards and specifications.
- The LOD must be clearly shown on all construction drawings and identified and protected in the field by acceptable signage, silt fence or other protective barrier.
- If a level spreader is to be used in the design, construction of the level spreader shall not commence until the CDA has been stabilized and perimeter soil erosion and sediment control measures have been removed and cleaned out. Stormwater must not be diverted into the disconnection area until the level spreader is installed and stabilized.

**Construction Supervision.** Construction supervision is recommended to ensure compliance with design standards. A qualified professional should evaluate the performance of the disconnection after the first significant rainfall event to look for evidence of gullies, outflanking, undercutting, or sparse vegetative cover. Spot repairs should be made as needed.

Construction phase inspection checklist for impervious cover disconnection can be found in Appendix E Construction Inspection Checklists.

#### 4.8.7 Impervious Surface Disconnection Maintenance Criteria

Maintenance of disconnected downspouts usually involves regular lawn or landscaping maintenance in the filter path from the roof to the street. In some cases, runoff from a disconnection may be directed to a more natural, undisturbed setting (i.e., where lot grading and clearing is “fingerprinted” and the proposed filter path is protected). Typical maintenance activities include erosion control of the receiving area and ensuring the receiving area remains uncompacted and pervious.

Maintenance inspection checklists for disconnection can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

**4.8.8 Impervious Surface Disconnection Stormwater Compliance Calculations** Disconnection practices are credited with 40% retention for the SWRV as well as 80% TSS, 40% TN, and 40% bacteria removal (see Table 4.31).

Table 4.31. Disconnection Retention and Pollutant Removal

Retention	= 40%
TSS Removal	= 80%

TN Removal	= 40%
Bacteria Removal	= 40%

Impervious surface disconnection also contributes to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume from the total runoff volume for the 2- to 25-year, and 100-year storms. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.



#### 4.9 Open Channel Systems

Open Channel Systems						
<b>Definition:</b> Vegetated open channels that are designed to capture and treat or convey the design storm volume (SWRv).						
Site Applicability		BMP Performance Summary				
Land Uses	Required Footprint	WQ Improvement: Moderate to High				
<ul style="list-style-type: none"><li>▪ Suburban</li><li>▪ Rural</li></ul>	Moderate	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>		
		50-80%	25-70%	30-80%		
		Runoff Reduction				
Construction Costs	Maintenance Burden	Volume				
Low	Low	Low				
Maintenance Frequency:		SWRv				
Routine	Non-Routine	O-1a	O-1b	O-2	O-3	O-4
Quarterly	Every 10-15 years	10%	20%	60%	0%	0%
Advantages/Benefits		Disadvantages/Limitation				
<ul style="list-style-type: none"><li>▪ Less expensive than curb and gutter</li><li>▪ Relatively low maintenance requirements</li><li>▪ Provides pretreatment if used as part of runoff conveyance system</li><li>▪ Provides partial infiltration of runoff in some soils</li><li>▪ Good for small drainage areas</li></ul>		<ul style="list-style-type: none"><li>▪ Must be carefully designed to achieve low flow rates in the channel (&lt; 1.0 ft/s)</li><li>▪ May re-suspend sediment</li><li>▪ May not be acceptable for some areas because of standing water in channel</li></ul>				
Components		Design considerations				
<ul style="list-style-type: none"><li>▪ Channel geometry</li><li>▪ Dense vegetation</li><li>▪ Check dams, as needed)</li></ul>		<ul style="list-style-type: none"><li>▪ Maximum drainage area of 2.5 acres</li><li>▪ Slopes (&lt;4% unless using O-4)</li><li>▪ Runoff velocities must be non-erosive</li><li>▪ Vegetation must withstand both relatively high velocity flows and wet/dry periods.</li></ul>				
Maintenance Activities						
<ul style="list-style-type: none"><li>▪ Mow grass to 3 or 4 inches high</li><li>▪ Inspect for, and correct, formation of rills and gullies</li></ul>		<ul style="list-style-type: none"><li>▪ Clean out sediment accumulation in channel</li><li>▪ Ensure that vegetation remains well established</li></ul>				

<sup>1</sup>Credited pollutant load removal

Often found along roadsides, parking lots, and property boundaries, open channels can provide stormwater conveyance, capture and/or treatment (Figure 4.33). One of the most visible stormwater BMPs, they are often part of stormwater conveyance systems.



**Figure 4.33. Open channel (photo: Center for Watershed Protection, Inc.)**

**Definition.** Vegetated open channels that are designed to capture and treat or convey the design storm volume (SWRv). Design variants include the following:

- O-1 Grass channels
- O-2 Dry swales/bioswales
- O-3 Wet swales
- O-4 Regenerative stormwater conveyance (RSC)

Open channel systems shall not be designed to provide stormwater detention except under extremely unusual conditions. Open channel systems must generally be combined with a separate facility to meet detention requirements.

**Grass channels (O-1)** can provide a modest amount of runoff filtering and volume attenuation within the stormwater conveyance system resulting in the delivery of less runoff and pollutants than a traditional system of curb and gutter, storm drain inlets, and pipes (see Figure 4.34). The performance of grass channels will vary depending on the underlying soil permeability. Grass channels, however, are not capable of providing the same stormwater functions as dry swales as they lack the storage volume associated with the engineered filter media. Their retention performance can be boosted when compost amendments are added to the bottom of the swale (see Appendix C Soil Compost Amendment Requirements). Grass channels are a preferable alternative to both curb and gutter and storm drains as a stormwater conveyance system, where development density, topography, and soils permit.

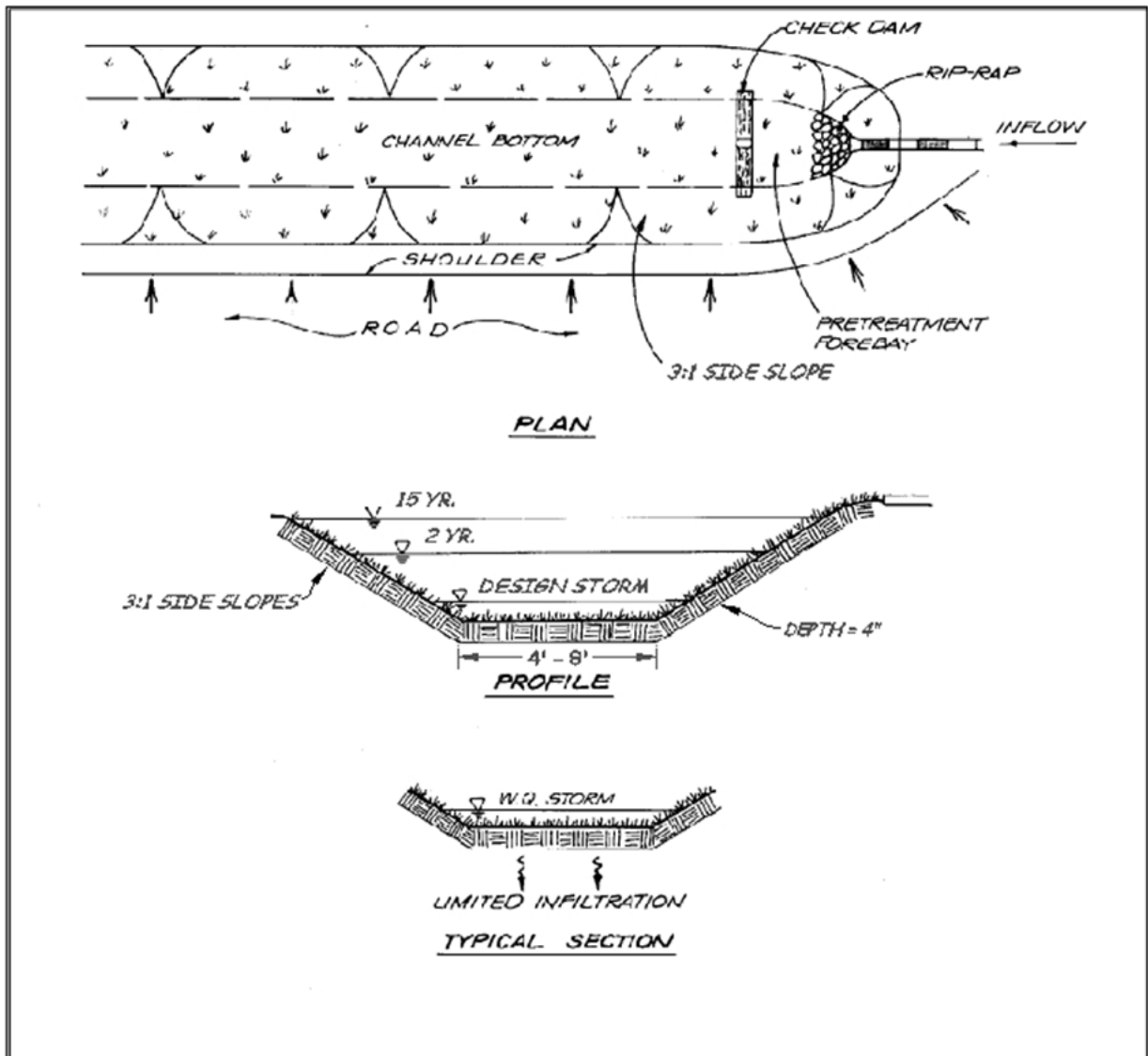


Figure 4.34. Grass channel typical plan, profile, and section views (O-1).

**Dry swales (O-2)**, also known as bioswales, are essentially bioretention cells that are shallower, configured as linear channels, and covered with turf or other surface material (other than mulch and ornamental plants). The dry swale is a soil filter system that temporarily stores and then filters the desired design storm volume. Dry swales rely on a premixed filter media below the channel that is identical to that used for bioretention. In most cases, the runoff treated by the filter media flows into an underdrain, which conveys treated runoff back to the conveyance system further downstream. The underdrain system consists of a perforated pipe within a gravel layer on the bottom of the swale, beneath the filter media. However, if soils are permeable, runoff infiltrates into underlying soils and the dry swale can be designed without an underdrain as if it were an enhanced bioretention. In either case, check dams should be constructed to encourage ponding (see Site Topography). Dry swales may appear as simple grass channels with the same shape and turf cover, while others may have more elaborate landscaping. Swales can be planted with turf grass, tall meadow grasses, decorative herbaceous cover, or trees.

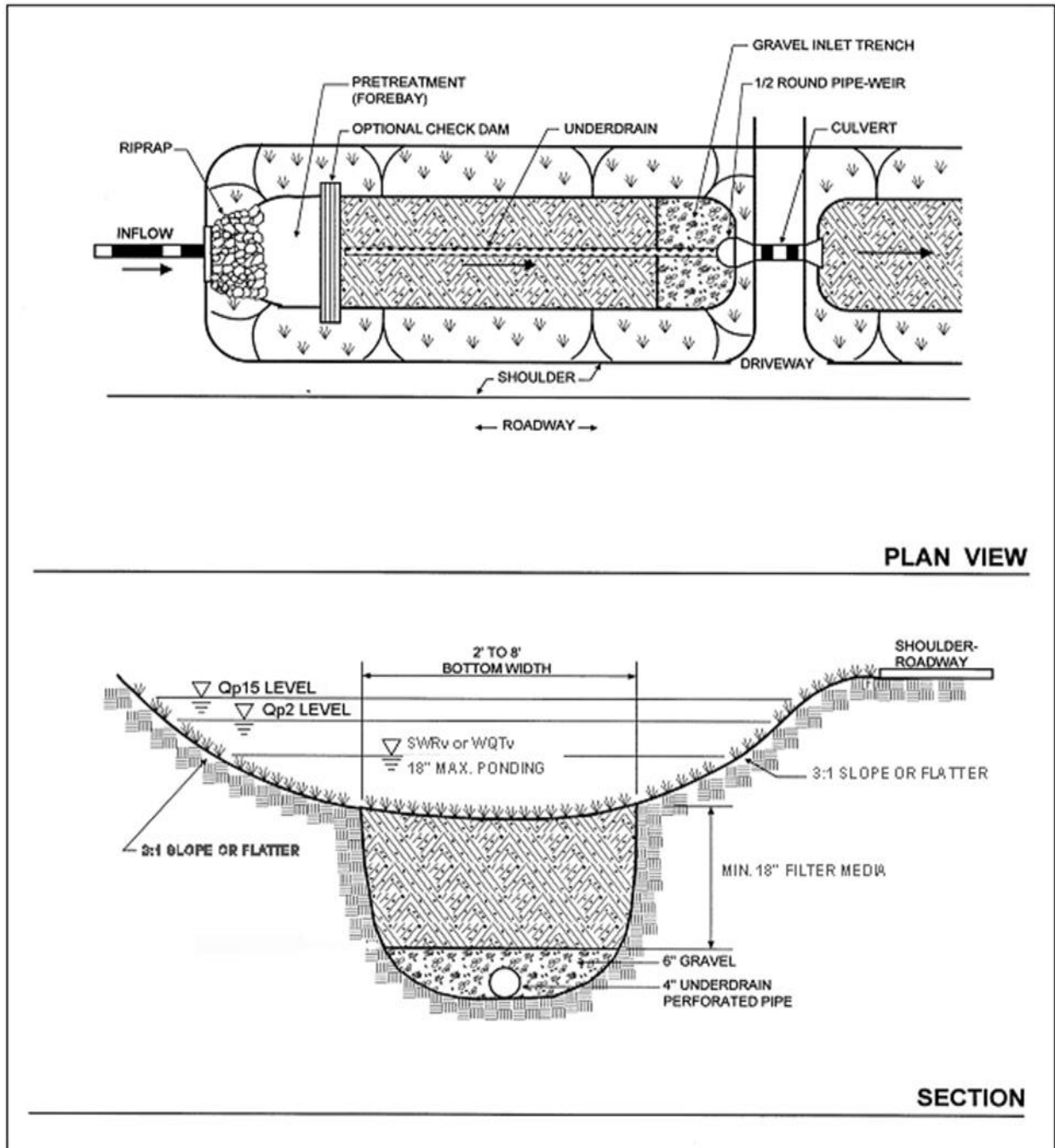
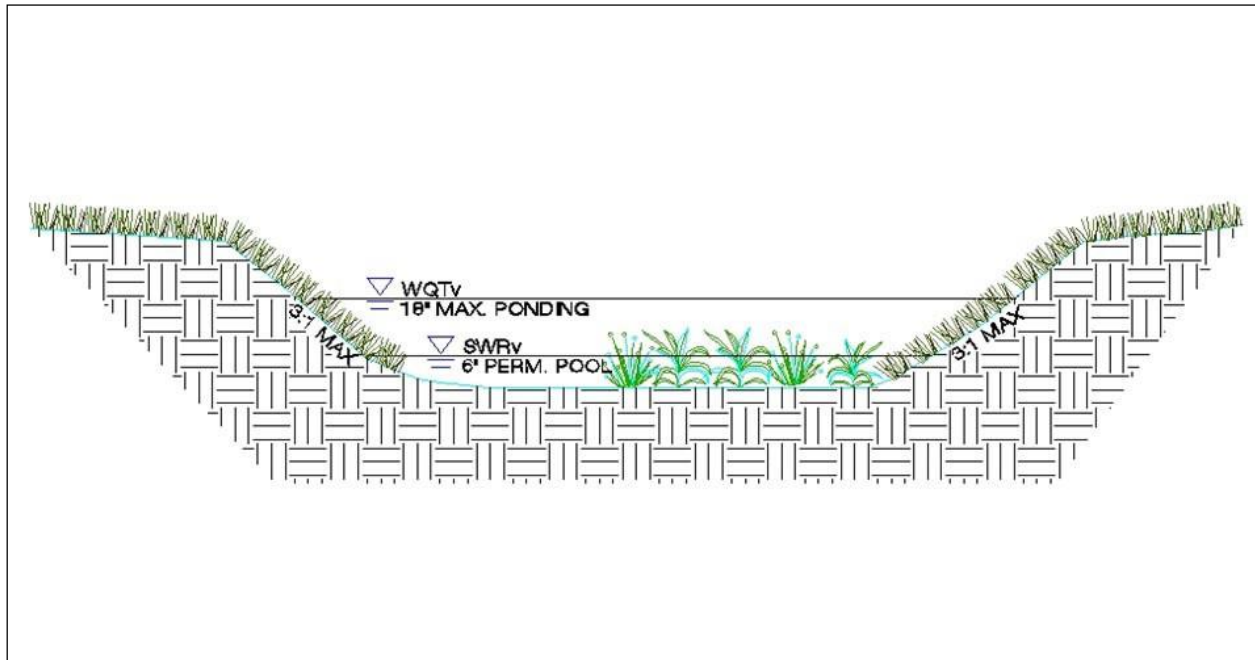


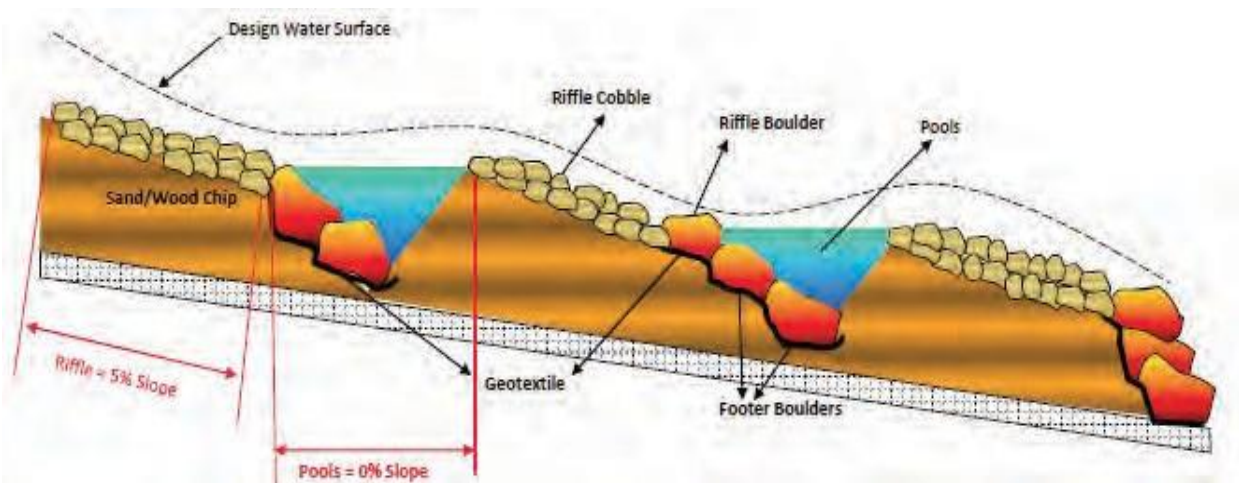
Figure 4.35. Example of a dry swale/bioswale (O-2).

**Wet swales (O-3)** can provide a modest amount of runoff filtering within the conveyance (see Figure 4.36). These linear wetland cells often intercept shallow groundwater to maintain a wetland plant community. The saturated soil and wetland vegetation provide an ideal environment for gravitational settling, biological uptake, and microbial activity. On-line or off-line cells are formed within the channel to create saturated soil or shallow standing water conditions (typically less than 6 inches deep).



**Figure 4.36. Example of a wet swale (O-3).**

**Regenerative Stormwater Conveyance (O-4).** RSC is a unique conveyance practice that can be used in locations where other conveyance practices are infeasible, or as a restoration practice for eroded or degraded outfalls and drainage channels (Figure 4.37). RSC utilizes a series of shallow aquatic pools, riffle weir grade controls, native vegetation and underlying sand and woodchip beds to treat, detain, and convey storm flow. It can be used in places where grades make traditional stormwater practices difficult to implement. Because of the regional topography and waters of the state limitations, RSC Systems will have limited application in the Southern Lowcountry. RSC Systems combine features and treatment benefits of Swales, Infiltration, Filtering and Wetland practices. In addition, they are designed to convey flows associated with larger storm events in a non-erosive manner, which results in a reduction of channel erosion impacts commonly encountered at conventional stormwater outfalls and headwater stream channels.



**Figure 4.37. Example of Regenerative Stormwater Conveyance (O-4).**

#### 4.9.1 Open Channel Feasibility Criteria

Open channel systems are primarily applicable for land uses, such as roads, highways, and residential development. Some key feasibility issues for open channels include the following:

**Contributing Drainage Area.** The maximum CDA to an open channel should be 2.5 acres, preferably less. When open channels treat and convey runoff from CDAs greater than 2.5 acres, the velocity and flow depth through the channel often becomes too great to treat runoff or prevent erosion in the channel. The design criteria for maximum channel velocity and depth are applied along the entire length (see Section 4.9.4 Open Channel Design Criteria). Dry Swales should be approximately 3%–10% of the size of the CDA, depending on the amount of impervious cover. Wet swale footprints usually cover about 5%–15% of their CDA.

**Available Space.** Open channel footprints can fit into relatively narrow corridors between utilities, roads, parking areas, or other site constraints. Grass channels can be incorporated into linear development applications (e.g., roadways) by utilizing the footprint typically required for an open section drainage feature. The footprint required will likely be greater than that of a typical conveyance channel. However, the benefit of the retention may reduce the footprint requirements for stormwater management elsewhere on the development site.

**Site Topography.** Grass channels and wet swales should be used on sites with longitudinal slopes of less than 4%. Check dams can be used to reduce the effective slope of the channel and lengthen the contact time to enhance filtering and/or infiltration. Longitudinal slopes of less than 2% are ideal and may eliminate the need for check dams. However, channels designed with longitudinal slopes of less than 1% should be monitored carefully during construction to ensure a continuous grade so as to avoid flat areas with pockets of standing water.

For dry swales, check dams will be necessary regardless of the longitudinal slope to create the necessary ponding volume.

**Land Uses.** Open channels can be used in residential, commercial, or institutional development settings.

When open channels are used for both conveyance and water quality treatment, they should be applied only in linear configurations parallel to the contributing impervious cover, such as roads and small parking areas. The linear nature of open channels makes them well-suited to treat highway or low- and medium-density residential road runoff, if there is adequate right-of-way width and distance between driveways. Typical applications of open channels include the following, as long as CDA limitations and design criteria can be met:

- Within a roadway or bicycle path right-of-way;
- Along the margins of small parking lots;
- Oriented from the roof (downspout discharge) to the street;
- Disconnecting small impervious areas; and
- Used to treat the managed turf areas of parkland, sports fields, golf courses, and other turf-intensive land uses, or to treat CDAs with both impervious and managed turf cover (such as residential streets and yards).

Open channels are not recommended when residential density exceeds more than four (4) dwelling units per acre, due to a lack of available land and the frequency of driveway crossings along the channel.

Open channels can also provide pretreatment for other stormwater treatment practices.

**Available Hydraulic Head.** A minimum amount of hydraulic head is needed to implement open channels in order to ensure positive drainage and conveyance through the channel. The hydraulic head for wet swales and grass channels is measured as the elevation difference between the channel inflow and outflow point. The hydraulic head for dry swales is measured as the elevation difference between the inflow point and the storm drain invert (unless an infiltration-based design will be used). Dry swales typically require 3 to 5 feet of hydraulic head since they have both a filter bed and underdrain.

**Hydraulic Capacity.** Open channels are typically designed as on-line practices that must be designed with enough capacity to (1) convey runoff from the 25-year design storm at non-erosive velocities, and (2) contain the 25-year flow within the banks of the swale. This means that the swale's surface dimensions are more often determined by the need to pass the 25-year storm events, which can be a constraint in the siting of open channels within existing rights-of-way (e.g., constrained by sidewalks).

**Depth to Water Table.** The bottom of dry swales and grass channels must be at least 0.5 feet above the seasonally high groundwater table, to ensure that groundwater does not intersect the filter bed, since

this could lead to groundwater contamination or practice failure. It is permissible for wet swales to intersect the water table.

**Soils.** Soil conditions do not constrain the use of open channels, although they do dictate some design considerations:

- Dry swales in soils with low infiltration rates may need an underdrain. Designers must verify site-specific soil permeability at the proposed location using the methods for on-site soil investigation presented in Appendix B Geotechnical Information Requirements for Underground BMPs to eliminate the requirements for a dry swale underdrain.
- Grass channels situated on low-permeability soils may incorporate compost amendments to improve performance (see Appendix C Soil Compost Amendment Requirements).
- Wet swales work best on the more impermeable HSG C or D soils.
- At infill soil locations, geotechnical investigations are required to determine if the use of an impermeable liner and underdrain are necessary for open channel designs.

**Utilities.** Typically, utilities can cross linear channels if they are specially protected (e.g., double-casing). Interference with underground utilities should be avoided, if possible. When large site development is undertaken, the expectation of achieving avoidance will be high. Conflicts may be commonplace on smaller sites and in the PROW. Where conflicts cannot be avoided, these guidelines shall be followed:

- Consult with each utility company on recommended offsets that will allow utility maintenance work with minimal disturbance to the BMP.
- Whenever possible, coordinate with utility companies to allow them to replace or relocate their aging infrastructure while BMPs are being implemented.
- BMP and utility conflicts will be a common occurrence in PROW projects. However, the standard solution to utility conflict should be the acceptance of conflict provided sufficient soil coverage over the utility can be assured.
- Additionally, when accepting utility conflict into the BMP design, it is understood that the BMP will be temporarily impacted during utility maintenance but restored to its original condition.

**Avoidance of Irrigation or Baseflow.** Open channels should be located so as to avoid inputs of springs, irrigation systems, chlorinated wash-water, or other dry weather flows.

**Setbacks.** To avoid the risk of seepage, stormwater cannot flow from the open channel reservoir layer or via baseflow to the traditional pavement base layer, existing structure foundations, or future foundations which may be built on adjacent properties. Open channels should be set back at least 10 feet down-gradient from building foundations and property lines, 50 feet from septic system fields and 150 feet from public or private drinking water wells. The 10-foot building setback may be relaxed if an impermeable building liner is installed.

**Pollutant Hotspot Land Use.** In areas where higher pollutant loading is likely (i.e. oils and greases from fueling stations or vehicle storage areas, sediment from un-stabilized pervious areas, or other pollutants from industrial processes), appropriate pretreatment, such as an oil-water separator or filtering device must be provided. These pretreatment facilities should be monitored and maintained frequently to avoid negative impacts to the channel and subsequent water bodies.



Runoff from hotspot land uses must not be treated with infiltrating dry swales due to the potential interaction with the water table and the risk that hydrocarbons, trace metals, and other toxic pollutants could migrate into the groundwater. An impermeable liner must be used for filtration of hotspot runoff for dry swales.

Grass channels can typically be used to convey runoff from stormwater hotspots, but they do not qualify as a hotspot treatment mechanism. Wet swales are not recommended to treat stormwater hotspots, due to the potential interaction with the water table and the risk that hydrocarbons, trace metals, and other toxic pollutants could migrate into the groundwater.

On sites with existing contaminated soils, infiltration is not allowed; dry and wet swales on these hotspots must include an impermeable liner.

**Feasibility.** Open channels are ideally suited to the Southern Lowcountry environment, since open channel drainage is often the norm due to the flat topography. Depending on underlying soil and other characteristics, however, a specific open channel option may be the most appropriate. For example, the wet swale design option is most suited to areas with elevated groundwater tables, while dry swales and grassed channels are best suited for sandy soils of the coastal plain.

**Economic Considerations.** While most open channel designs provide relatively small water quality credits when compared with other stormwater practices, they nevertheless provide greater quality benefits than traditional conveyance designs, such as curb and gutter.

#### 4.9.2 Open Channel Conveyance Criteria

The bottom width and slope of a grass channel must be designed such that the velocity of flow from the design storm provides a minimum hydraulic residence time (average travel time for a particle of water through a waterbody) of 9 minutes for the peak flows from the SWRV or design storm. Check dams may be used to achieve the needed retention volume, as well as to reduce the flow velocity. Check dams must be spaced based on channel slope and ponding requirements, consistent with the criteria in Section 4.9.4 Open Channel Design Criteria.

Open channels must also convey the 25-year storm at non-erosive velocities (generally less than 6 feet per second) for the soil and vegetative cover provided. The final designed channel shall provide 6 inches minimum freeboard above the designated water surface profile of the channel. The analysis must evaluate the flow profile through the channel at normal depth, as well as the flow depth over top of the check dams.

RSC systems are typically designed to convey larger storm events, up to and including the 100- year storm event.

#### 4.9.3 Open Channel Pretreatment Criteria

Pretreatment is required for open channels to dissipate energy, trap sediments, and slow down the runoff velocity.

The selection of a pretreatment method depends on whether the channel will experience sheet flow or concentrated flow. Several options are as follows:

- **Check Dams (channel flow).** These energy dissipation devices are acceptable as pretreatment on small open channels with CDAs of less than 1 acre. The most common form is the use of wooden or stone check dams. The pretreatment volume stored must be 15% of the design volume.
- **Tree Check Dams (channel flow).** These are street tree mounds that are placed within the bottom of grass channels up to an elevation of 9 to 12 inches above the channel invert. One side has a gravel or river stone bypass to allow runoff to percolate through (Cappiella et al, 2006). The pretreatment volume stored must be 15% of the design volume.
- **Grass Filter Strip (sheet flow).** Grass filter strips extend from the edge of the pavement to the bottom of the open channel at a slope of 5H:1V or flatter. Alternatively, provide a combined 5 feet of grass filter strip at a maximum 5% (20H:1V) cross slope and 3H:1V or flatter side slopes on the open channel.
- **Gravel or Stone Diaphragm (sheet flow).** The gravel diaphragm is located at the edge of the pavement or the edge of the roadway shoulder and extends the length of the channel to pretreat lateral runoff. This requires a 2- to 4-inch elevation drop from a hard-edged surface into a gravel or stone diaphragm. The stone must be sized according to the expected rate of discharge.
- **Gravel or Stone Flow Spreaders (concentrated flow).** The gravel flow spreader is located at curb cuts, downspouts, or other concentrated inflow points, and should have a 2- to 4-inch elevation drop from a hard-edged surface into a gravel or stone diaphragm. The gravel should extend the entire width of the opening and create a level stone weir at the bottom or treatment elevation of the channel.
- **Initial Sediment Forebay (channel flow).** This grassed cell is located at the upper end of the open channel segment with a recommended 2:1 length to width ratio and a storage volume equivalent to at least 15% of the total design storm volume. If the volume of the forebay will be included as part of the dry swale storage volume, the forebay must de-water between storm events. It cannot have a permanent ponded volume.

#### 4.9.4 Open Channel Design Criteria

**Channel Geometry.** Design guidance regarding the geometry and layout of open channels is provided below:

- Open channels should generally be aligned adjacent to and the same length as the CDA identified for treatment.
- Open channels should be designed with a trapezoidal or parabolic cross section. A parabolic shape is preferred for aesthetic, maintenance, and hydraulic reasons.
- The bottom width of the channel should be between 4 to 8 feet wide to ensure that an adequate surface area exists along the bottom of the swale for filtering. If a channel will be wider than 8 feet, the designer must incorporate benches, check dams, level spreaders, or multi-level cross sections to prevent braiding and erosion along the channel bottom.
- Open-channel side slopes should be no steeper than 3H:1V for ease of mowing and routine maintenance. Flatter slopes are encouraged, where adequate space is available, to enhance pretreatment of sheet flows entering the channel.
- RSC has several specific geometry requirements, which are outlined in RSC Sizing below.

**Check dams.** Check dams may be used for pretreatment, to break up slopes, and to increase the hydraulic residence time in the channel. Design requirements for check dams are as follows:

- Check dams should be spaced based on the channel slope, as needed to increase residence time, provide design storm storage volume, or any additional volume attenuation requirements. In typical spacing, the ponded water at a downhill check dam should not touch the toe of the upstream check dam. More frequent spacing may be desirable in dry swales to increase the ponding volume.
- The maximum desired check dam height is 12 inches, for maintenance purposes. However, for some sites, a maximum of 18 inches can be allowed, with additional design elements to ensure the stability of the check dam and the adjacent and underlying soils.
- Armoring may be needed at the downstream toe of the check dam to prevent erosion.
- Check dams must be firmly anchored into the side-slopes to prevent outflanking; check dams must also be anchored into the channel bottom so as to prevent hydrostatic head from pushing out the underlying soils.
- Check dams must be designed with a center weir sized to pass the channel design storm peak flow (25-year storm event for man-made channels).
- For grass channels, each check dam must have a weep hole, or similar drainage feature, so it can dewater after storms. This is not appropriate for dry swales.
- Check dams should be composed of wood, concrete, stone, compacted soil, or other non-erodible material, or should be configured with elevated driveway culverts.
- Individual channel segments formed by check dams or driveways should generally be at least 25 to 40 feet in length.

Check dams for grass channels must be spaced to reduce the effective slope to less than 2%, as indicated in Table 4.32.

**Table 4.32. Typical Check Dam Spacing to Achieve Effective Channel Slope**

Channel Longitudinal Slope (%)	Check Dam Spacing to Achieve Effective Slope <sup>a, b, c</sup>	
	Effective Slope of 2% (ft)	Effective Slope of 0%–1% (ft)
0.5	–	
1.0	–	
1.5	–	67–200
2.0	–	50–100
2.5	200	40–67
3.0	100	33–50
3.5	67	30–40
4.0	50	25–33

4.5 <sup>d</sup>	40	20–30
5.0 <sup>d</sup>	40	20–30

<sup>a</sup> All check dams require a stone energy dissipator at the downstream toe.

<sup>b</sup> Check dams require weep holes at the channel invert. Swales with slopes less than 2% will require multiple weep holes (at least 3) in each check dam.

<sup>c</sup> Assumed check dam height is 12 inches. The spacing dimension is half of the above distances if a 6-inch check dam is used.

<sup>d</sup> Open channels with slopes greater than 4% require special design considerations, such as drop structures to accommodate greater than 12-inch high check dams (and therefore a flatter effective slope), in order to ensure non-erosive flows.

**Ponding Depth.** Check dams must be used in dry swales to create ponding cells along the length of the channel. The maximum ponding depth in a dry swale must not exceed 18 inches. Minimum surface ponding depth is 3 inches (averaged over the surface area of the open channel). In order to increase the ponding depth, it may be necessary or desirable to space check dams more frequently than is shown in Table 4.32.

**Dry Swale Filter Media.** Dry swales require replacement of native soils with a prepared filter media. The filter media provides adequate drainage, supports plant growth, and facilitates pollutant removal within the dry swale. At least 18 inches of filter media must be added above the choker stone layer (and no more than 6 feet) to create an acceptable filter. The recipe for the filter media is identical to that used for bioretention and is provided in Section 4.1 Bioretention. The batch receipt confirming the source of the filter media should be submitted to the Beaufort County Public Works Department inspector. One acceptable design adaptation is to use 100% sand for the first 18 inches of the filter and add a combination of topsoil and compost, as specified in Appendix C Soil Compost Amendment Requirements, for the top 4 inches, where turf cover will be maintained.

**Dry Swale Drawdown.** Dry swales must be designed so that the desired design storm volume is completely filtered within 72 hours, using the equations specified in Section 4.9.6 Open Channel Construction Sequence.

**Dry Swale Underdrain.** Some dry swale designs will not use an underdrain (where soil infiltration rates meet minimum standards). See Section 4.9.1 Open Channel Feasibility Criteria for more details. When underdrains are necessary, they should have a minimum diameter of 4 to 6 inches and be encased in a 12-inch deep gravel bed. Two layers of stone should be used. A choker stone layer, consisting of No. 8 or No. 89 stone at least 3 inches deep, must be installed immediately below the filter media. Below the choker stone layer, the underdrain must be encased (a minimum of 2 inches above and below the underdrain) in a layer of clean, double-washed ASTM D448 No.57 or smaller (No. 68, 8, or 89) stone. The maximum depth of the underdrain stone layer combined with the choking layer is 12 inches, and it cannot extend beyond the surface dimensions of the dry swale filter media.

**Impermeable Liner.** An impermeable liner is not typically required, although it may be utilized in fill applications where deemed necessary by a geotechnical investigation, on sites with contaminated soils, or on the sides of the practice to protect adjacent structures from seepage. Use a PVC geomembrane liner or an equivalent of an appropriate thickness (follow manufacturer's instructions for installation). Field seams must be sealed according to the liner manufacturer's specifications. A minimum 6-inch overlap of material is required at all seams.

**Dry Swale Observation Well.** A dry swale must include well-anchored, 4- to 6-inch diameter PVC pipe observation wells along the length of the swale. For a dry swale with an underdrain, the wells should be tied into any Ts or Ys in the underdrain system and must extend upward above the surface of the ponding. These observation wells may double as clean outs. For an infiltrating dry swale, the observation well should be perforated in the gravel layer only.

**Grass Channel Material Specifications.** The basic material specifications for grass channels are outlined in Table 4.33.

**Table 4.33. Grass Channel Material Specifications**

Component	Specification
Grass	<p>A dense cover of water-tolerant, erosion-resistant grass. The selection of an appropriate species or mixture of species is based on several factors including climate, soil type, topography, and sun or shade tolerance.</p> <p>Grass species should have the following characteristics:</p> <ul style="list-style-type: none"> <li>▪ A deep root system to resist scouring;</li> <li>▪ A high stem density with well-branched top growth;</li> <li>▪ Water-tolerance;</li> <li>▪ Resistance to being flattened by runoff;</li> <li>▪ An ability to recover growth following inundation; and</li> </ul>
Check Dams	<p>Check dams should be constructed of a non-erodible material such as wood, gabions, riprap, or concrete.</p> <p>Wood used for check dams should consist of pressure-treated logs or timbers or water-resistant tree species such as cedar, hemlock, swamp oak, or locust.</p> <p>Computation of check dam material is necessary, based on the surface area and depth used in the design computations.</p>
Diaphragm	Pea gravel used to construct pretreatment diaphragms must consist of washed, open-graded, coarse aggregate between 3 and 10 mm in diameter.
Erosion Control Fabric	Where flow velocities dictate, biodegradable erosion control netting or mats that are durable enough to last at least two growing seasons must be used.

**Dry Swale Material Specifications.** For additional material specifications pertaining to dry swales, designers should consult Section 4.1.4 Bioretention Design Criteria and Table 4.34.

**Table 4.34. Dry Swale Material Specifications**

Material	Specification	Notes
Filter Media Composition	<p>Filter Media to contain:</p> <ul style="list-style-type: none"> <li>☐ 80%–90% sand</li> <li>☐ 10%–20% soil fines</li> <li>☐ Maximum 10% clay</li> </ul>	To account for settling/compaction, it is recommended that 110% of the plan volume be utilized.

Material	Specification	Notes
	☑ 3%–5% organic matter	
Filter Media Testing	P content = 5 to 15 mg/kg (Mehlich I) or 18 to 40 mg/kg (Mehlich III) CEC > 5 milliequivalents per 100 grams	See Section 4.3.4 Bioretention, for additional filter media information.
Geotextile	Geotextile fabric meeting the following specifications: ☑ AASHTO M-288 Class 2, latest edition ☑ Has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability. ☑ Apply along sides of the filter media only and do not apply along the swale bottom.	
Choking Layer	A 2- to 4-inch layer of choker stone (typically No. 8 or No. 89 washed gravel) laid above the underdrain stone.	
Underdrain Stone Layer	Stone must be double-washed and clean and free of all fines (ASTM D448 No. 57 or smaller stone).	
Underdrains and Cleanouts	4-inch or 6-inch rigid schedule 40 PVC pipe, with 3 or 4 rows of 3/8-inch perforations at 6 inches on center.	Install perforated pipe for the full length of the dry swale cell. Use non-perforated pipe, as needed, to connect with the storm drain system.
Observation Wells	4-inch or 6-inch rigid schedule 40 PVC pipe	For dry swales with underdrains, tie the non-perforated observation well to the underdrain via T or Y connection. This observation well can double as a cleanout. For dry swales without an underdrain, the pipe should only be perforated in the gravel layer. The observation wells should extend to the top of ponding.
Impermeable Liner	Where appropriate, use a PVC geomembrane liner or equivalent.	
Vegetation	Plant species as specified on the landscaping plan.	
Check Dams	Use non-erosive material, such as wood, gabions, riprap, or concrete. Wood used for check dams should consist of pressure-treated logs or timbers, or water-resistant tree species, such as cedar, hemlock, swamp oak, or locust.	
Erosion Control Fabric	Where flow velocities dictate, use woven biodegradable erosion control fabric or mats (EC2) that are durable enough to last at least 2 growing seasons.	

**RSC Material Specifications.** RSC has several design elements that are unique to this practice. The practice includes riffle and pool segments, underlain with a sand/ wood chip bed, and with a top dressing of compost and plant material. Table 4.35 outlines the materials needed for this practice.

**Table 4.35. Regenerative Stormwater Conveyance System Material Specifications**

Material	Specification
Footer Boulders	Should have a natural appearance and be equivalent in size to Class 3 Rip Rap (average diameter 26.4 inches)
Cobble	Should have a natural appearance and a minimum diameter of 6"
Sand/ Woodchip Bed	The sand component of the sand/wood chip bed should meet the AASHTO- M-6 or ASTM-C-33, 0.02 inches to 0.04 inches in size. Sand shall be a silica-based coarse aggregate. Substitutions such as Diabase and Gray- stone (AASHTO) #10 are not acceptable. No calcium carbonate or dolomitic sand substitutions are acceptable. No "rock dust" can be used for sand. Locally-approved pulverized glass may be substituted if the local authority undertakes testing to verify compliance with the particle size specification. No art glass shall be used for a pulverized glass material. For woodchips, use aged, shredded hardwood chips/mulch. The woodchips should be added to the sand mix, approximately 20 percent by volume, to increase the organic content and promote plant growth and sustainability.
Choker Stone	The choker stone layer between the sand bed and the bank run gravel should be clean, washed #8 or #78 stone.
Bank Run Gravel	The bank run gravel layer that is placed beneath and above the sand bed/choker stone layers should be constructed using clean, washed # 5 or # 57 coarse aggregate.
Compost	The compost used as a top dressing over the RSC System should consist of a 100% organic compost, with a pH of between 6.0 and 7.0, a moisture content of between 30 and 55%, and a particle size of 0.25 inches or less. (See Appendix C for compost specifications)
Wood Chips	The wood chips used within the sand bed should consist of double-shredded or double-ground hardwood mulch that is free of dyes, chromated copper arsenate and other preservatives.
Plant Materials	Plants should be native species, appropriate to the planting/wetness zone where they are located.

**Wet Swale Design Issues.** The following criteria apply to the design of wet swales:

- ❑ The average normal pool depth (dry weather) throughout the swale must be 6 inches or less.
- ❑ The maximum temporary ponding depth in any single wet swale cell must not exceed 18 inches at the most downstream point (e.g., at a check dam or driveway culvert).
- ❑ Check dams should be spaced as needed to maintain the effective longitudinal slope.

- ⑦ Individual wet swale segments formed by check dams or driveways should generally be at least 25 to 40 feet in length.
- ⑦ Wet swale side slopes should be no steeper than 4H:1V to enable wetland plant growth. Flatter slopes are encouraged where adequate space is available, to enhance pretreatment of sheet flows entering the channel. Under no circumstances are side slopes to steeper than 3H:1V.

**Grass Channel Enhancement using Compost Soil Amendments.** Soil compost amendments serve to increase the retention capability of a grass channel. The following design criteria apply when compost amendments are used:

- ⑦ The compost-amended strip must extend over the length and width of the channel bottom, and the compost must be incorporated to a depth as outlined in Appendix C Soil Compost Amendment Requirements.
- ⑦ For grass channels on steep slopes, it may be necessary to install a protective biodegradable erosion control mat to protect the compost-amended soils. Care must be taken to consider the erosive characteristics of the amended soils when selecting an appropriate erosion control mat.

**Grass Channel Sizing.** Unlike other BMPs, grass channels are designed based on a peak rate of flow. Designers must demonstrate channel conveyance and treatment capacity in accordance with the following guidelines:

- Hydraulic capacity should be verified using Manning's Equation or an accepted equivalent method, such as erodibility factors and vegetal retardance.
- ⑦ The flow depth for the peak flow generated by the SWRV must be maintained at 4 inches or less.
- Manning's "n" value for grass channels is 0.2 for flow depths up to 4 inches, decreasing to 0.03 at a depth of 12 inches and above, which would apply to the 2- to 25-year storms if an on-line application (Haan et. al, 1994).
- ⑦ Peak flow rates for the 25-year frequency storm must be non-erosive, in accordance with Table 4. 37 (see Section 4.9.5 Open Channel Landscaping Criteria), or subject to a site-specific analysis of the channel lining material and vegetation; and the 25-year peak flow rate must be contained within the channel banks (with a minimum of 6 inches of freeboard).
- ⑦ Calculations for peak flow depth and velocity must reflect any increase in flow along the length of the channel, as appropriate. If a single flow is used, the flow at the outlet must be used.
- ⑦ The hydraulic residence time (e.g., the average travel time for a particle of water through a waterbody) must be a minimum of 9 minutes for the peak flows from the SWRV or design storm (Mar et al., 1982; Barrett et al., 1998; Washington State Department of Ecology, 2005). If flow enters the swale at several locations, a 9-minute minimum hydraulic residence time must be demonstrated for each entry point, using Equation 4.13 through Equation 4. 17.

The bottom width of the grass channel is therefore sized to maintain the appropriate flow geometry as follows:



**Equation 4. 13 Manning's Equation**

$$V = \left( \frac{1.49}{n} \right) \times D^{2/3} \times S^{1/2}$$

Where:

- $V$  = flow velocity (ft/s)
- $n$  = roughness coefficient (0.2, or as appropriate)
- $D$  = flow depth (ft) (Note:  $D$  approximates hydraulic radius for shallow flows)
- $S$  = channel slope (ft/ft)

**Equation 4. 14 Continuity Equation**

$$Q = V \times (W + 3 \times D) \times D$$

where:

- $Q$  = design storm peak flow rate (cfs)
  - $V$  = design storm flow velocity (ft/s)
  - $W$  = channel bottom width (ft)
  - $D$  = flow depth (ft)
- (Note: Channel width ( $W$ ) plus 3 times the depth ( $D$ ) represents the average width of a trapezoidal channel with 3H:1V side slopes. Average width multiplied by depth equals the cross-sectional flow area.)

Combining Equation 4.13 and Equation 4.14, and rewriting them provides a solution for the minimum width (Equation 4.15):

**Equation 4. 15 Minimum Width**

$$W = \frac{D \times Q}{1.49 \times D^{5/3} \times S^{1/2}} - (3 \times D)$$

where:

- $W$  = channel bottom width (ft)
- $n$  = roughness coefficient (0.2, or as appropriate)
- $Q$  = design storm peak flow rate (cfs)
- $D$  = flow depth (ft)
- $S$  = channel slope (ft/ft)

Equation 4.16 provides the corresponding velocity:

**Equation 4. 16 Corresponding Velocity**

$$VV = \frac{QQ}{(WW + 3 \times DD) \times DD}$$

where:

$V$	=	design storm flow velocity (ft/s)
$Q$	=	design storm peak flow rate (cfs)
$W$	=	channel bottom width (ft)
$D$	=	flow depth (ft)

The width, slope, or Manning's "n" value can be adjusted to provide an appropriate channel design for the site conditions. However, if a higher density of grass is used to increase the Manning's "n" value and decrease the resulting channel width, it is important to provide material specifications and construction oversight to ensure that the denser vegetation is actually established. Equation 4.17 can then be used to ensure adequate hydraulic residence time.

**Equation 4. 17 Grass Channel Length for Hydraulic Residence Time of 9 minutes (540 seconds)**

$$LL = 540 \times VV$$

where:

$L$	=	minimum swale length (ft)
$V$	=	flow velocity (ft/s)

The storage volume ( $S_v$ ) provided by the grass channel is equal to the total runoff from the design storm (typically  $SWR_v$ ) used to size the channel (conveyed at a depth of 4 inches or less), as shown in Equation 4.18.

**Equation 4. 18 Grass Channel Storage Volume**

$$SSRR = DDDDDDDDDSSSSDDDDDD$$

where:

$S_v$	=	total storage volume of grass channel (ft <sup>3</sup> )
<i>DesignStorm</i>	=	$SWR_v$ or other design storm volume (ft <sup>3</sup> ) (e.g., portion of the $SWR_v$ )

**Dry Swale Sizing.** Dry swales are typically sized to capture the  $SWR_v$  or larger design storm volumes in the surface ponding area, filter media, and gravel reservoir layers of the dry swale.

Total storage volume of the BMP is calculated using Equation 4.19.

#### Equation 4. 19 Dry Swale Storage Volume

$$SSRR = SSS_{bottom} \times d_{media} \times \eta_{media} + (SSS_{gravel} \times \eta_{gravel}) + (SSS_{average} \times d_{ponding})$$

where:

$S_v$	=	total storage volume of dry swale (ft <sup>3</sup> )
$SA_{bottom}$	=	bottom surface area of dry swale (ft <sup>2</sup> )
$d_{media}$	=	depth of the filter media, including mulch layer (ft)
$\eta_{media}$	=	effective porosity of the filter media (typically 0.25)
$d_{gravel}$	=	depth of the underdrain and underground storage gravel layer, including choker stone (ft)
$\eta_{gravel}$	=	effective porosity of the gravel layer (typically 0.4)
$SA_{average}$	=	average surface area of the dry swale (ft <sup>2</sup> ) typically, where $SA_{top}$ is the top surface area of dry swale,

$$SA_{average} = \frac{SA_{bottom} + SA_{top}}{2}$$

$d_{ponding}$	=	the maximum ponding depth of the dry swale (ft)
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Equation 4.19 can be modified if the storage depths of the filter media, gravel layer, or ponded water vary in the actual design or with the addition of any surface or subsurface storage components (e.g., additional area of surface ponding, subsurface storage chambers, etc.). The maximum depth of ponding in the dry swale must not exceed 18 inches. If storage practices will be provided off-line or in series with the dry swale, the storage practices should be sized using the guidance in Section 0 Storage Practices.

Dry swales can be designed to address, in whole or in part, the detention storage needed to comply with channel protection and/or flood control requirements. The  $S_v$  can be counted as part of the 2- to 25-year runoff volumes to satisfy stormwater quantity control requirements.

Note: To increase the storage volume of a dry swale, the ponding surface area may be increased beyond the filter media surface area. However, the top surface of the BMP (at the top of the ponding elevation) may not be more than twice the size of surface area of the filter media ( $SA_{bottom}$ ).

**Wet Swale Sizing.** Wet swales can be designed to capture and treat the SWRV remaining from any upstream stormwater retention practices. The storage volume is made up of the temporary and permanent storage created within each wet swale cell. This includes the permanent pool volume and up to 12 inches of temporary storage created by check dams or other design features that has 24 hours extended detention.

The storage volume ( $S_v$ ) of the practice is equal to the volume provided by the pond permanent pool plus the 24-hour extended detention (ED) volume provided by the practice (Equation 4.20). The total  $S_v$  cannot exceed the design SWRV.

#### Equation 4. 20 Wet Swale Storage Volume

$$SSRR = PPDDDDd + PPDDDDppDDDDDD + PPDDDD \eta_{RRDD} + 24 h_{DD} EDD \eta_{RRDD}$$

**RSC Sizing.** RSC design is an iterative process in which the channel is sized to convey the 100-year storm event, using Manning's equation for parabolic channels.

Some key RSC sizing considerations include the following:

- One control structure and pool (riffle-pool) combination is needed for each foot of elevation difference along the channel.
- The length of each grade control structure or pool is determined by Equation 4.21

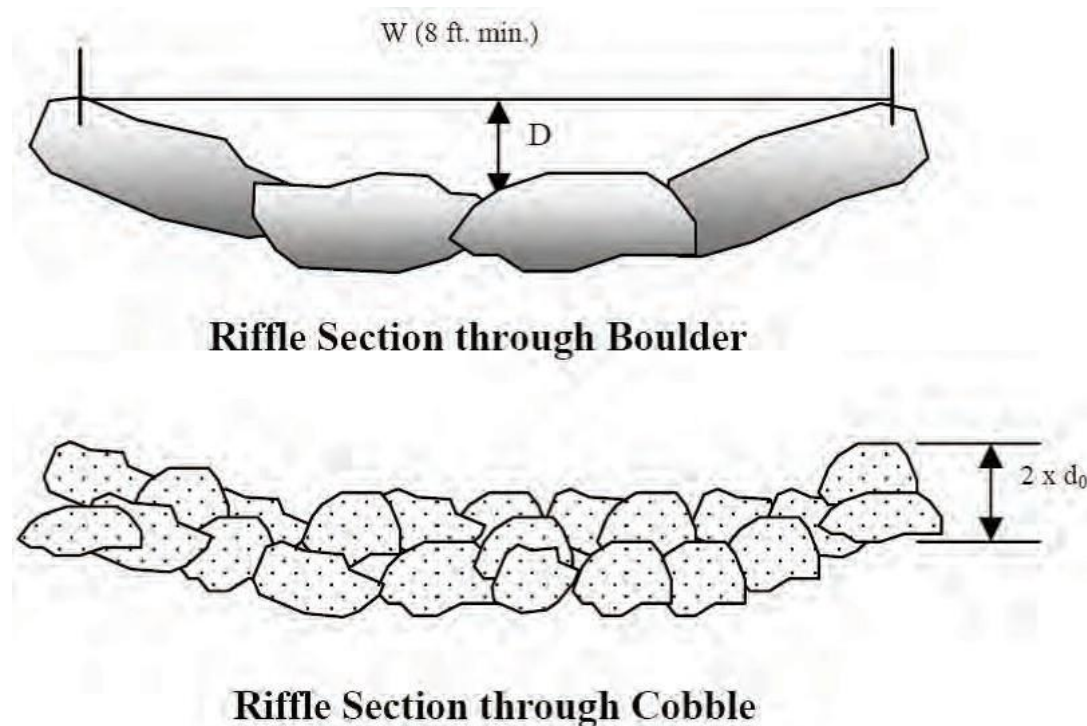
#### Equation 4. 21 Riffle Pool Length

$$L_{\text{riffle}} = \frac{L_{\text{pool}}}{(E_{\text{riffle}} \times 2)}$$

where:

$L_{\text{pool}}$	=	surface length of each pool (ft)
$L_{\text{riffle}}$	=	total length of riffle pool (ft)
Elevation Change	=	difference in elevation between pool and bottom pool (ft)

- In areas with steep slopes (10% or greater) the length of the pool or riffle may be small (<10'). In these locations, cascades may be needed as a part of the system design.
- The minimum width of grade control structures should be 8 ft and the width should be equal to 10 times the channel depth (Figure 4.38).
- The depth of flow in the riffle sections should be less than 4 inches.
- Cobbles in the riffle section should be sized so that the velocity of the 100-year storm is non-erosive (Table 4.36).



**Figure 4.38. Typical Width and Depth of Riffle Sections (Anne Arundel County, 2011).**

**Table 4.36. Maximum Allowable Velocity**

Cobble size (in)		Allowable velocity (ft/s)
4		5.8
5		6.4
6		6.9
7		7.4
8		7.9
9		8.4
10		8.8
11		9.2
12		9.6
15		10.4

- Pools should be between 1.5 and 3 feet deep, and equal to the width of the riffle sections.
- The RSC system is underlain with a sand bed with a 1–5 foot depth and a width between 4 and 14 feet.
- The downstream edge of the riffle should incorporate a series of boulders in a parabolic shape.
- Place a cobble apron below the riffle section to allow for a stable transition between the riffle section and the downstream pools when the pools are dry. The cobble apron should be approximately 5 feet wide and 3 feet long.

The total  $S_v$  in the RSC system (available for water quality treatment) is determined by Equation 4.22.

#### Equation 4.22 RSC Systems Storage Volume

$$SSRR = VV_{ppbbgg} + VV_{ssaappmmmbmmmm}$$

where:

$S_v$	=	total storage volume of RSC system (ft <sup>3</sup> )
$V_{pool}$	=	volume in pools (ft <sup>3</sup> )
$V_{sandbed}$	=	volume in sand bed (ft <sup>3</sup> ), use effective porosity of 0.25

#### 4.9.5 Open Channel Landscaping Criteria

All open channels must be stabilized to prevent erosion or transport of sediment to receiving practices or drainage systems. There are several types of grasses appropriate for dry open channels (grass channels and dry swales). These are listed in Table 4.37. Designers should choose plant species that can withstand both wet and dry periods and relatively high velocity flows for planting within the channel. Designers should ensure that the maximum flow velocities do not exceed the values listed in the table for the selected grass species and the specific site slope. For more information on stabilization seeding, see the Charleston County Stabilization Specifications.

**Table 4.37. Recommended Vegetation for Open Channels**

Vegetation Type	Slope (%)	Maximum Velocity (ft/s)	
		Erosion Resistant Soil	Easily Eroded Soil
Bermuda Grass	0–5	8	6
	5–10	7	5
	>10	6	4
Kentucky Bluegrass	0–5	7	5
	5–10	6	4
	>10	5	3
Tall Fescue Grass Mixture	0–5	6	4
	5–10	4	3
Annual and Perennial Rye	0–5	4	3
Sod		4	3

Source: USDA, TP-61, 1954; Roanoke Virginia, Stormwater Design Manual, 2008

Wet swales should be planted with grass and wetland plant species that can withstand both wet and dry periods as well as relatively high velocity flows within the channel. For a list of wetland plant species suitable for use in wet swales, refer to the wetland planting guidance and plant lists provided in Section 0 Stormwater Wetlands.

Landscape design shall specify proper grass species based on site-specific soils and hydric conditions present along the channel.

Open channels should be seeded at such a density to achieve a 90% vegetated cover after the second growing season. Taller and denser grasses are preferable, although the species is less important than good stabilization and dense vegetative cover.

Grass channels should be seeded and not sodded. Seeding establishes deeper roots and sod may have muck soil that is not conducive to infiltration. Grass channels should be protected by a biodegradable erosion control fabric to provide immediate stabilization of the channel bed and banks.

#### 4.9.6 Open Channel Construction Sequence

**Design Notes.** Channel invert and tops of banks are to be shown in plan and profile views. A cross sectional view of each configuration and completed limits of grading must be shown for proposed channels. For proposed channels, the transition at the entrance and outfall is to be clearly shown on plan and profile views.

**Open Channel Installation.** The following is a typical construction sequence to properly install open channels, although steps may be modified to reflect different site conditions or design variations. Grass channels should be installed at a time of year that is best to establish turf cover without irrigation. For more specific information on the installation of wet swales, designers should consult the construction criteria outlined in Section 0 Stormwater Wetlands.

1. **Protection During Site Construction.** Ideally, open channels should remain outside the limits of disturbance during construction to prevent soil compaction by heavy equipment. However, this is seldom practical, given that the channels are a key part of the drainage system at most sites. In these cases, temporary soil erosion and sediment controls such as dikes, silt fences, and other erosion control measures should be integrated into the swale design throughout the construction sequence. Specifically, barriers should be installed at key check dam locations, and erosion control fabric should be used to protect the channel. Dry swales that lack underdrains (and rely on infiltration) must be fully protected by silt fence or construction fencing to prevent compaction by heavy equipment during construction.
2. **Installation.** Installation may only begin after the entire CDA has been stabilized with vegetation. Any accumulation of sediments that does occur within the channel must be removed during the final stages of grading to achieve the design cross section. Soil erosion and sediment controls for construction of the channel must be installed as specified in the soil erosion and sediment control plan. Stormwater flows must not be permitted into the channel until the bottom and side slopes are fully stabilized.
3. **Grading.** Grade the grass channel to the final dimensions shown on the plan. Excavators or backhoes should work from the sides to grade and excavate the open channels to the appropriate design dimensions. Excavating equipment should have scoops with adequate reach so they do not have to sit inside the footprint of the open channel area. If constructing a dry swale, the bottom of the swale should be ripped, rototilled or otherwise scarified to promote greater infiltration.
4. **Placing Stone Layer (for dry swales).** If constructing a dry swale, place an acceptable geotextile fabric on the underground (excavated) sides of the dry swale with a minimum 6-inch overlap. Place the stone needed for storage layer over the filter bed. Add the perforated underdrain pipe. Add the remaining stone jacket, and then pack No. 57 stone (clean, double-washed) to 3 inches above the top of the underdrain, and then add 3 inches of pea gravel as a filter layer. Add the filter media in 12-inch lifts until the desired top elevation of the dry swale is achieved. Water thoroughly and add additional media as needed where settlement has occurred.
5. **Add Amendments (optional, for grass channels).** Add soil amendments as needed. Till the bottom of the grass channel to a depth of 1 foot and incorporate compost amendments according to Appendix C Soil Compost Amendment Requirements.
6. **Install Check Dams.** Install check dams, driveway culverts and internal pretreatment features as shown on the plan. Fill material used to construct check dams should be placed in 8- to 12-inch lifts and compacted to prevent settlement. The top of each check dam must be constructed level at the design elevation.
7. **Hydro-seed.** Hydro-seed the bottom and banks of the open channel, and peg in erosion control fabric or blanket where needed. After initial planting, a biodegradable erosion control fabric should be used, conforming the South Carolina BMP Handbook (SDHEC, 2005).
8. **Plant.** Plant landscaping materials as shown in the landscaping plan, and water them weekly during the first 2 months. The construction contract should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction.
9. **Final Inspection.** A qualified professional should conduct the final construction inspection and develop a punch list for facility acceptance.



**Open Channel Construction Supervision.** Supervision during construction is recommended to ensure that the open channel is built in accordance with these specifications.

Construction phase inspection checklist is available in Appendix E Construction Inspection Checklists.

Some common pitfalls can be avoided by careful construction supervision that focuses on the following key aspects of dry swale installation:

- Make sure the desired coverage of turf or erosion control fabric has been achieved following construction, both on the channel beds and their contributing side-slopes.
- Inspect check dams and pretreatment structures to make sure they are at correct elevations, are properly installed, and are working effectively.
- For dry swale designs:
  - ❑ Check the filter media to confirm that it meets specifications and is installed to the correct depth.
  - ❑ Check elevations, such as the invert of the underdrain, inverts for the inflow and outflow points, and the ponding depth provided between the surface of the filter bed and the overflow structure.
  - ❑ Ensure that caps are placed on the upstream (but not the downstream) ends of the underdrains.
  - ❑ Check that outfall protection/energy dissipation measures at concentrated inflow and outflow points are stable.

The real test of an open channel occurs after its first big storm. The post-storm inspection should focus on whether the desired sheet flow, shallow concentrated flows or fully concentrated flows assumed in the plan actually occur in the field. Minor adjustments are normally needed as part of this post-storm inspection (e.g., spot reseeding, gully repair, added armoring at inlets, or realignment of outfalls and check dams). Also, a qualified professional should check that dry swale practices drain completely within the 72-hour drawdown period.

#### 4.9.7 Open Channel Maintenance Criteria

Maintenance is a crucial and required element that ensures the long-term performance of open channels. Once established, grass channels have minimal maintenance needs outside of the spring cleanup, regular mowing, repair of check dams, and other measures to maintain the hydraulic efficiency of the channel and a dense, healthy grass cover. Dry swale designs may require regular pruning and management of trees and shrubs. The surface of dry swale filter beds can become clogged with fine sediment over time, but this can be alleviated through core aeration or deep tilling of the filter bed. Additional effort may be needed to repair check dams, stabilize inlet points, and remove deposited sediment from pretreatment cells. Table 4.38 provides a schedule of typical maintenance activities required for open channels.

**Table 4.38. Typical Maintenance Activities and Schedule for Open Channels**

Schedule	Maintenance Activity
As needed	<ul style="list-style-type: none"> <li>Mow grass channels and dry swales during the growing season to maintain grass heights in the 4- to 6-inch range.</li> </ul>
Quarterly	<ul style="list-style-type: none"> <li>Ensure that the CDA, inlets, and facility surface are clear of debris.</li> <li>Ensure that the CDA is stabilized. Perform spot-reseeding if where needed.</li> <li>Remove accumulated sediment and oil/grease from inlets, pretreatment devices, flow diversion structures, and overflow structures.</li> <li>Repair undercut and eroded areas at inflow and outflow structures.</li> </ul>
Annual inspection	<ul style="list-style-type: none"> <li>Add reinforcement planting to maintain 90% turf cover. Reseed areas of dead vegetation.</li> <li>Remove any accumulated sand or sediment deposits behind check dams.</li> <li>Inspect upstream and downstream of check dams for evidence of undercutting or erosion. Remove trash or blockages at weepholes.</li> <li>Examine channel bottom for evidence of erosion, braiding, excessive ponding, or dead grass.</li> <li>Check inflow points for clogging and remove any sediment.</li> <li>Inspect side slopes and grass filter strips for evidence of any rill or gully erosion and repair.</li> <li>Look for any bare soil or sediment sources in the CDA and stabilize immediately.</li> </ul>

**Maintenance Inspections.** Annual inspections by a qualified professional are used to trigger maintenance operations, such as sediment removal, spot revegetation, and inlet stabilization. Maintenance inspection checklists for disconnection and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### 4.9.8 Open Channel Stormwater Compliance Calculations

Grass channels are credited with 10% retention for the storage volume (Sv) provided by the practice as well as 50% TSS, 25% TN, and 30% bacteria removal (see Table 4.39).

**Table 4.39. Grass Channel Retention and Pollutant Removal**

Retention	= 10%
TSS Removal	= 50%
TN Removal	= 25%
Bacteria Removal	= 30%

Grass channels with amended soils are credited with 20% retention for the storage volume (Sv) provided by the practice as well as 50% TSS, 35% TN, and 30% bacteria removal (Table 4.40).

Table 4.40. Grass Channel on Amended Soils Retention and Pollutant Removal

Retention	= 20%
TSS Removal	= 50%
TN Removal	= 35%
Bacteria Removal	= 30%

Dry swales are credited with 60% retention for the storage volume (Sv) provided by the practice as well as 85% TSS, 70% TN, and 80% bacteria removal (Table 4.41).

**Table 4.41. Dry Swale Retention and Pollutant Removal**

Retention	= 60%
TSS Removal	= 85%
TN Removal	= 70%
Bacteria Removal	= 80%

Wet Swales are credited with 0% retention, but they do receive 80% TSS, 25% TN, and 60% bacteria removal for the storage volume (Sv) provided by the practice (Table 4.42).

**Table 4.42. Wet Swale Retention and Pollutant Removal**

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 25%
Bacteria Removal	= 60%

RSCs are credited with 0% retention, but they do receive 80% TSS, 40% TN, and 80% bacteria removal for the storage volume (Sv) provided by the practice (Table 4.43).

**Table 4.43. RSC Retention and Pollutant Removal**

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 40%
Bacteria Removal	= 80%

All practices must be sized using the guidance detailed in Section 4.9.4 Open Channel Design Criteria.

Open channels also contribute to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume from the total runoff volume for the 2-year through the 50-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

#### 4.10 Filtering Systems

Filtering Systems				
<b>Definition:</b> Practices that capture and temporarily store the design storm volume and pass it through a filter bed of sand media. Filtered runoff may be collected and returned to the conveyance system or allowed to partially infiltrate into the soil.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		80%	30%	80%
		Runoff Reductions		
Construction Costs	Maintenance Burden	Volume		
High	High	Low		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	0%		
At least annually	Every 5 years			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Applicable to small drainage areas</li><li>▪ Good for highly impervious areas</li><li>▪ Good for water quality retrofits to existing developments</li></ul>		<ul style="list-style-type: none"><li>▪ High maintenance burden</li><li>▪ Not recommended for areas with high sediment content in stormwater or clay/silt runoff areas</li><li>▪ Relatively costly</li><li>▪ Possible odor problems, if not maintained</li><li>▪ Limited volume and rate control</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Conveyance</li><li>▪ Pretreatment</li><li>▪ Sand bed (or Filtration) chamber</li><li>▪ Spillway/outlet system(s)</li><li>▪ Liner, as needed</li></ul>		<ul style="list-style-type: none"><li>▪ Typically requires 2 to 10 feet of head</li><li>▪ Maximum CDA of 2-5 acres</li><li>▪ Must drain within 40 hours</li><li>▪ In karst areas, watertight structure required</li><li>▪ Maintenance access</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Inspect for clogging—rake first inch of sand</li><li>▪ Remove sediment from pretreatment areas</li></ul>		<ul style="list-style-type: none"><li>▪ Replace filter media as needed</li><li>▪ Clean spillway/outlet system(s)</li></ul>		

<sup>1</sup>Credited pollutant load removal

Stormwater filters are a useful practice to treat stormwater runoff from small, highly impervious sites. Stormwater filters capture, temporarily store, and treat stormwater runoff by passing it through an engineered filter media, collecting the filtered water in an underdrain, and then returning it back to the storm drainage system. Stormwater filters are a versatile option because they consume very little surface land and have few site restrictions. They provide moderate pollutant removal performance at small sites where space is limited.

**Definition.** Practices that capture and temporarily store the design storm volume and pass it through a filter bed of sand media. Filtered runoff may be collected and returned to the conveyance system or allowed to partially infiltrate into the soil. Design variants include the following:

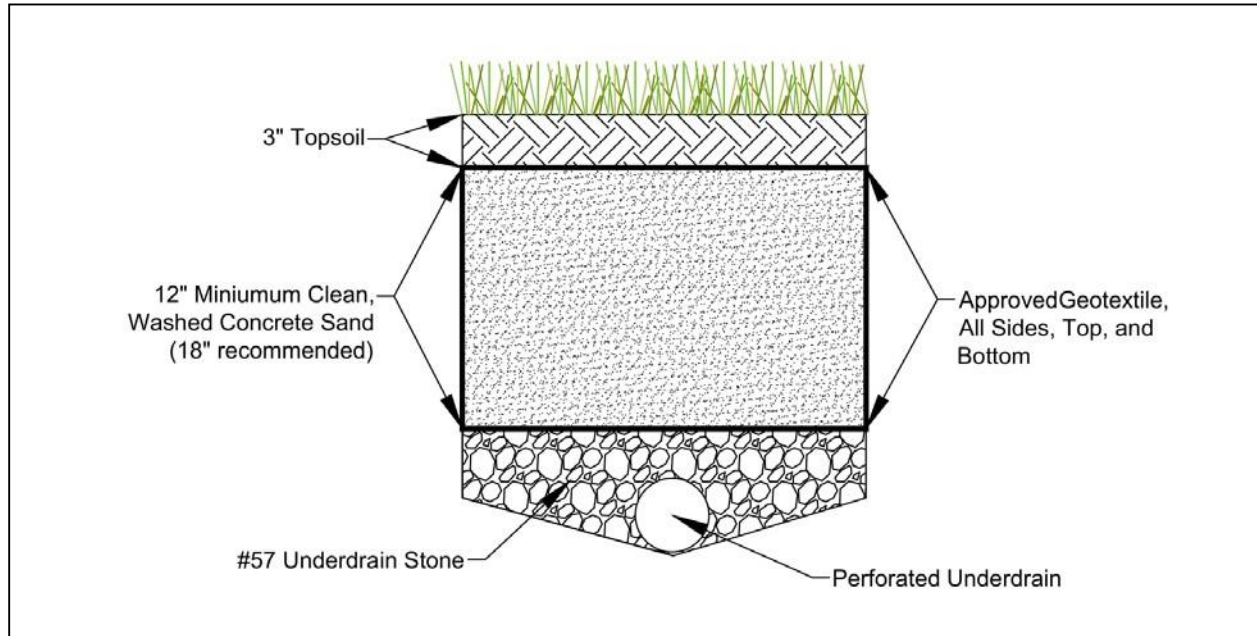
- F-1 Nonstructural sand filter
- F-2 Surface sand filter
- F-3 Three-chamber underground sand filter
- F-4 Perimeter sand filter

Filters have no retention capability, so designers should consider using up-gradient retention practices, which have the effect of decreasing the design storm volume and size of the filtering practices. Filtering practices are also suitable to provide special treatment at designated stormwater hotspots.

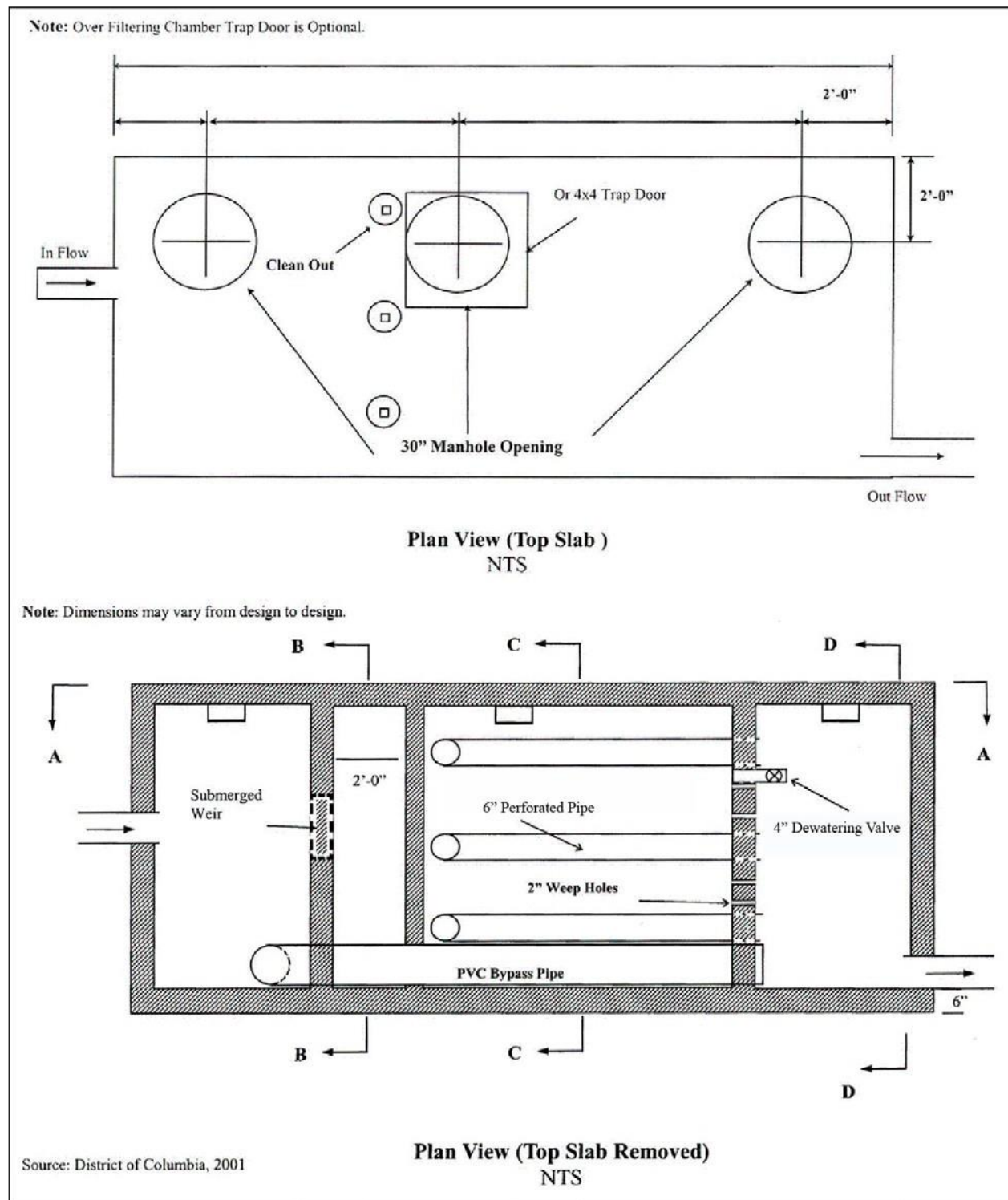
Filtering systems are typically not designed to provide stormwater detention, but they may be in some circumstances. Filtering practices are generally combined with separate facilities to provide this type of control. However, the three-chamber underground sand filter can be modified by expanding the first (or settling) chamber, or by adding an extra chamber between the filter chamber and the clear well chamber to handle the detention volume, which is subsequently discharged at a predetermined rate through an orifice and weir combination.

A nonstructural or surface sand filter is depicted in Figure 4.39, while Figure 4.40 through Figure 4.45 depict three-chamber underground sand filters.

Perimeter sand filters (Figure 4.46) are enclosed stormwater management practices that are typically located just below grade in a trench along the perimeter of parking lot, driveway, or other impervious surface. Perimeter sand filters consist of a pretreatment forebay and a filter bed chamber. Stormwater runoff is conveyed into a perimeter sand filter through grate inlets located directly above the system



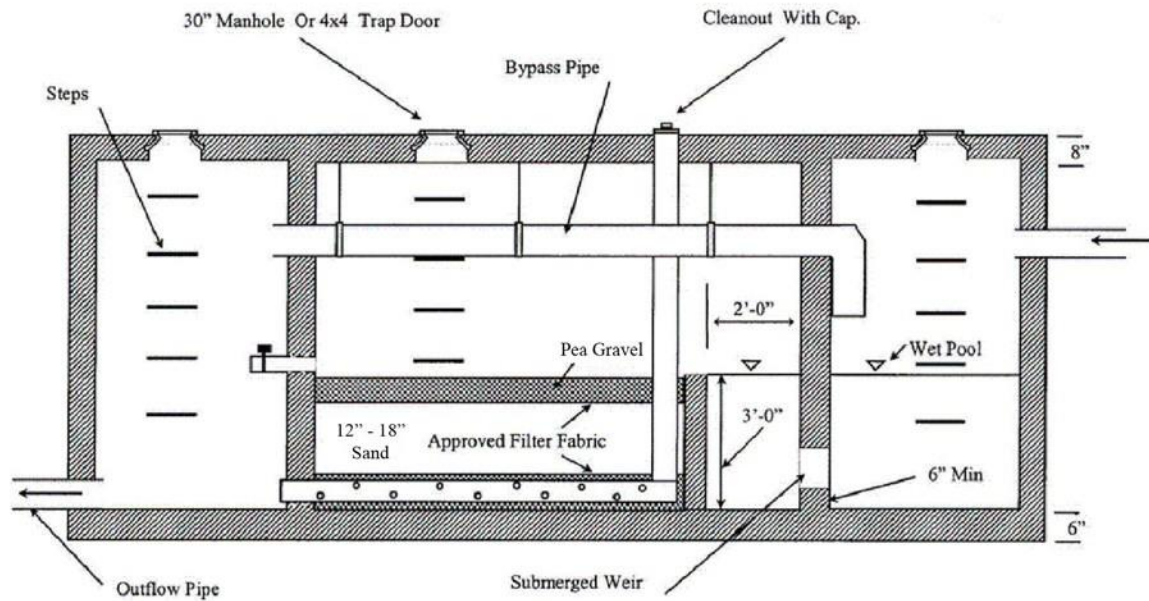
**Figure 4.39. Typical schematic for a nonstructural or surface sand filter (note: material specifications are found in Table 4.44).**



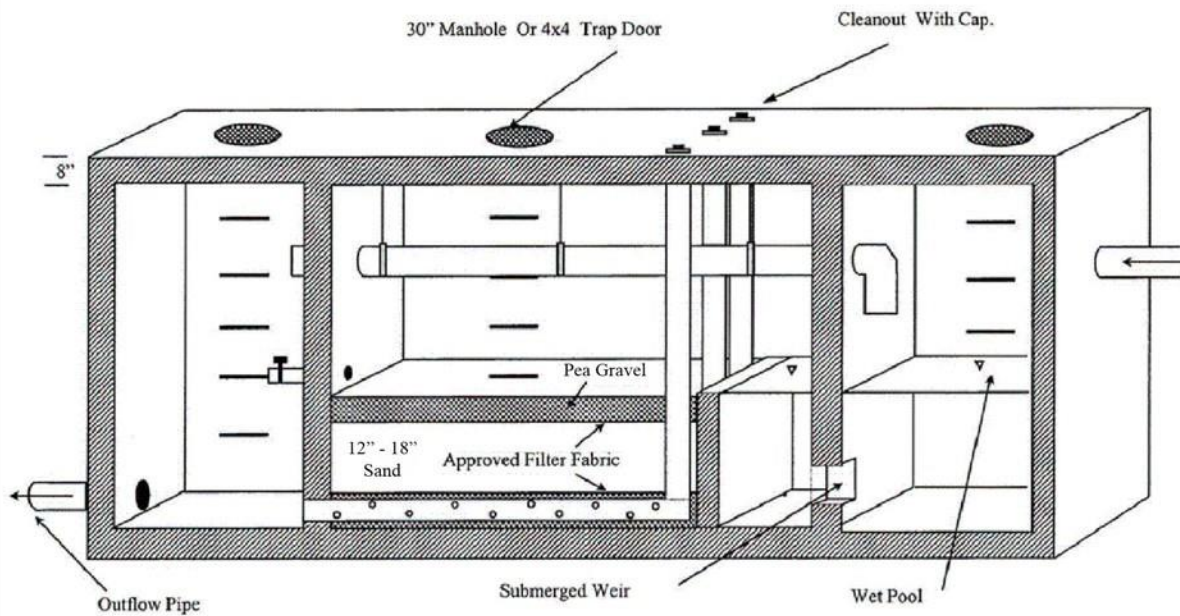
**Figure 4.40. Example of a three-chamber underground sand filter (F-3) for separate sewer options. Part A.** Note: material specifications are indicated in Table 4.44.



Note: Dimensions may vary from design to design.



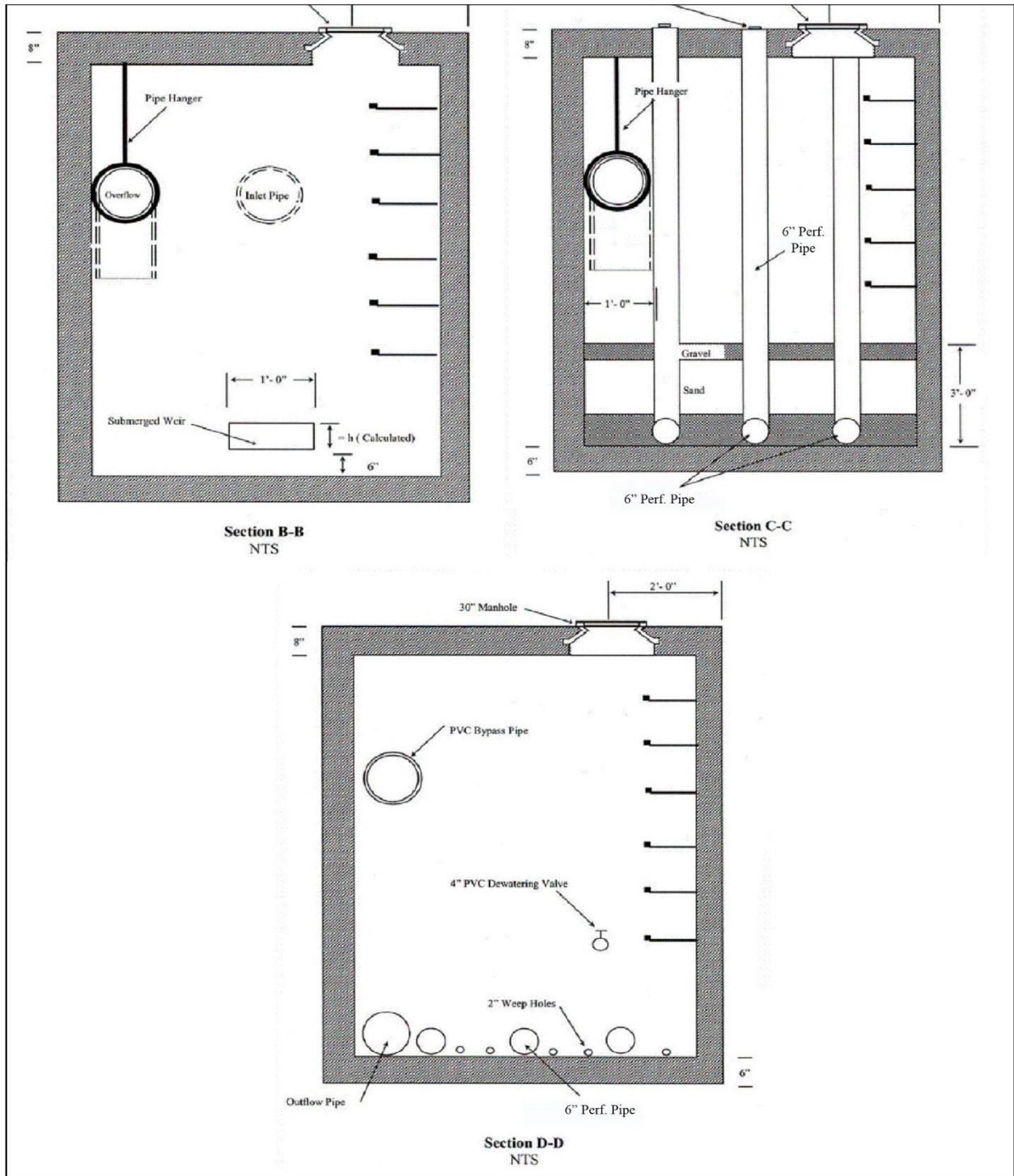
Section A-A  
NTS



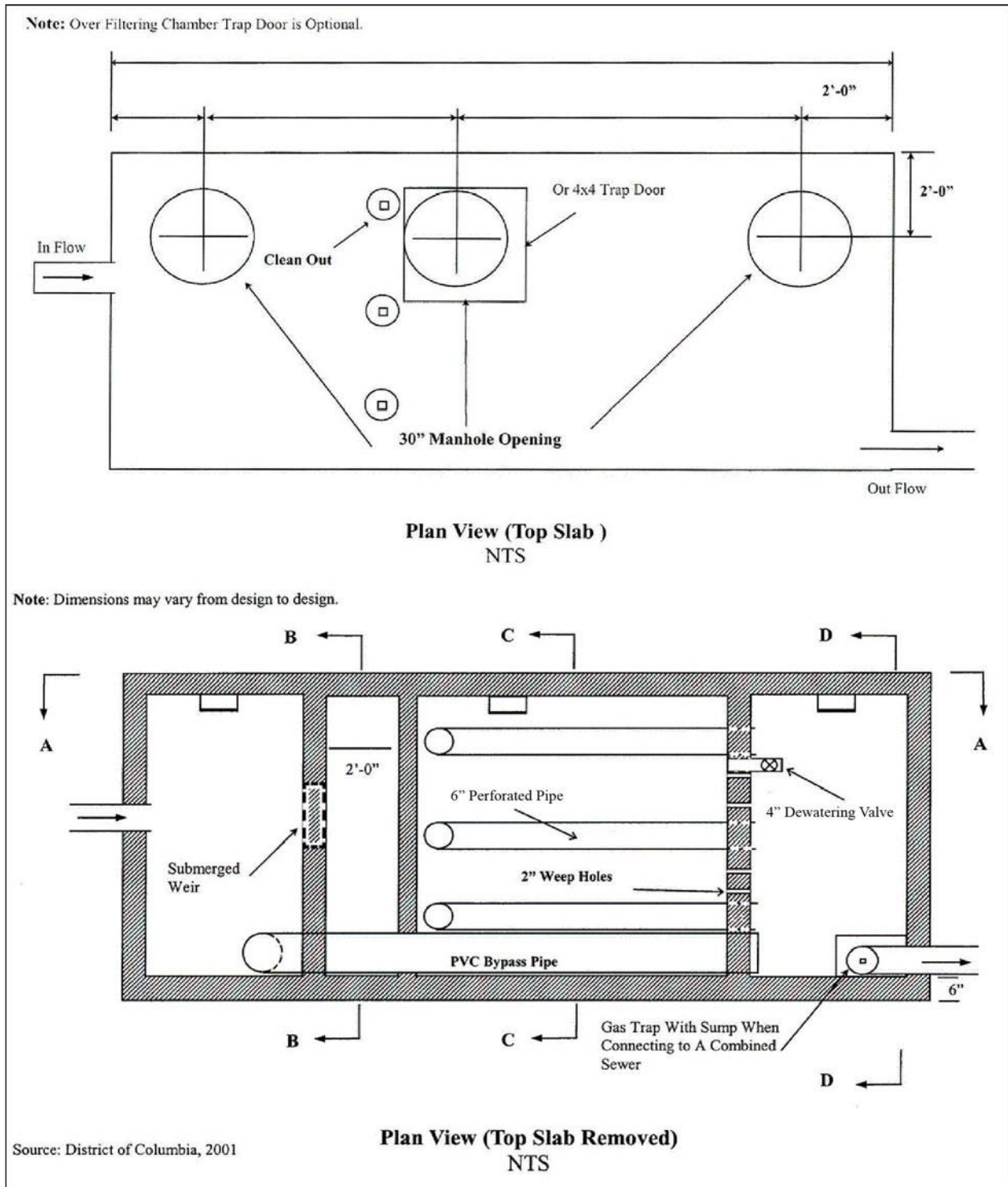
Section A-A (3D)  
NTS

Source: District of Columbia, 2001

Figure 4.41. Example of a three-chamber underground sand filter (F-3) for separate sewer areas. Part B. Note: material specifications are indicated in Table 4.44.

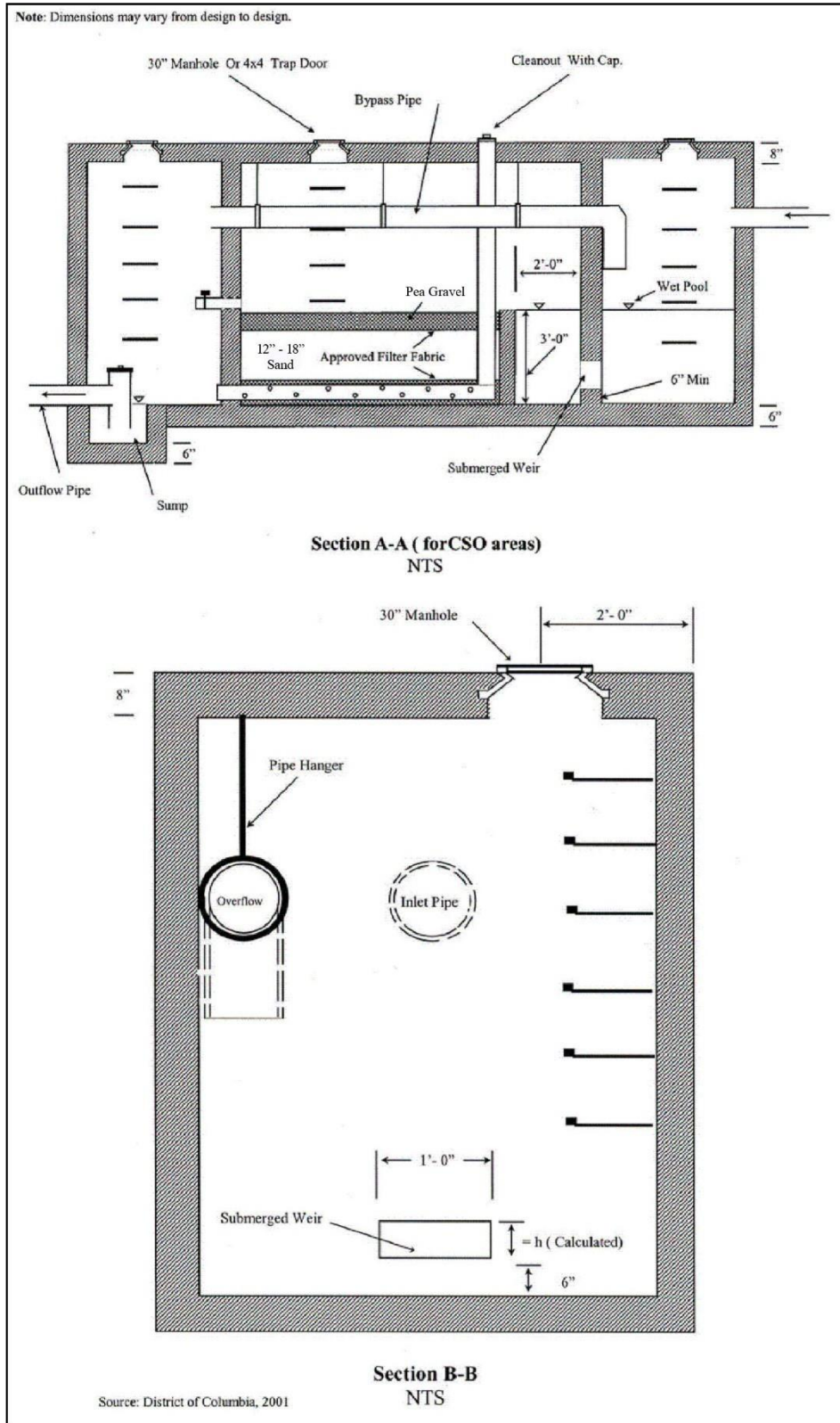


**Figure 4. 42. Example of a three-chamber underground sand filter (F-3) for separate sewer areas. Part C. Note: material specifications are indicated in Table 4.44.**

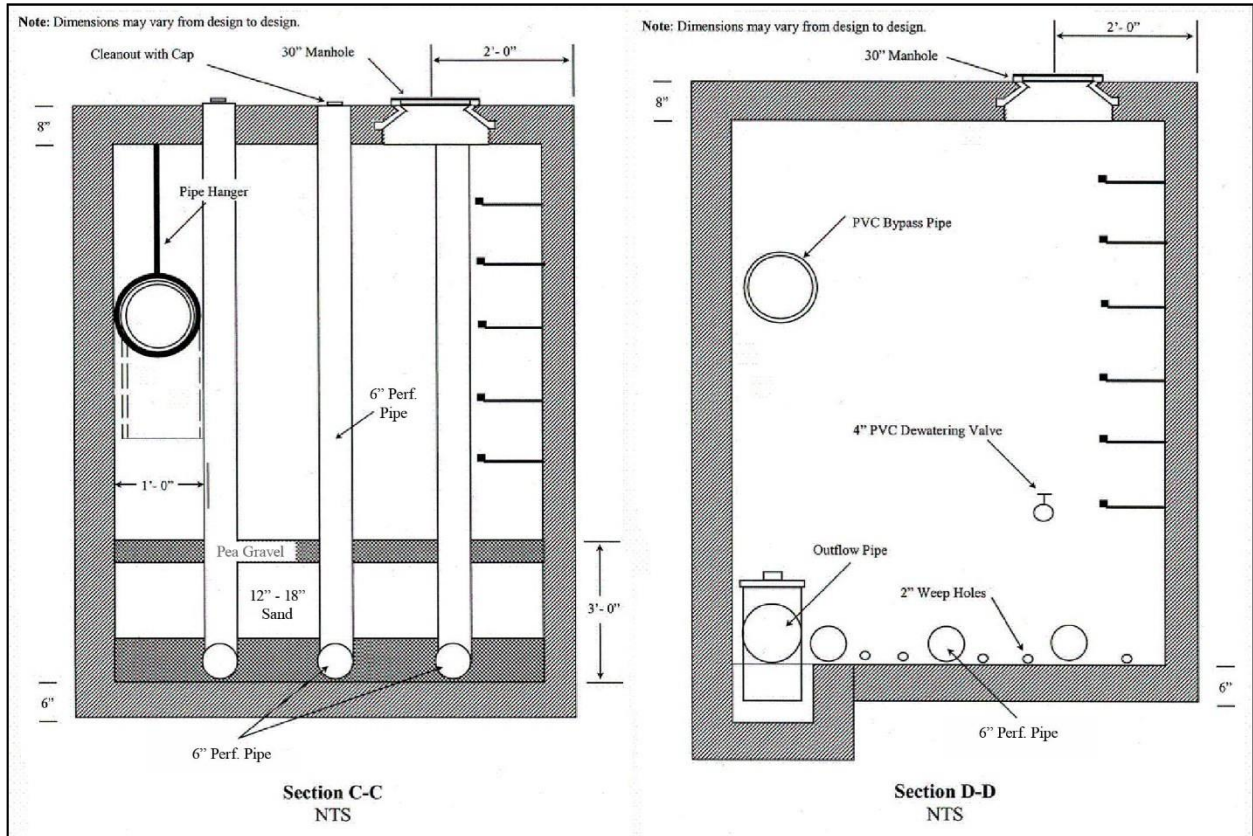


**Figure 4.43. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part A. Note: Material specifications are indicated in Table 4.44.**

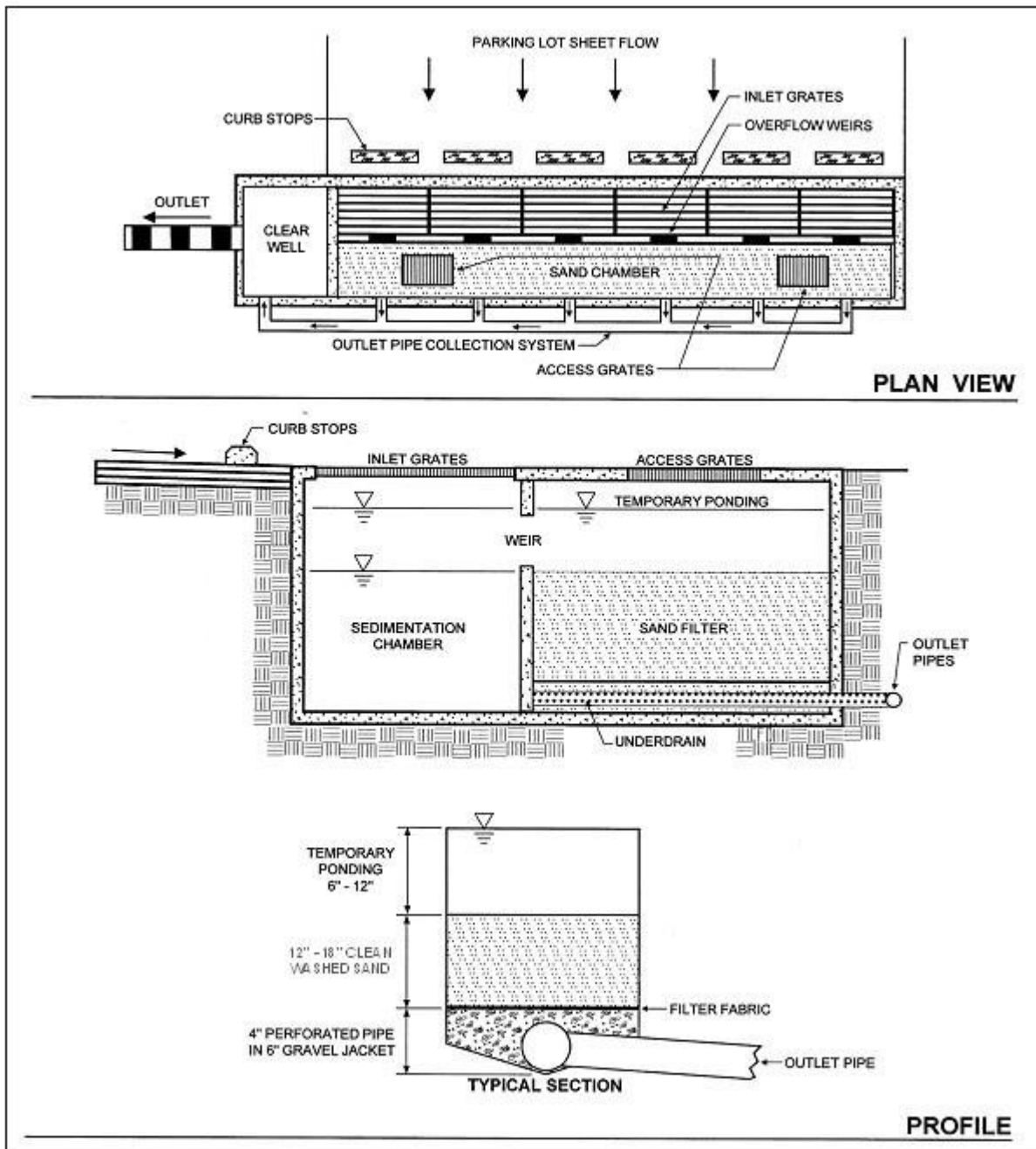




**Figure 4. 44. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part B. Note: Material specifications are indicated in Table 4.44.**



**Figure 4.45. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part C. Note: Material specifications are indicated in Table 4.44.**



**Figure 4.46.** Example of a perimeter sand filter (F-4). Note: material specifications are indicated in Table 4.44.

#### 4.10.1 Filtering System Feasibility Criteria

Stormwater filters can be applied to most types of urban land. They are not always cost-effective, given their high unit cost and small area served, but there are situations where they may clearly be the best option for stormwater treatment (e.g., hotspot runoff treatment, small parking lots, ultra-urban areas, etc.). The following criteria apply to filtering practices:

**Available Hydraulic Head.** The principal design constraint for stormwater filters is available hydraulic head, which is defined as the vertical distance between the top elevation of the filter and the bottom elevation of the existing storm drain system that receives its discharge. The head required for stormwater filters ranges from 2 to 10 feet, depending on the design variant. It is difficult to employ filters in extremely flat terrain, since they require gravity flow through the filter. The only exception is the perimeter sand filter, which can be applied at sites with as little as 2 feet of head.

**Depth to Water Table.** The designer must assure a standard separation distance of at least 0.5 feet between the groundwater table and the bottom invert of the filtering practice.

**Contributing Drainage Area.** Filters are best applied on small sites where the CDA is as close to 100% impervious as possible to reduce the risk that eroded sediment will clog the filter. If the CDA is pervious, then the vegetation must be dense and stable. Turf is acceptable (see Section 4.10.5 Filtering Landscaping Criteria). A maximum CDA of 5 acres is recommended for surface sand filters, and a maximum CDA of 2 acres is recommended for perimeter or underground filters. Filters have been used on larger CDAs in the past, but greater clogging problems have typically resulted.

**Space Required.** The amount of space required for a filter practice depends on the design variant selected. Surface sand filters typically consume about 2%–3% of the CDA, while perimeter sand filters typically consume less than 1%. Underground stormwater filters generally consume no surface area except their manholes.

**Land Use.** As noted above, filters are particularly well suited to treat runoff from stormwater hotspots and smaller parking lots. Other applications include redevelopment of commercial sites or when existing parking lots are renovated or expanded. Filters can work on most commercial, industrial, institutional, or municipal sites and can be located underground if surface area is not available.

**Site Topography.** Filters shall not be located on slopes greater than 6%.

**Utilities.** All utilities shall have a minimum 5-foot, horizontal clearance from the filtering practice.

**Facility Access.** All filtering systems shall be located in areas where they are accessible for inspection and for maintenance (by vacuum trucks).

**Soils.** Soil conditions do not constrain the use of filters. At least one soil boring must be taken at a low point within the footprint of the proposed filtering practice to establish the water table and evaluate soil suitability. A geotechnical investigation is required for all underground stormwater BMPs, including underground filtering systems. Geotechnical testing requirements are outlined in Appendix B Geotechnical Information Requirements for Underground BMPs.

**Setbacks.** Filters should be set back at least 10 feet from the property line, and the bottom of the practice should be separated from groundwater by at least 0.5 feet.

**Economic Considerations.** Perimeter sand filters are expensive relative to other treatment practices, but may be the only option to treat small hotspot drainage areas.

#### 4.10.2 Filtering System Conveyance Criteria

Most filtering practices are designed as off-line systems so that all flows enter the filter storage chamber until it reaches capacity, at which point larger flows are then diverted or bypassed around the filter to an

outlet chamber and are not treated. Runoff from larger storm events must be bypassed using an overflow structure or a flow splitter.

Some underground filters will be designed and constructed as on-line BMPs. In these cases, designers must indicate how the device will safely pass larger storm events (e.g., the 25-year event) to a stabilized water course without resuspending or flushing previously trapped material.

All stormwater filters must be designed to drain or dewater within 40 hours (1.67 days) after a storm event to reduce the potential for nuisance conditions.

#### 4.10.3 Filtering System Pretreatment Criteria

Adequate pretreatment is needed to prevent premature filter clogging and ensure filter longevity. Dry or wet pretreatment shall be provided prior to filter media. Pretreatment devices are subject to the following criteria:

- Sedimentation chambers are typically used for pretreatment to capture coarse sediment particles before they reach the filter bed.
- Sedimentation chambers may be wet or dry but must be sized to accommodate at least 25% of the total design storm volume (inclusive).
- Sediment chambers should be designed as level spreaders such that inflows to the filter bed have near zero velocity and spread runoff evenly across the bed.
- Non-structural and surface sand filters may use alternative pretreatment measures, such as a grass filter strip, forebay, gravel diaphragm, check dam, level spreader, or a combination of these. The grass filter strip must be a minimum length of 15 feet and have a slope of 3% or less. The check dam may be wooden or concrete and must be installed so that it extends only 2 inches above the filter strip and has lateral slots to allow runoff to be evenly distributed across the filter surface. Alternative pretreatment measures must contain a non-erosive flow path that distributes the flow evenly over the filter surface. If a forebay is used, it must be designed to accommodate at least 25% of the total design storm volume (inclusive).

#### 4.10.4 Filtering System Design Criteria

**Detention time.** All filter systems must be designed to drain the design storm volume from the filter chamber within 40 hours (1.67 days) after each rainfall event.

**Structural Requirements.** If a filter will be located underground or experience traffic loads, a licensed structural engineer must certify the structural integrity of the design.

**Geometry.** Filters are gravity flow systems that normally require 2 to 5 feet of driving head to push the water through the filter media through the entire maintenance cycle; therefore, sufficient vertical clearance between the inverts of the inflow and outflow pipes is required.

**Type of Filter Media.** The normal filter media consists of clean, washed AASHTO M-6/ASTM C-33 medium aggregate concrete sand with individual grains 0.02 to 0.04 inches in diameter.

**Depth of Filter Media.** The depth of the filter media plays a role in how quickly stormwater moves through the filter bed and how well it removes pollutants. The recommended filter bed depth is 18 inches. An absolute minimum filter bed depth of 12 inches above underdrains is required; although,



designers should note that specifying the minimum depth of 12 inches will incur a more intensive maintenance schedule and possibly result in costlier maintenance.

**Underdrain and Liner.** Stormwater filters are normally designed with an impermeable liner and underdrain system that meet the criteria provided in Table 4. 44 below.

**Underdrain Stone.** The underdrain should be covered by a minimum 6-inch gravel layer consisting of clean, double washed No. 57 stone.

**Type of Filter.** There are several design variations of the basic filter that enable designers to use filters at challenging sites or to improve pollutant removal rates. The choice of which filter design to apply depends on available space, hydraulic head, and the level of pollutant removal desired. In ultra-urban situations where surface space is at a premium, underground sand filters are often the only design that can be used. Surface and perimeter filters are often a more economical choice when adequate surface area is available. The most common design variants include the following:

- **Non-Structural Sand Filter (F-1).** The non-structural sand filter is applied to sites less than 2 acres in size and is very similar to a bioretention practice (see Section 4.3 Bioretention), with the following exceptions:
  - The bottom is lined with an impermeable liner and always has an underdrain.
  - The surface cover is sand, turf, or pea gravel.
  - The filter media is 100% sand.
  - The filter surface is not planted with trees, shrubs, or herbaceous materials.
  - The filter has two cells, with a dry or wet sedimentation chamber preceding the sand filter bed.

The non-structural sand filter is the least expensive filter option for treating hotspot runoff. The use of bioretention areas is generally preferred at most other sites.

- **Surface Sand Filter (F-2).** The surface sand filter is designed with both the filter bed and sediment chamber located at ground level. The most common filter media is sand; however, a peat/sand mixture may be used to increase the removal efficiency of the system. In most cases, the filter chambers are created using precast or cast-in-place concrete. Surface sand filters are normally designed to be off-line facilities, so that only the desired design volume is directed to the filter for treatment. However, in some cases they can be installed on the bottom of a dry pond (see Section 4.11 Storage Practices).
- **Underground Sand Filter.** The underground sand filter is modified to install the filtering components underground and is often designed with an internal flow splitter or overflow device that bypasses runoff from larger stormwater events around the filter. Underground sand filters are expensive to construct, but they consume very little space and are well suited to ultra-urban areas.
- **Three-Chamber Underground Sand Filter (F-3).** The three-chamber underground sand filter is a gravity flow system. The facility may be precast or cast-in-place. The first chamber acts as a pretreatment facility removing any floating organic material such as oil, grease, and tree leaves. It should have a submerged orifice leading to a second chamber, and it should be designed to minimize the energy of incoming stormwater before the flow enters the second chamber (i.e., filtering or processing chamber).

The second chamber is the filtering or processing chamber. It should contain the filter material consisting of gravel and sand and should be situated behind a weir. Along the bottom of the structure should be a subsurface drainage system consisting of a parallel perforated PVC pipe system in a stone bed. A dewatering valve should be installed at the top of the filter layer for safety release in cases of emergency. A bypass pipe crossing the second chamber to carry overflow from the first chamber to the third chamber is required.

The third chamber is the discharge chamber. It should also receive the overflow from the first chamber through the bypass pipe when the storage volume is exceeded.

Water enters the first chamber of the system by gravity or by pumping. This chamber removes most of the heavy solid particles, floatable trash, leaves, and hydrocarbons. Then the water flows to the second chamber and enters the filter layer by overtopping a weir. The filtered stormwater is then picked up by the subsurface drainage system that empties it into the third chamber.

Whenever there is insufficient hydraulic head for a three-chamber underground sand filter, a well pump may be used to discharge the effluent from the third chamber into the receiving storm or combined sewer. For three-chamber sand filters in combined-sewer areas, a water trap shall be provided in the third chamber to prevent the back flow of odorous gas.

- **Perimeter Sand Filter (F-4).** The perimeter sand filter also includes the basic design elements of a sediment chamber and a filter bed. The perimeter sand filter typically consists of two parallel trenches connected by a series of overflow weir notches at the top of the partitioning wall, which allows water to enter the second trench as sheet flow. The first trench is a pretreatment chamber removing heavy sediment particles and debris. The second trench consists of the sand filter layer. A subsurface drainage pipe must be installed at the bottom of the second chamber to facilitate the filtering process and convey filter water into a receiving system.

In this design, flow enters the system through grates, usually at the edge of a parking lot. The perimeter sand filter is usually designed as an on-line practice (i.e., all flows enter the system), but larger events bypass treatment by entering an overflow chamber. One major advantage of the perimeter sand filter design is that it requires little hydraulic head and is therefore a good option for sites with low topographic relief.

**Surface Cover.** The surface cover for non-structural and surface sand filters should consist of a 3-inch layer of topsoil on top of the sand layer. The surface may also have pea gravel inlets in the topsoil layer to promote filtration. The pea gravel may be located where sheet flow enters the filter, around the margins of the filter bed, or at locations in the middle of the filter bed.

Underground sand filters should have a pea gravel or No. 57 stone layer on top of the sand layer. This gravel layer helps to prevent bio-fouling or blinding of the sand surface.

**Maintenance Reduction Features.** The following maintenance issues should be addressed during filter design to reduce future maintenance problems:

- **Observation Wells and Cleanouts.** Non-structural and surface sand filters must include an observation well consisting of a 6-inch diameter non-perforated PVC pipe fitted with a lockable cap. It should be installed flush with the ground surface to facilitate periodic inspection and maintenance. In most cases, a cleanout pipe will be tied into the end of all underdrain pipe runs. The portion of the cleanout pipe/observation well in the underdrain layer should be perforated. At least one cleanout pipe must be provided for every 2,000 square feet of filter surface area.

- **Access.** Good maintenance access is needed to allow crews to perform regular inspections and maintenance activities. “Sufficient access” is operationally defined as the ability to get a vacuum truck or similar equipment close enough to the sedimentation chamber and filter to enable cleanouts. Direct maintenance access shall be provided to the pretreatment area and the filter bed. For underground structures, sufficient headroom for maintenance should be provided. A minimum head space of 5 feet above the filter is recommended for maintenance of the structure. However, if 5 feet of headroom is not available, manhole access must be installed.
- **Manhole Access (for underground filters).** Access to the headbox and clearwell of Underground Filters must be provided by manholes at least 30 inches in diameter, along with steps to the areas where maintenance will occur.
- **Visibility.** Stormwater filters should be clearly visible at the site so inspectors and maintenance crews can easily find them. Adequate signs or markings must be provided at manhole access points for Underground Filters.
- **Confined Space Issues.** Underground filters are often classified as a confined space. Consequently, special OSHA rules apply, and training may be needed to protect the workers that access them. These procedures often involve training about confined space entry, venting, and the use of gas probes.

**Filter Material Specifications.** The basic material specifications for filtering practices that utilize sand as a filter media are outlined in Table 4.44.

**Table 4.44. Filtering Practice Material Specifications**

Material	Specification
Surface Cover	Non-structural and surface sand filters: 3-inch layer of topsoil on top of the sand layer. The surface may also have pea gravel inlets in the topsoil layer to promote filtration.  Underground sand filters: Clean, double-washed pea gravel or No. 57 stone on top of the sand layer.
Sand	Clean AASHTO M-6/ASTM C-33 medium aggregate concrete sand with a particle size range of 0.02–0.04 inches in diameter.
Choker Stone and/or Geotextile/Filter Fabric	For choker stone, a 2- to 4-inch layer of choker stone (e.g., typically ASTM D448 No. 8 or No. 89 washed gravel) should be placed between the sand layer and the underdrain stone. Alternatively, if available head is limited, an appropriate geotextile fabric that meets AASHTO M-288 Class 2, latest edition, requirements may be used. The geotextile fabric must have a flow rate of > 125 gpm/ft <sup>2</sup> (ASTM D4491) and an Apparent Opening Size (AOS) equivalent to a US No. 70 or No. 80 sieve.
Underdrain/Perforated Pipe	4- or 6-inch perforated schedule 40 PVC pipe, with three or four rows of 3/8-inch perforations at 6 inches on center.
Underdrain Stone	Use No. 57 stone or the ASTM equivalent (1-inch maximum).
Impermeable Liner	Where appropriate, use a PVC Geomembrane liner or equivalent.

**Filter Sizing.** Filtering devices are sized to accommodate a specified design storm volume (typically SWRv). The volume to be treated by the device is a function of the storage depth above the filter and the surface area of the filter. The storage volume is the volume of ponding above the filter. For a given design volume, Equation 4.23 is used to determine the required filter surface area.

#### Equation 4.23 Minimum Filter Surface Area for Filtering Practices

$$SA_{filter} = \frac{DesignVolume \times d_f}{k \times (h_{avg} + d_f) \times t_d}$$

where:

$SA_{filter}$	=	area of the filter surface (ft <sup>2</sup> )
$DesignVolume$	=	design storm volume, typically the SWRv (ft <sup>3</sup> )
$d_f$	=	filter media depth (thickness) (ft), with a minimum of 1 ft
$k$	=	coefficient of permeability (ft/day) (3.5 ft/day for partially clogged sand)
$h_f$	=	height of water above the filter bed (ft), with a maximum of 5 ft
$h_{avg}$	=	average height of water above the filter bed (ft), one half of the filter height ( $h_f$ )
$t_d$	=	allowable drawdown time (1.67 days)

The coefficient of permeability (ft/day) is intended to reflect the worst-case situation (i.e., the condition of the sand media at the point in its operational life where it is in need of replacement or maintenance). Filtering practices are therefore sized to function within the desired constraints at the end of the media's operational life cycle.

The entire filter treatment system, including pretreatment, shall temporarily hold at least 50% of the design storm volume prior to filtration (see Equation 4.24). This reduced volume takes into account the varying filtration rate of the water through the media, as a function of a gradually declining hydraulic head.

#### Equation 4. 24 Required Ponding Volume for Filtering Practices

$$V_{ponding} = 0.50 \times DesignVolume$$

where:

$V_{ponding}$	=	storage volume required prior to filtration (ft <sup>3</sup> )
$DesignVolume$	=	design storm volume, typically the SWRv (ft <sup>3</sup> )

The total storage volume for the practice ( $S_v$ ) can be determined using Equation 4. 25 below.

### Equation 4.25 Storage Volume for Filtering Practices

$$SSRR = 2.0 \times W_{ppbbppmmppgg}$$

where:

$S_v$  = total storage volume for the practice (ft<sup>3</sup>)  
 $V_{ponding}$  = storage volume required prior to filtration (ft<sup>3</sup>)

#### 4.10.5 Filtering System Landscaping Criteria

A dense and vigorous vegetative cover shall be established over the contributing pervious drainage areas before runoff can be accepted into the facility. Filtering practices should be incorporated into site landscaping to increase their aesthetics and public appeal.

Surface filters (e.g., surface and non-structural sand filters) can have a grass cover to aid in pollutant adsorption. The grass should be capable of withstanding frequent periods of inundation and drought.

#### 4.10.6 Filtering System Construction Sequence

**Soil Erosion and Sediment Control.** No runoff shall be allowed to enter the filter system prior to completion of all construction activities, including revegetation and final site stabilization. Construction runoff shall be treated in separate sedimentation basins and routed to bypass the filter system. Should construction runoff enter the filter system prior to final site stabilization, all contaminated materials must be removed and replaced with new clean filter materials before a regulatory inspector approves its completion. The approved soil erosion and sediment control plan shall include specific measures to provide for the protection of the filter system before the final stabilization of the site.

**Filter Installation.** The following is the typical construction sequence to properly install a structural sand filter. This sequence can be modified to reflect different filter designs, site conditions, and the size, complexity, and configuration of the proposed filtering application.

1. **Stabilize Contributing Drainage Area.** Filtering practices should only be constructed after the CDA to the facility is completely stabilized, so sediment from the CDA does not flow into and clog the filter. If the proposed filtering area is used as a sediment trap or basin during the construction phase, the construction notes should clearly specify that, after site construction is complete, the sediment control facility will be dewatered, dredged, and regraded to design dimensions for the post-construction filter.
2. **Install Soil Erosion and Sediment Control Measures for the Filtering Practice.** Stormwater should be diverted around filtering practices as they are being constructed. This is usually not difficult to accomplish for off-line filtering practices. It is extremely important to keep runoff and eroded sediment away from the filter throughout the construction process. Silt fence or other sediment controls should be installed around the perimeter of the filter, and erosion control fabric may be needed during construction on exposed side-slopes with gradients exceeding 4H:1V. Exposed soils in the vicinity of the filtering practice should be rapidly stabilized by hydro-seed, sod, mulch, or other method.
3. **Assemble Construction Materials on Site.** Inspect construction materials to ensure they conform to design specifications and prepare any staging areas.
4. **Clear and Strip.** Bring the project area to the desired subgrade.

5. **Excavate and Grade.** Survey to achieve the appropriate elevation and designed contours for the bottom and side slopes of the filtering practice.
6. **Install Filter Structure.** Install filter structure in design location and check all design elevations (i.e., concrete vaults for surface, underground, and perimeter sand filters). Upon completion of the filter structure shell, inlets and outlets must be temporarily plugged and the structure filled with water to the brim to demonstrate water tightness. Maximum allowable leakage is 5% of the water volume in a 24-hour period. See Appendix E Construction Inspection Checklists for the Stormwater Facility Leak Test form. If the structure fails the test, repairs must be performed to make the structure watertight before any sand is placed into it.
7. **Install Base Material Components.** Install the gravel, underdrains, and choker layers of the filter.
8. **Install Top Sand Component.** Spread sand across filter bed in 1-foot lifts up to the design elevation. Backhoes or other equipment can deliver the sand from outside the filter structure. Sand should be manually raked. Clean water is then added until the sedimentation chamber and filter bed are completely full. The facility is then allowed to drain, hydraulically compacting the sand layers. After 48 hours of drying, refill the structure to the final top elevation of the filter bed.
9. **Install Surface Layer (Surface Sand Filters only).** Add a 3-inch topsoil layer and pea gravel inlets and immediately seed with the permanent grass species. The grass should be watered, and the facility should not be switched on-line until a vigorous grass cover has become established.
10. **Stabilize Surrounding Areas.** Stabilize exposed soils on the perimeter of the structure with temporary seed mixtures appropriate for a buffer. All areas above the normal pool should be permanently stabilized by hydroseed, sod, or seeding and mulch.
11. **Final Inspection.** Conduct the final construction inspection. Multiple construction inspections by a qualified professional are critical to ensure that stormwater filters are properly constructed. Inspections are recommended during the following stages of construction:
  - Initial site preparation, including installation of soil erosion and sediment control measures;
  - Excavation/grading to design dimensions and elevations;
  - Installation of the filter structure, including the water tightness test;
  - Installation of the underdrain and filter bed;
  - Check that turf cover is vigorous enough to switch the facility on-line; and
  - Final inspection after a rainfall event to ensure that it drains properly and all pipe connections are watertight. Develop a punch list for facility acceptance. Log the filtering practice's GPS coordinates and submit them for entry into the BMP maintenance tracking database.

Construction phase inspection checklist for filters and the Stormwater Facility Leak Test form can be found in Appendix E Construction Inspection Checklists.

#### 4.10.7 Filtering System Maintenance Criteria

Maintenance of filters is required and involves several routine maintenance tasks, which are outlined in Table 4.45. A cleanup should be scheduled at least once a year to remove trash and floatables that accumulate in the pretreatment cells and filter bed. Frequent sediment cleanouts in the dry and wet sedimentation chambers are recommended every 1 to 3 years to maintain the function and performance of the filter. If the filter treats runoff from a stormwater hotspot, crews may need to test

the filter bed media before disposing of the media and trapped pollutants. Petroleum hydrocarbon contaminated sand or filter cloth must be disposed of according to State solid waste disposal regulations. Testing is not needed if the filter does not receive runoff from a designated stormwater hotspot, in which case the media can be safely disposed of in a landfill.

**Table 4.45. Typical Annual Maintenance Activities for Filtering Practices**

Frequency	Maintenance Tasks
At least 4 times per growing season	<ul style="list-style-type: none"> <li>Mow grass filter strips and perimeter turf around surface sand filters. Maximum grass heights should be less than 12 inches.</li> </ul>
2 times per year (may be more or less frequently depending on land use)	<ul style="list-style-type: none"> <li>Check to see if sediment accumulation in the sedimentation chamber has exceeded 6 inches. If so, schedule a cleanout.</li> </ul>
Annually	<ul style="list-style-type: none"> <li>Conduct inspection and cleanup.</li> <li>Dig a small test pit in the filter bed to determine whether the first 3 inches of sand are visibly discolored and need replacement.</li> <li>Check to see if inlets and flow splitters are clear of debris and are operating properly.</li> <li>Check concrete structures and outlets for any evidence of spalling, joint failure, leakage, corrosion, etc.</li> <li>Ensure that the filter bed is level and remove trash and debris from the filter bed. Sand or gravel covers should be raked to a depth of 3 inches.</li> </ul>
Every 5 years	<ul style="list-style-type: none"> <li>Replace top sand layer.</li> <li>Till or aerate surface to improve infiltration/grass cover.</li> </ul>
As needed	<ul style="list-style-type: none"> <li>Remove blockages and obstructions from inflows. Trash collected on the grates protecting the inlets shall be removed regularly to ensure the inflow capacity of the BMP is preserved.</li> <li>Stabilize CDA and side-slopes to prevent erosion. Filters with a turf cover should have 95% vegetative cover.</li> </ul>
Upon failure	<ul style="list-style-type: none"> <li>Corrective maintenance is required any time the sedimentation basin and sediment trap do not draw down completely after 72 hours (i.e., no standing water is allowed).</li> </ul>

**Maintenance Inspections.** Regular inspections by a qualified professional are critical to schedule sediment removal operations, replace filter media, and relieve any surface clogging. Frequent inspections are especially needed for underground and perimeter filters, since they are out of sight and can be easily forgotten. Depending on the level of traffic or the particular land use, a filter system may either become clogged within a few months of normal rainfall or could possibly last several years with only routine maintenance. Maintenance inspections should be conducted within 24 hours following a storm that exceeds 0.5 inch of rainfall, to evaluate the condition and performance of the filtering practice.

Note: Without regular maintenance, reconditioning sand filters can be very expensive.

Maintenance inspection checklists for filters and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### 4.10.8 Filtering System Stormwater Compliance Calculations

Filtering practices are credited with 0% retention, but they do receive 80% TSS, 30% TN, and 80% bacteria removal for the storage volume (Sv) provided by the (Table 4.46).

**Table 4.46. Filter Retention and Pollutant Removal**

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 30%
Bacteria Removal	= 80%

The practice must be sized using the guidance detailed in Section 4.8.4 Filtering Design Criteria.



#### 4.11 Storage Practices

Storage Practices				
<b>Definition:</b> Practices that are explicitly designed to provide stormwater detention (2- to 25-year, and/or flood control).				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Low		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Medium	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		60%	10%	60%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
Moderate	Low	Low		
Maintenance Frequency:		SWR <sub>v</sub>		
Routine	Non-Routine	0%		
Quarterly	Every 10–15 years			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Flood control</li><li>▪ Typically less costly than stormwater (wet) ponds for equivalent flood storage</li><li>▪ Provides recreational and other open space opportunities between storm runoff events</li></ul>		<ul style="list-style-type: none"><li>▪ Minimal water quality treatment</li><li>▪ Best suited to large CDAs (at least 10 acres)</li><li>▪ Tends to re-suspend sediment</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Conveyance</li><li>▪ Inlets/outlets</li><li>▪ Forebay</li><li>▪ Ponding area with available storage</li><li>▪ Micropool</li><li>▪ Spillway system(s)</li><li>▪ Liners, as needed</li></ul>		<ul style="list-style-type: none"><li>▪ Depth to seasonal high water table must be at least 6 inches below bottom of practice</li><li>▪ Drawdown of 24 to 48 hours</li><li>▪ Shallow pond with large surface area performs better than deep pond of same volume</li><li>▪ Maintenance access</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Remove debris (inlets/outlets/basin surface)</li><li>▪ Remove sediment buildup</li><li>▪ Repair and revegetate eroded areas.</li></ul>		<ul style="list-style-type: none"><li>▪ Perform structural repairs to inlet and outlets.</li><li>▪ Mow unwanted vegetation</li></ul>		

<sup>1</sup>Credited pollutant load removal

**Storage practices are a common BMP used to temporarily detain runoff to reduce peak flows (Figure 4.47).**



**Figure 4.47. Dry Extended Detention Pond (Photo: Center for Watershed Protection, Inc.)**

**Definition.** Storage practices are explicitly designed to provide stormwater detention (2- to 25-year, and/or flood control). Design variants include the following:

- S-1      Underground detention vaults and tanks
- S-2      Dry detention ponds
- S-3      Rooftop storage
- S-4      Stone storage under permeable pavement or other BMPs

Detention vaults are box-shaped underground stormwater storage facilities typically constructed with reinforced concrete. Detention tanks are underground storage facilities typically constructed with large diameter concrete or plastic pipe (see Figure 4.44). Both serve as an alternative to surface dry detention for stormwater quantity control, particularly for space-limited areas where there is not adequate land for a dry detention basin or multi-purpose detention area. Prefabricated concrete vaults are available from commercial vendors. In addition, several pipe manufacturers have developed packaged detention systems.

Dry detention ponds are widely applicable for most land uses and are best suited for larger SDAs. An outlet structure restricts stormwater flow, so it backs up and is stored within the basin (see Figure 4.

45). The temporary ponding reduces the maximum peak discharge to the downstream channel, thereby reducing the effective shear stress on the bed and banks of the receiving stream.

Storage practices do not receive any stormwater retention or treatment volume and should be considered only for management of larger storm events. Storage practices are not considered an acceptable practice to meet the SWRV. Storage practices must be combined with a separate facility to meet these requirements. Upland practices can be used to satisfy some, or all, of the stormwater retention requirements at many sites, which can help to reduce the footprint and volume of storage practices.

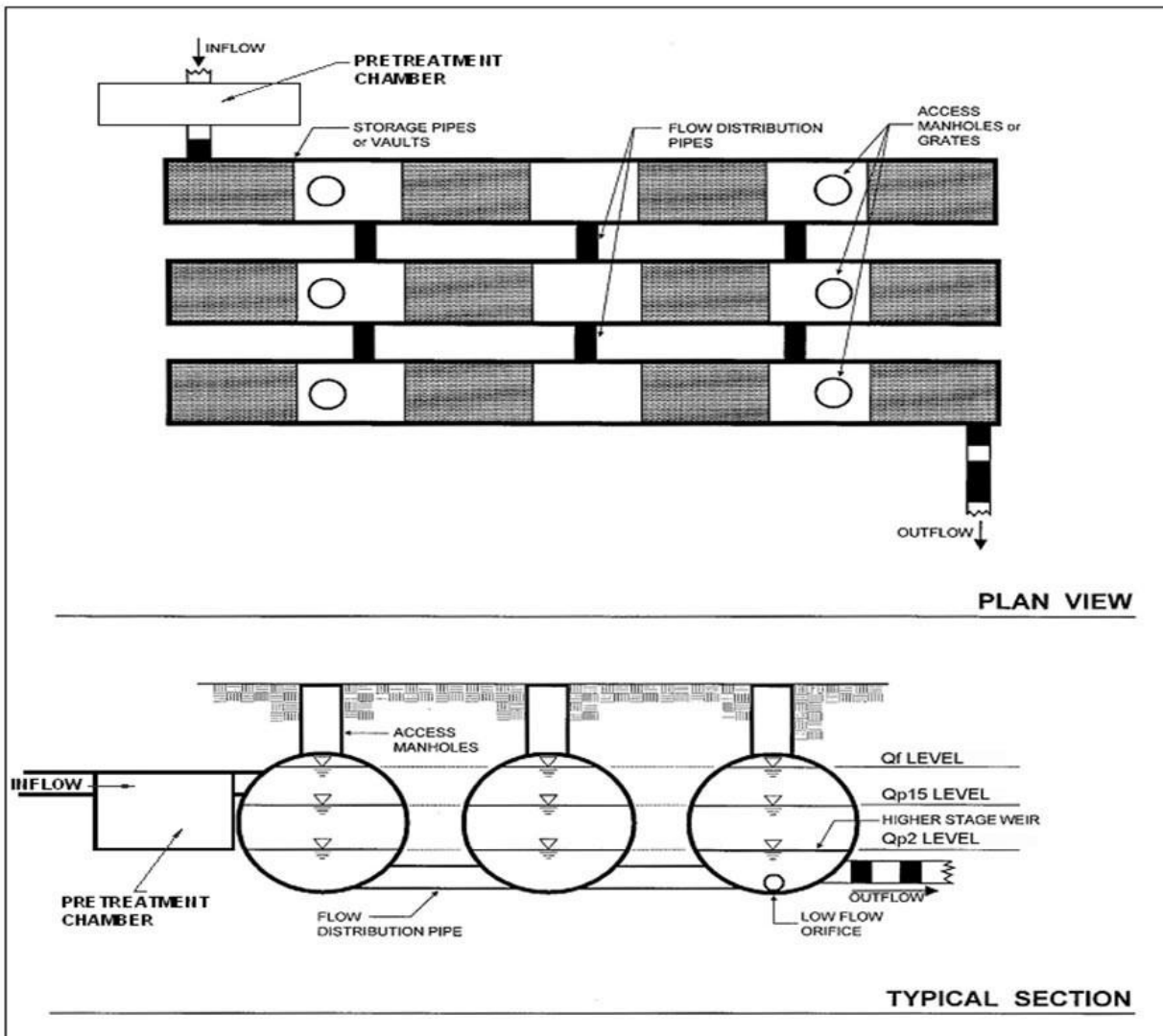
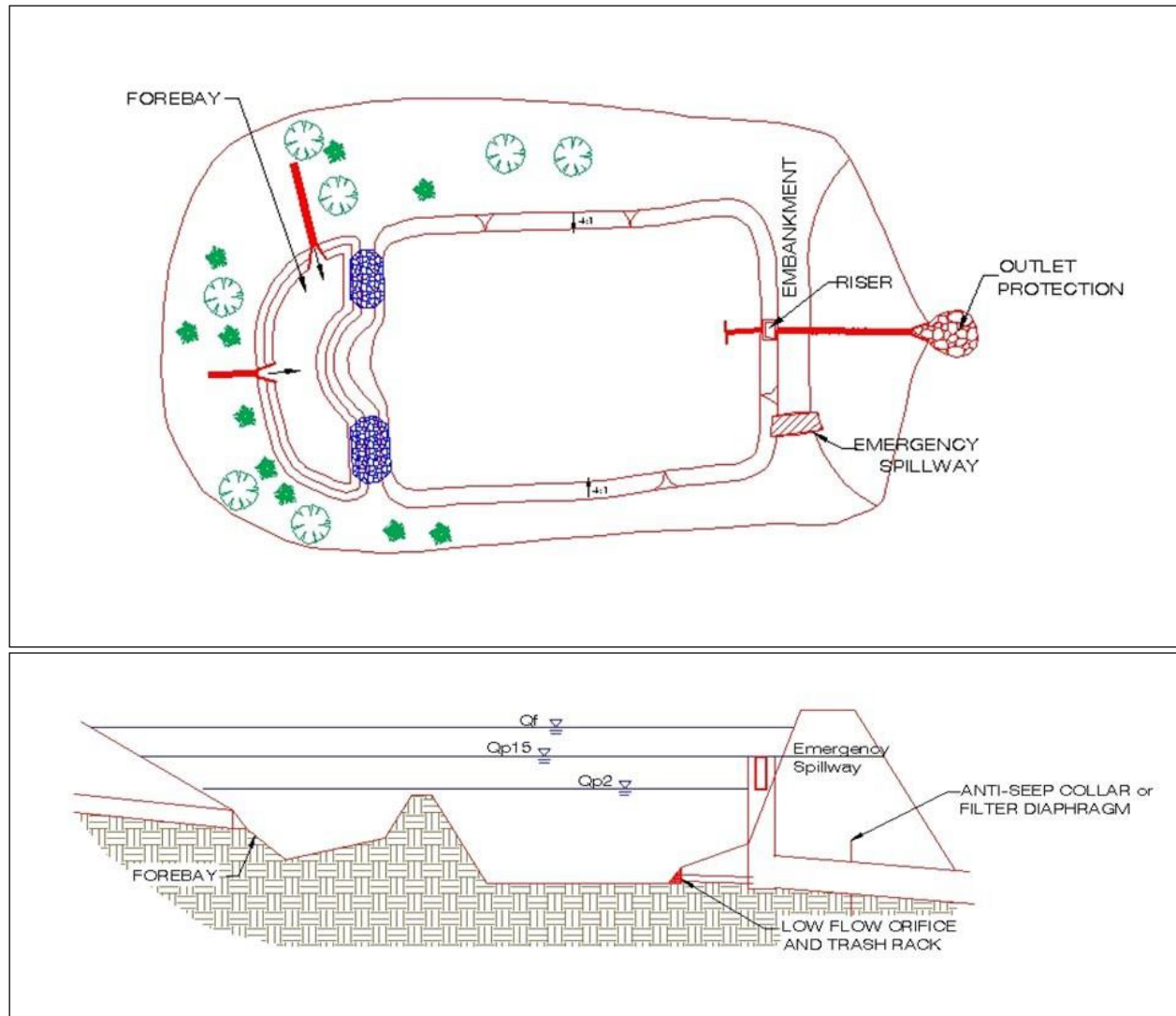


Figure 4.48 Example of an underground detention vault and/or tank (S-1).



**Figure 4.49 Example of a dry detention pond (S-2).**

#### 4.11.1 Storage Feasibility Criteria

The following feasibility issues need to be evaluated when storage practices are considered as the final practice in a treatment train:

**Space Required.** A typical storage practice requires a footprint of 1%–3% of its CDA, depending on the depth of the pond or storage vault (i.e., the deeper the practice, the smaller footprint needed).

**Contributing Drainage Area.** A CDA of at least 10 acres is preferred for dry ponds in order to keep the required orifice size from becoming a maintenance problem. Designers should be aware that small “pocket” ponds will typically (1) have very small orifices that will be prone to clogging, (2) experience fluctuating water levels such that proper stabilization with vegetation is very difficult, and (3) generate more significant maintenance problems.

Underground detention systems can be located downstream of other structural stormwater controls providing treatment of the design storm. For treatment train designs where upland practices are utilized

for treatment of the SWRv, designers can use a site-adjusted Rv or NRCS CN that reflects the volume reduction of upland practices and likely reduce the size and cost of detention (see Storage Practice Sizing in Section 4.8.4 Storage Design Criteria).

The maximum CDA to be served by a single underground detention vault or tank is 25 acres.

**Available Hydraulic Head.** The depth of a storage practice is usually determined by the amount of hydraulic head available at the site (dimension between the surface drainage and the bottom elevation of the site). The bottom elevation is normally the invert of the existing downstream conveyance system to which the storage practice discharges. Depending on the size of the development and the available surface area of the basin, as much as 6 to 8 feet of hydraulic head may be needed for a dry detention practice to function properly for storage. An underground storage practice will require sufficient head room to facilitate maintenance—at least 5 feet depending on the design configuration.

**Setbacks.** Setbacks to structures and property lines must be at least 10 feet, and adequate waterproofing protection must be provided for foundations and basements.

**Depth to Water Table.** Dry ponds are not allowed if the water table will be within 0.5 feet of the floor of the pond. For underground detention vaults and tanks, an anti-flotation analysis is required to check for buoyancy problems in high water table areas.

**Tidal Impacts.** The outlet of a dry detention practice should be located above the tidal mean high water elevation. In tidally impacted areas, detention practices may have minimal benefit, and re-requesting a variance for detention requirements may be an option.

**Tailwater Conditions.** The flow depth in the receiving channel should be considered when determining outlet elevations and discharge rates from the dry detention practice. Design tailwater condition elevation shall be supported by a reasonable resource and/or analysis. For direct discharges to tidal waters, a king tide evaluation shall accompany the tailwater condition evaluation.

**Soils.** The permeability of soils is seldom a design constraint for storage practices. Soil infiltration tests should be conducted at proposed dry pond sites to estimate infiltration rates and patterns, which can be significant in HSG A soils and some group B soils. Infiltration through the bottom of the pond is typically encouraged unless it may potentially migrate laterally thorough a soil layer and impair the integrity of the embankment or other structure.

**Structural Stability.** Underground detention vaults and tanks must meet structural requirements for overburden support and traffic loading if appropriate as verified by shop drawings signed by an appropriately licensed professional.

**Geotechnical Tests.** At least one soil boring must be taken at a low point within the footprint of any proposed storage practice to establish the water table elevations and evaluate soil suitability. A geotechnical investigation is required for all underground BMPs, including underground storage systems. Geotechnical testing requirements are outlined in Appendix B Geotechnical Information Requirements for Underground BMPs.

**Utilities.** For a dry pond system, no utility lines shall be permitted to cross any part of the embankment where the design water depth is greater than 2 feet. Typically, utilities require a minimum 5-foot horizontal clearance from storage facilities.

**Perennial Streams.** Locating dry ponds on perennial streams will require both a Section 401 and Section 404 permit from the appropriate state or federal regulatory agency.

**Economic Considerations.** Underground detention can be expensive, but often allows for greater use of a development site. Dry detention ponds are generally inexpensive to construct and maintain. Depending upon the type of development, dry detention practices may be required to treat a larger volume of water than other BMPs. Dry detention practices must store 1 inch of runoff from the site, whereas infiltration practices and other BMPs must capture 1 inch of runoff from only the impervious cover on a site.

#### 4.11.2 Storage Conveyance Criteria

Designers must use accepted hydrologic and hydraulic routing calculations to determine the required storage volume and an appropriate outlet design for storage practices. See Section 3.7.2 Hydrologic and Hydraulic Analysis for a summary of acceptable hydrologic methodologies and models.

For management of the 2-year storm, a control structure with a trash rack designed to release the required predevelopment  $Q_{p2}$  must be provided. Ideally, the channel protection orifice should have a minimum diameter of 3 inches in order to pass minor trash and debris. However, where smaller orifices are required, the orifice must be adequately protected from clogging by an acceptable external trash rack.

As an alternative, the orifice diameter may be reduced if internal orifice protection is used (i.e., a perforated vertical stand pipe with 0.5-inch orifices or slots that are protected by wirecloth and a stone filtering jacket). Adjustable gate valves, weir manholes, and other structures designed for simple maintenance can also be used to achieve this equivalent diameter.

For overbank flood protection, an additional outlet is sized for 2- to 25-year frequency storm event control and can consist of a weir, orifice, outlet pipe, combination outlet, or other acceptable control structure.

Riprap, plunge pools or pads, or other energy dissipators are to be placed at the end of the outlet to prevent scouring and erosion and to provide a non-erosive velocity of flow from the structure to a water course. The design must specify an outfall that will be stable for the 25-year design storm event. The channel immediately below the storage practice outfall must be modified to prevent erosion. This is typically done by calculating channel velocities and flow depths, then placing appropriately sized riprap, over geotextile fabric, which can reduce flow velocities from the principal spillway to non-erosive levels (3.5 to 5.0 feet per second depending on the channel lining material). The storage practice geometry and outfall design may need to be altered in order to yield adequate channel velocities and flow.

Flared pipe sections that discharge at or near the stream invert or into a step pool arrangement should be used at the spillway outlet. An outfall analysis shall be included in the SWMP showing discharge velocities down to the nearest downstream water course. Where indicated, the developer/contractor must secure an off-site drainage easement for any improvements to the downstream channel.

When the discharge is to a manmade pipe or channel system, the system must be adequate to convey the required design storm peak discharge.

If discharge daylight to a channel with dry weather flow, care should be taken to minimize tree clearing along the downstream channel, and to reestablish a forested riparian zone in the shortest possible distance. Excessive use of riprap should be avoided.

The final release rate of the facility shall be modified if any increase in flooding or stream channel erosion would result at a downstream structure, highway, or natural point of restricted streamflow.

The following **additional** conveyance criteria apply to underground detention or ponds:

- **High Flow Bypass (underground detention).** An internal or external high flow bypass or overflow must be included in underground detention designs to safely pass the extreme flood flow.
- **Primary Spillway (dry ponds).** The primary spillway shall be designed with acceptable anti-flotation, anti-vortex, and trash rack devices. The spillway must generally be accessible from dry land. When reinforced concrete pipe is used for the principal spillway to increase its longevity, “O”-ring gaskets (ASTM C361) must be used to create watertight joints, and they should be inspected during installation.
- **Avoid Outlet Clogging (dry ponds).** The risk of clogging in outlet pipes with small orifices can be reduced by the following:
  - ❑ Providing a micropool at the outlet structure. For more information on micropool extended detention ponds see Section 4.12 Ponds.
  - ❑ Installing a trash rack to screen the low-flow orifice.
  - ❑ Using a perforated pipe under a gravel blanket with an orifice control at the end in the riser structure.
- **Emergency Spillway (dry ponds).** Dry ponds must be constructed with overflow capacity to safely pass the 100-year design storm event through either the primary spillway or a vegetated or armored emergency spillway unless waived by Beaufort County Public Works Department.
- **Inlet Protection (dry ponds).** Inflow points into dry pond systems must be stabilized to ensure that non-erosive conditions exist during storm events up to the overbank flood event (i.e., the 25-year storm event).

#### 4.11.3 Storage Pretreatment Criteria

**Dry Pond Pretreatment Forebay.** A forebay must be located at each major inlet to a dry pond to trap sediment and preserve the capacity of the main treatment cell. The following criteria apply to dry pond forebay design:

- A major inlet is defined as an individual storm drain inlet pipe or open channel serving at least 10% of the storage practice’s CDA.
- The forebay consists of a separate cell, formed by an acceptable barrier (e.g., an earthen berm, concrete weir, gabion baskets, etc.).
- The forebay shall be sized to contain 0.1 inches per impervious acre of contributing drainage. The relative size of individual forebays should be proportional to the percentage of the total inflow to the dry pond.

- The forebay should be designed in such a manner that it acts as a level spreader to distribute runoff evenly across the entire bottom surface area of the main storage cell.
- Exit velocities from the forebay shall be non-erosive or an armored overflow shall be provided. Non-erosive velocities are 4 feet per second for the 2-year event and 6 feet per second for the 25-year event.
- The bottom of the forebay may be hardened (e.g., concrete, asphalt, or grouted riprap) in order to make sediment removal easier.
- Direct maintenance access for appropriate equipment shall be provided to the each forebay.

**Underground Detention Pretreatment.** A pretreatment structure to capture sediment, coarse trash, and debris must be placed upstream of any inflow points to underground detention. A separate sediment sump or vault chamber sized to capture 0.1 inches per impervious acre of contributing drainage, or a proprietary structure with demonstrated capability of removing sediment and trash, should be provided at the inlet for underground detention systems that are in a treatment train with off-line water quality treatment structural controls. Refer to Section 0 Proprietary Practices for information on approved proprietary practices.

#### 4.11.4 Storage Design Criteria

**Dry Pond Internal Design Features.** The following apply to dry pond design:

- **No Pilot Channels.** Dry ponds shall not have a low-flow pilot channel, but instead must be constructed in a manner whereby flows are evenly distributed across the pond bottom, to avoid scour, promote attenuation and, where possible, infiltration.
- **Internal Slope.** The maximum longitudinal slope through the pond should be approximately 0.5%–1%.
- **Side Slopes.** Side slopes within the dry pond should generally have a gradient of 3H:1V to 4H:1V. The mild slopes promote better establishment and growth of vegetation and provide for easier maintenance and a more natural appearance. Ponds with side slopes steeper than 5H:1V must be fenced and include a lockable gate.
- **Long Flow Path.** Dry pond designs should have an irregular shape and a long flow path distance from inlet to outlet to increase water residence time, treatment pathways, pond performance, and to eliminate short-cutting. In terms of flow path geometry, there are two design considerations: (1) the overall flow path through the pond, and (2) the length of the shortest flow path (Hirschman et al., 2009):
  - The overall flow path can be represented as the length-to-width ratio OR the flow path ratio. These ratios must be at least 2L:1W (3L:1W preferred). Internal berms, baffles, or topography can be used to extend flow paths and/or create multiple pond cells.
  - The shortest flow path represents the distance from the closest inlet to the outlet. The ratio of the shortest flow to the overall length must be at least 0.4. In some cases—due to site geometry, storm sewer infrastructure, or other factors—some inlets may not be able to meet these ratios. However, the CDA served by these “closer” inlets must constitute no more than 20% of the total CDA.
- **Top of Bank.** Dry ponds shall be provided with a 20-ft maintenance access at the top of bank with a maximum cross slope of 48:1.



**Safety Features.** The following safety features must be considered for storage practices:

- The underground spillway access must be designed and constructed to prevent access by small children.
- End walls above pipe outfalls greater than 48 inches in diameter must be fenced at the top of the wall to prevent a falling hazard.
- Storage practices must incorporate an additional 1 foot of freeboard above the emergency spillway, or 2 feet of freeboard if design has no emergency spillway, for the 100-year storm.
- The emergency spillway must be located so that downstream structures will not be impacted by spillway discharges
- Underground maintenance access should be locked at all times.

**Maintenance Access.** All storage practices shall be designed so as to be accessible to annual maintenance. Unless waived by Beaufort County Public Works Department, a 5H:1V slope and 15-foot-wide entrance ramp is required for maintenance access to dry ponds. Adequate maintenance access must also be provided for all underground detention systems. Access must be provided over the inlet pipe and outflow structure with access steps. Access openings can consist of a standard 30-inch diameter frame, grate and solid cover, a hinged door, or removable panel. Removable panels must be designed with sufficient support so they cannot fall through the opening into the vault when removed.

**Outlets.** Trash racks shall be provided for low-flow pipes and for risers not having anti-vortex devices.

To reduce maintenance problems for small orifices, a standpipe design can be used that includes a smaller inner standpipe with the required orifice size, surrounded by a larger standpipe with multiple openings, and a gravel jacket surrounding the larger standpipe. This design will reduce the likelihood of the orifice being clogged by sediment.

**Detention Vault and Tank Materials.** Underground stormwater detention structures shall be composed of materials as approved by Beaufort County Public Works Department. All construction joints and pipe joints shall be soil-tight. Cast-in-place wall sections must be designed as retaining walls. The maximum depth from finished grade to the vault invert is 20 feet. The minimum pipe diameter for underground detention tanks is 24 inches unless otherwise approved by Beaufort County Public Works Department. Manufacturer's specifications should be consulted for underground detention structures.

**Anti-floatation Analysis for Underground Detention.** Anti-floatation analysis is required to check for buoyancy problems in high water table areas. Anchors shall be designed to counter the pipe and structure buoyancy by at least a 1.2 factor of safety.

**Storage Practice Sizing.** Storage facilities should be sized to control peak flow rates from the 2- to 25-year frequency storm event or other design storm. Design calculations must ensure that the post-development peak discharge does not exceed the predevelopment peak discharge. See Section 3.7.2 Hydrologic and Hydraulic Analysis for a summary of acceptable hydrologic methodologies and models.

For treatment train designs where upland practices are utilized for treatment of the SWRv, designers can use a site-adjusted Rv or NRCS CN that reflects the volume reduction of upland practices to compute the 2- 50-year frequency storm event that must be treated by the storage practice.

#### 4.11.5 Storage Landscaping Criteria

No landscaping criteria apply to underground storage practices.

For dry ponds, a landscaping plan must be provided that indicates the methods used to establish and maintain vegetative coverage within the dry pond. Minimum elements of a plan include the following:

- Delineation of pondscaping zones within the pond.
- Selection of corresponding plant species.
- The planting plan.
- The sequence for preparing the wetland bed, if one is incorporated with the dry pond (including soil amendments, if needed).
- Sources of native plant material.
- The planting plan should allow the pond to mature into a native forest in the right places, but yet keep mowable turf along the embankment and all access areas. The wooded wetland concept proposed by Cappiella et al. (2005) may be a good option for many dry ponds.
- Woody vegetation may not be planted or allowed to grow within 15 feet of the toe of the embankment nor within 25 feet from the principal spillway structure.

#### 4.11.6 Storage Construction Sequence

Construction of underground storage systems must be in accordance with manufacturer's specifications. All runoff into the system should be blocked until the site is stabilized. The system must be inspected and cleaned of sediment after the site is stabilized.

The following is a typical construction sequence to properly install a dry pond. The steps may be modified to reflect different dry pond designs, site conditions, and the size, complexity, and configuration of the proposed facility.

- 1. Use of Dry Pond for Soil Erosion and Sediment Control.** A dry pond may serve as a sediment basin during project construction. Installation of the permanent riser should be initiated during the construction phase, and design elevations should be set with final cleanout of the sediment basin and conversion to the post-construction dry pond in mind. The bottom elevation of the dry pond should be lower than the bottom elevation of the temporary sediment basin. Appropriate procedures must be implemented to prevent discharge of turbid waters when the basin is being converted into a dry pond.
- 2. Stabilize the Contributing Drainage Area.** Dry ponds should only be constructed after the CDA to the pond is completely stabilized. If the propose dry pond site will be used as a sediment trap or basin during the construction phase, the construction notes must clearly indicate that the facility will be dewatered, dredged, and regraded to design dimensions after the original site construction is complete.
- 3. Assemble Construction Materials on Site.** Inspect construction materials to ensure they conform to design specifications and prepare any staging areas.
- 4. Clear and Grade.** Bring the project area to the desired subgrade.
- 5. Soil Erosion and Sediment Controls.** Install soil erosion and sediment control measures prior to construction, including temporary stormwater diversion practices. All areas surrounding the pond that are graded or denuded during construction must be planted with turf grass, native plantings, or other approved methods of soil stabilization.

6. **Install the Spillway Pipe.** Ensure the top invert of the spillway pipe is set to design elevation.
7. **Install the Riser or Outflow Structure.** Once riser and outflow structures are installed, ensure the top invert of the overflow weir is constructed level and at the design elevation.
8. **Construct the Embankment and any Internal Berms.** Construct the embankment and berms in 8- to 12-inch lifts and compact the lifts with appropriate equipment.
9. **Excavate and Grade.** Survey to achieve the appropriate elevation and designed contours for the bottom and side slopes of the dry pond.
10. **Construct the Emergency Spillway.** The emergency spillway must be constructed in cut or structurally stabilized soils.
11. **Install Outlet Pipes.** The installation of outlet pipes must include a downstream riprap protection apron.
12. **Stabilize Exposed Soils.** All areas above the normal pool elevation should be permanently stabilized by hydroseeding or seeding over straw.

**Dry Pond Construction Supervision.** Ongoing construction supervision is recommended to ensure that stormwater ponds are properly constructed. Supervision/inspection is recommended during the following stages of construction:

- Preconstruction meeting
- Initial site preparation including the installation of soil erosion and sediment control measures
- Excavation/Grading (interim and final elevations)
- Installation of the embankment, the riser/primary spillway, and the outlet structure
- Implementation of the pondscaping plan and vegetative stabilization
- Immediately seed or install vegetated ground cover upon completion of sloping and grading of each storage practice, where applicable, within a project.
- Inspect within two weeks to ensure vegetation is in fact holding banks and slopes in place.
- Prior to completion of project, mechanically remove erosion deposition from ponds that occurred during the project. Criteria should be based on erosion of designed bank slopes and loss of storage capacity.
- Final inspection (develop a punch list for facility acceptance)

Construction phase inspection checklist for storage practices and the Stormwater Facility Leak Test form can be found in Appendix E Construction Inspection Checklists.

If the dry pond has a permanent pool, then to facilitate maintenance the contractor should measure the actual constructed dry pond depth at three areas within the permanent pool (forebay, mid-pond, and at the riser), and they should mark and geo-reference them on an as-built drawing. This simple data set will enable maintenance inspectors to determine pond sediment deposition rates in order to schedule sediment cleanouts.

#### 4.11.7 Storage Maintenance Criteria

Typical maintenance activities for storage practices are outlined in Table 4.47. Maintenance requirements for underground storage facilities will generally require quarterly visual inspections from the manhole access points by a qualified professional to verify that there is no standing water or excessive sediment buildup. Entry into the system for a full inspection of the system components (pipe or vault joints, general structural soundness, etc.) should be conducted annually. Confined space entry credentials are typically required for this inspection.

**Table 4.47. Typical Maintenance Activities for Storage Practices.**

Schedule	Maintenance Activity
As needed	<ul style="list-style-type: none"> <li>Water dry pond side slopes to promote vegetation growth and survival.</li> </ul>
Quarterly	<ul style="list-style-type: none"> <li>Remove sediment and oil/grease from inlets, pretreatment devices, flow diversion structures, storage practices, and overflow structures.</li> <li>Ensure that the CDA, inlets, and facility surface are clear of debris.</li> <li>Ensure that the CDA is stabilized. Perform spot-reseeding where needed.</li> <li>Repair undercut and eroded areas at inflow and outflow structures.</li> </ul>
Annual inspection	<ul style="list-style-type: none"> <li>Measure sediment accumulation levels in forebay. Remove sediment when 50% of the forebay capacity has been lost.</li> <li>Inspect the condition of stormwater inlets for material damage, erosion or undercutting. Repair as necessary.</li> <li>Inspect the banks of upstream and downstream channels for evidence of sloughing, animal burrows, boggy areas, woody growth, or gully erosion that may undermine pond embankment integrity.</li> <li>Inspect outfall channels for erosion, undercutting, riprap displacement, woody growth, etc.</li> <li>Inspect condition of principal spillway and riser for evidence of spalling, joint failure, leakage, corrosion, etc.</li> <li>Inspect condition of all trash racks, reverse sloped pipes, or flashboard risers for evidence of clogging, leakage, debris accumulation, etc.</li> <li>Inspect maintenance access to ensure it is free of debris or woody vegetation and check to see whether valves, manholes, and locks can be opened and operated.</li> <li>Inspect internal and external side slopes of dry ponds for evidence of sparse vegetative cover, erosion, or slumping, and make needed repairs immediately.</li> <li>Monitor the growth of wetlands, trees and shrubs planted in dry ponds. Remove invasive species and replant vegetation where necessary to ensure dense coverage.</li> </ul>

Maintenance of storage practices is driven by annual inspections that evaluate the condition and performance of the storage practice. Based on inspection results, specific maintenance tasks will be triggered.

Maintenance inspection checklists for extended detention ponds and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### 4.11.8 Storage Stormwater Compliance Calculations

Storage practices are credited with 0% retention, but they do receive 80% TSS, 30% TN, and 80% bacteria removal for the SWRV (Table 4.48).

Table 4.48. Storage Retention and Pollutant Removal

Retention	= 0%
TSS Removal	= 60%
TN Removal	= 10%
Bacteria Removal	= 60%

#### 4.12 Ponds

Ponds				
<b>Definition:</b> Stormwater storage practices that consist of a combination of a permanent pool, micropool, or shallow marsh that promote a good environment for gravitational settling, biological uptake, and microbial activity.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Medium	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		80%	30%	60%
		Runoff Reductions		
Construction Costs	Maintenance Burden	Volume		
Moderate	Moderate	Low		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	0%		
At least annually	Every 5–7 years			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ Moderate to high pollutant removal</li><li>▪ Can be designed as a multi-functional BMP</li><li>▪ Cost effective</li><li>▪ Good for sites with high water table and/or poorly drained soils</li><li>▪ Wildlife habitat potential</li><li>▪ High community acceptance when integrated into a development</li></ul>		<ul style="list-style-type: none"><li>▪ Requires large amount of flat land (1-3% of CDA)</li><li>▪ Must be properly designed, installed, and maintained to avoid nuisance problems</li><li>▪ Routine sediment cleanout may be needed</li><li>▪ Potential for thermal impacts downstream</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Conveyance</li><li>▪ Forebay</li><li>▪ Ponding area with available storage</li><li>▪ Micropool</li><li>▪ Spillway system(s)</li><li>▪ Liners, as needed</li></ul>		<ul style="list-style-type: none"><li>▪ CDA of at least 10 acres and slopes &lt;15%</li><li>▪ Use CN adjustment factor ARC III for CDA that are irrigated with harvested rainwater</li><li>▪ Minimum length to width ratio = 3:1</li><li>▪ Maximum depth of permanent pool = 8’</li><li>▪ 3:1 side slopes or flatter around pond perimeter</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Remove debris from inlet and outlet structures</li><li>▪ Maintain side slopes/remove invasive vegetation</li></ul>		<ul style="list-style-type: none"><li>▪ Monitor sediment accumulation and remove periodically</li></ul>		

<sup>1</sup>Credited pollutant load removal

Stormwater ponds are widely applicable for most land uses and are best suited for larger drainage areas (Figure 4.47); however, they should be considered for use after all other upland retention opportunities have been exhausted and there is still a remaining treatment volume or runoff from larger storms (i.e., 2- to 25-year or flood control events) to manage.

Stormwater ponds receive no retention credit and should be considered mainly for management of larger storm events. Stormwater ponds have both community and environmental concerns (see Section 4.12.1 Pond Feasibility Criteria) that should be considered before choosing stormwater ponds as the appropriate stormwater practice on site.



**Figure 4.48 Wet Pond (photo: Denise Sanger)**

**Definition.** Stormwater ponds are stormwater storage practices that consist of a combination of a permanent pool, micropool, or shallow marsh that promote a good environment for gravitational settling, biological uptake, and microbial activity. Ponds are best suited for larger SDAs. Runoff from each new storm enters the pond and partially displaces pool water from previous storms. The pool also acts as a barrier to resuspension of sediments and other pollutants deposited during prior storms. When sized properly, stormwater ponds have a residence time that ranges from many days to several weeks, which allows numerous pollutant removal mechanisms to operate. Stormwater ponds can also provide storage above the permanent pool to help meet stormwater management requirements for larger storms. Design variants include the following (see Figure 4. 47 and Figure 4. 48):

- C-1 Micropool extended detention pond
- C-2 Wet pond
- C-3 Wet extended detention pond



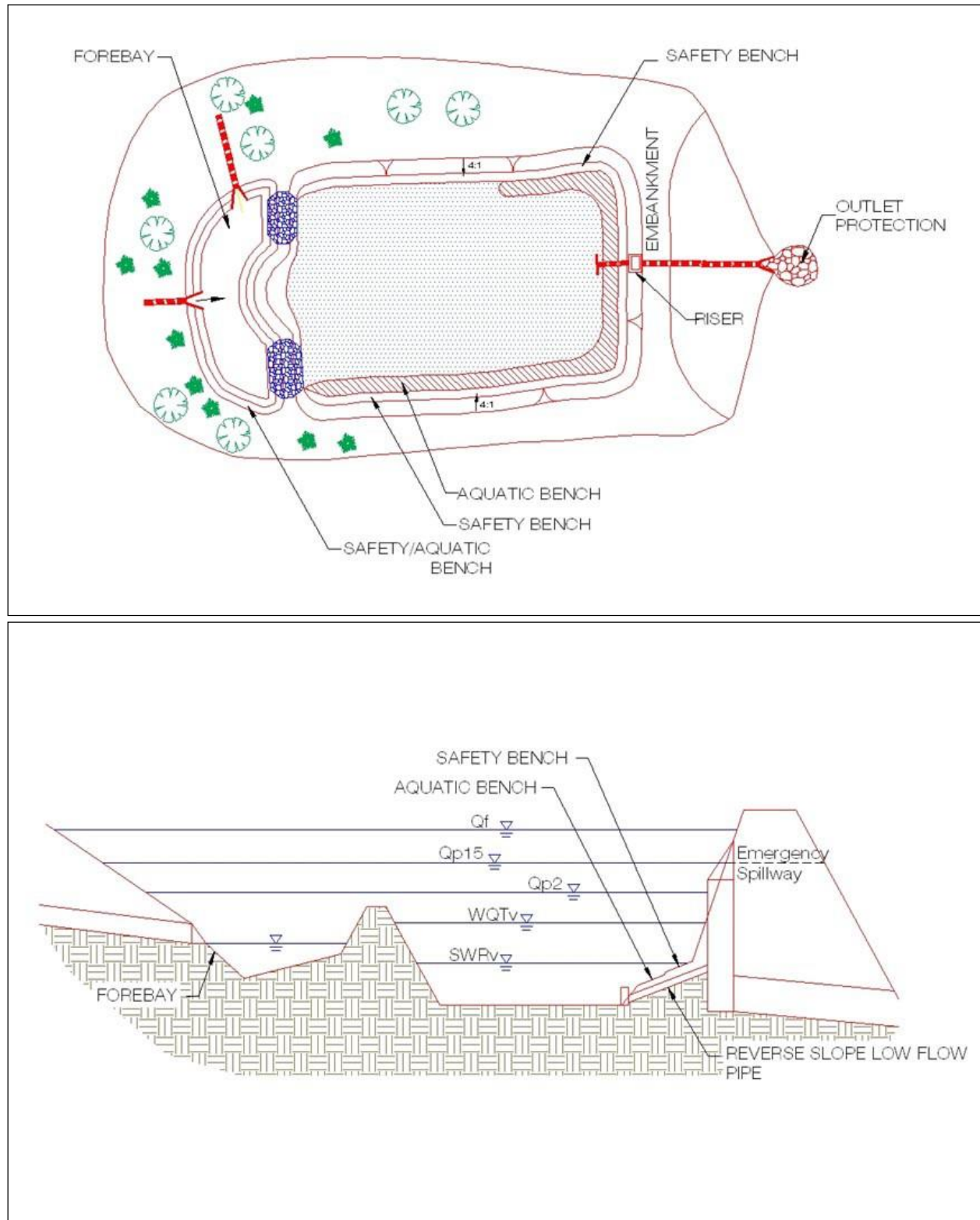
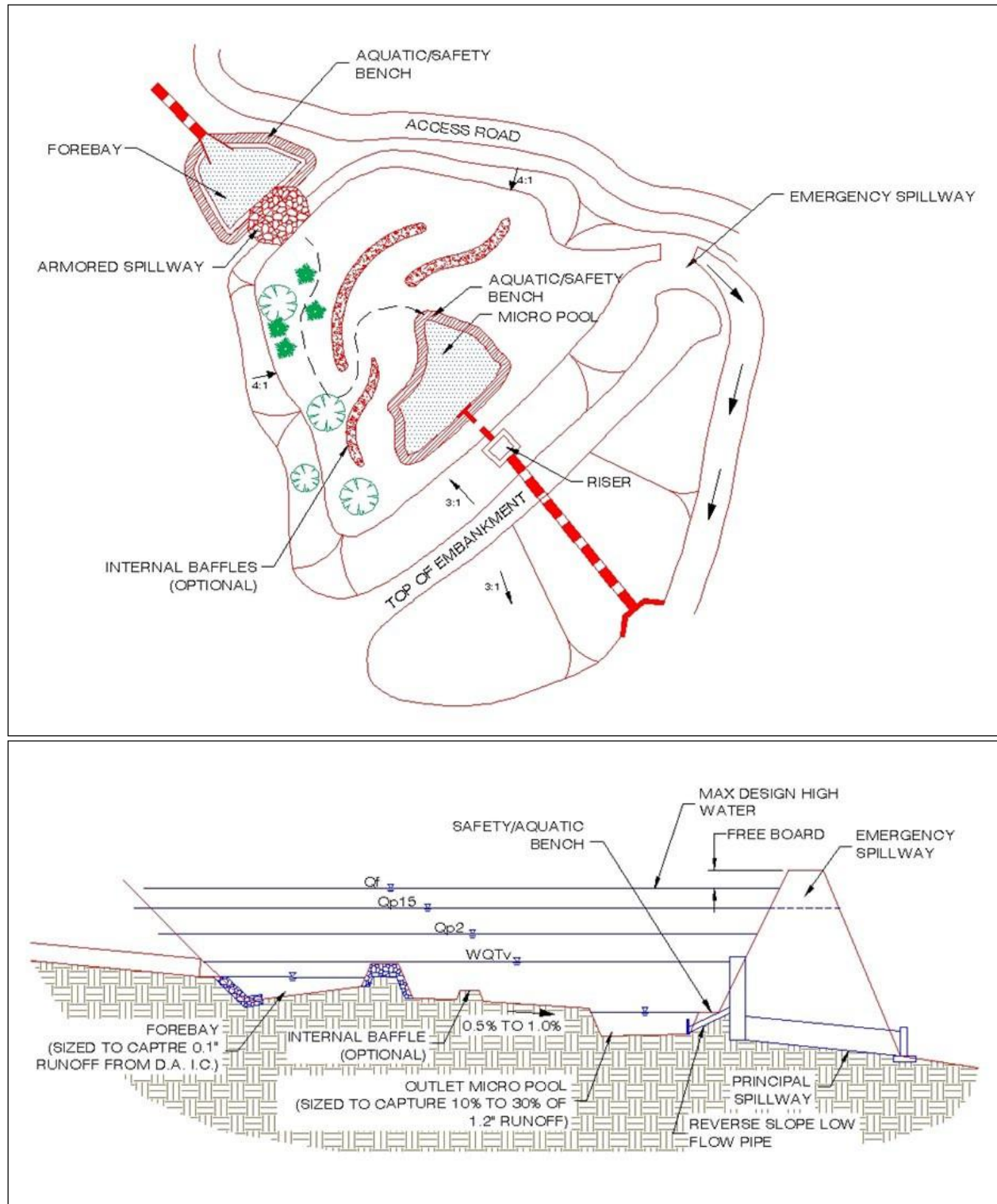


Figure 4. 50 Design schematics for a wet pond (C-2).



**Figure 4.51 Typical extended detention pond (C-3) details.**

#### 4.12.1 Pond Feasibility Criteria

The following feasibility issues need to be considered when ponds are considered a final stormwater management practice of the treatment train.

**Adequate Water Balance.** Wet ponds must have enough water supplied from groundwater, runoff, or baseflow so that the wet pools will not draw down by more than 2 feet after a 30-day summer drought. A simple water balance calculation must be performed using the Equation 4.27 in Section 4.10.4 Pond Design Criteria.

**Contributing Drainage Area.** A CDA of 10 to 25 acres is typically recommended for ponds to maintain constant water elevations. Ponds can still function with CDAs less than 10 acres, but designers should be aware that these “pocket” ponds will be prone to clogging, experience fluctuating water levels, and generate more nuisance conditions.

**Space Requirements.** The surface area of a pond will normally be at least 1%–3% of its CDA, depending on the pond’s depth.

**Site Topography.** Ponds are best applied when the grade of contributing slopes is less than 15%.

**Available Hydraulic Head.** The depth of a pond is usually determined by the hydraulic head available on the site. The bottom elevation is normally the invert of the existing downstream conveyance system to which the pond discharges. Typically, a minimum of 6 to 8 feet of head are needed to hold the wet pool and any additional large storm storage or overflow capacity for a pond to function.

**Setbacks.** Setbacks to structures and property lines must be at least 10 feet and adequate waterproofing protection must be provided for foundations and basements.

**Proximity to Utilities.** For an open pond system, no utility lines shall be permitted to cross any part of the embankment of a wet pool.

**Depth to Water Table.** The depth to the groundwater table is not a major constraint for stormwater ponds because a high water table can help maintain wetland conditions. However, groundwater inputs can also reduce the pollutant removal rates of ponds. Further, if the water table is close to the surface, it may make excavation difficult and expensive.

**Tailwater Conditions.** The flow depth in the receiving channel should be considered when determining outlet elevations and discharge rates from wet pond. Design tailwater condition elevation shall be supported by a reasonable resource and/or analysis. For direct discharges to tidal waters, a king tide evaluation shall accompany the tailwater condition evaluation.

**Soils.** Highly permeable soils will make it difficult to maintain a healthy permanent pool. Soil infiltration tests need to be conducted at proposed pond sites to determine the need for a pond liner or other method to ensure a constant water surface elevation. Underlying soils of HSG C or D should be adequate to maintain a permanent pool. Most HSG A soils and some HSG B soils will require a liner (see Table 3.42). Geotechnical tests should be conducted to determine the saturated hydraulic conductivity and other subsurface properties of the soils beneath the proposed pond.

**Use of or Discharges to Natural Wetlands.** Ponds cannot be located within State waters, including wetlands, without obtaining a Section 404 permit or other permissions from the appropriate state or federal regulatory agency. In addition, the designer should investigate the wetland status of adjacent areas to determine if the discharge from the pond will change the hydroperiod of a downstream natural wetland (see Cappiella et al., 2006, for guidance on minimizing stormwater discharges to existing wetlands).

**Perennial Streams.** Locating ponds on perennial streams will require both US Army COE permits under Clean Water Act Section 401 and Section 404 or other permissions from the appropriate state or federal regulatory agency.

**Economic Considerations.** Wet detention ponds tend to have low construction costs and low space demands (in terms of the land area needed to treat a given volume of water) relative to other LID practices. In addition, the soil excavated to construct ponds can be used as fill, which is often needed for construction on low-lying coastal areas.

**Community and Environmental Concerns.** Ponds can generate the following community and environmental concerns that need to be addressed during design:

- **Aesthetic Issues.** Many residents feel that ponds are an attractive landscape feature, promote a greater sense of community and are an attractive habitat for fish and wildlife. Designers should note that these benefits are often diminished where ponds are under-sized or have small CDAs.
- **Existing Forests.** Construction of a pond may involve extensive clearing of existing forest cover. Designers can expect a great deal of neighborhood opposition if they do not make a concerted effort to save mature trees during pond design and construction. Consideration of Better Site Design Principles is implicit with permitting decisions related to clearing of existing forest cover.
- **Safety Risk.** Pond safety is an important community concern, since both young children and adults have perished by drowning in ponds through a variety of accidents, including falling through thin ice cover. Gentle side slopes and safety benches should be provided to avoid potentially dangerous drop-offs, especially where ponds are located near residential areas.
- **Pollutant Concerns.** Ponds collect and store water and sediment to increase residence time that will increase the likelihood for contaminated water and sediments to be neutralized. However, poorly sized, maintained, and/or functioning ponds can export contaminated sediments and/or water to receiving waterbodies (Mallin, 2000; Mallin et al., 2001; Messersmith, 2007). Further, designers are cautioned that recent research on ponds has shown that some ponds can be hotspots or incubators for algae that generate harmful algal blooms (HABs).
- **Mosquito Risk.** Mosquitoes are not a major problem for larger ponds (Santana et al., 1994; Ladd and Frankenburg, 2003; Hunt et al., 2005). However, fluctuating water levels in smaller or under-sized ponds could pose some risk for mosquito breeding. Mosquito problems can be minimized through simple design features and maintenance operations described in MSSC (2005).
- **Geese and Waterfowl.** Ponds with extensive turf and shallow shorelines can attract nuisance populations of resident geese and other waterfowl, whose droppings add to the nutrient and bacteria loads, thus reducing the removal efficiency for those pollutants. Several design and landscaping features can make ponds much less attractive to geese (see Schueler, 1992).

#### 4.12.2 Pond Conveyance Criteria

**Internal Slope.** The longitudinal slope of the pond bottom should be at least 0.5% to facilitate maintenance.

**Primary Spillway.** The spillway shall be designed with acceptable anti-flotation, anti-vortex and trash rack devices. The spillway must generally be accessible from dry land. When reinforced concrete pipe is used for the principal spillway to increase its longevity, “O-ring” gaskets (ASTM C361) shall be used to create watertight joints.

**Non-Clogging Low-Flow Orifice.** A low-flow orifice must be provided that is adequately protected from clogging by either an acceptable external trash rack or by internal orifice protection that may allow for smaller diameters. Orifices less than 3 inches in diameter may require extra attention during design to minimize the potential for clogging.

- One option is a submerged reverse-slope pipe that extends downward from the riser to an inflow point 1 foot below the normal pool elevation.
- Alternative methods must employ a broad crested rectangular V-notch (or proportional) weir, protected by a half-round CMP that extends at least 12 inches below the normal pool elevation.

**Emergency Spillway.** Ponds must be constructed with overflow capacity to pass the 100-year design storm event through either the primary spillway or a vegetated or armored emergency spillway unless waived by Beaufort County Public Works Department.

**Adequate Outfall Protection.** The design must specify an outfall that will be stable for the 25-year design storm event. The channel immediately below the pond outfall must be modified to prevent erosion and conform to natural dimensions in the shortest possible distance. This is typically done by placing appropriately sized riprap over geotextile fabric, which can reduce flow velocities from the principal spillway to non-erosive levels (3.5 to 5.0 feet per second) depending on the channel lining material. Flared pipe sections, which discharge at or near the stream invert or into a step pool arrangement, should be used at the spillway outlet.

When the discharge is to a manmade pipe or channel system, the system must be adequate to convey the required design storm peak discharge.

If a pond daylights to a channel with dry weather flow, care should be taken to minimize tree clearing along the downstream channel, and to reestablish a forested riparian zone in the shortest possible distance. Excessive use of riprap should be avoided.

The final release rate of the facility shall be modified if any increase in flooding or stream channel erosion would result at a downstream structure, highway, or natural point of restricted streamflow.

**Inlet Protection.** Inflow points into the pond must be stabilized to ensure that non-erosive conditions exist during storm events up to the overbank flood event (i.e., the 25-year storm event). Inlet pipe inverts should generally be located at or slightly below the permanent pool elevation. A forebay shall be provided at each inflow location, unless the inlet is submerged or inflow provides less than 10% of the total design storm inflow to the pond.

**Dam Safety Permits.** The designer must verify whether or not Dam Safety permits or approvals are required for the embankment.

#### 4.12.3 Pond Pretreatment Criteria

**Sediment forebays** are considered to be an integral design feature to maintain the longevity of all ponds. A forebay must be located at each major inlet to trap sediment and preserve the capacity of the main treatment cell. The following criteria apply to forebay design:

- A major inlet is defined as an individual storm drain inlet pipe or open channel serving at least 10% of the pond's CDA.
- The forebay consists of a separate cell, formed by an acceptable barrier (e.g., an earthen berm, concrete weir, gabion baskets, etc.).
- The forebay should be between 4 and 6 feet deep and must be equipped with a variable width aquatic bench for safety purposes. The aquatic bench should be 4 to 6 feet wide at a depth of 1 to 2 feet below the water surface. Small forebays may require alternate geometry to achieve the goals of pretreatment and safety within a small area.
- The forebay shall be sized to contain 0.1 inches of runoff from the contributing drainage impervious area. The relative size of individual forebays should be proportional to the percentage of the total inflow to the pond.
- The bottom of the forebay may be hardened (e.g., with concrete, asphalt, or grouted riprap) to make sediment removal easier.
- The forebay must be equipped with a metered rod in the center of the pool (as measured lengthwise along the low-flow water travel path) for long-term monitoring of sediment accumulation.
- Exit velocities from the forebay shall be non-erosive or an armored overflow shall be provided. Non-erosive velocities are 4 feet per second for the 2-year event, and 6 feet per second for the 25-year event.
- Direct maintenance access for appropriate equipment shall be provided to each forebay.
- Designers of ponds that are used for irrigation should be mindful of pretreatment provisions that help prevent irrigation system pluggages and operational issues.

#### 4.12.4 Pond Design Criteria

**Pond Storage Design.** The pond permanent pool must be sized to store a volume equivalent to the SWRV. Volume storage may be provided in multiple cells. Performance is enhanced when multiple treatment pathways are provided by using multiple cells, longer flowpaths, high surface area to volume ratios, complex microtopography, and/or redundant treatment methods (combinations of pool, ED, and marsh). Volume storage below the permanent pool is not considered in the detention calculations.

**Pond Geometry.** Pond designs should have an irregular shape and a long flow path from inlet to outlet to increase water residence time and pond performance. The minimum length to width ratio (i.e., length relative to width) for ponds is 1.5:1. Greater flowpaths and irregular shapes are recommended. Internal berms, baffles, or vegetated peninsulas can be used to extend flow paths and/or create multiple pond cells.

**Permanent Pool Depth.** The maximum depth of the permanent pool should not generally exceed 8 feet unless the pond is designed for multiple uses.

**Micropool.** A micropool is a 3- to 6-foot-deep pool used to protect the low-flow pipe from clogging and to prevent sediment resuspension. For micropool extended detention ponds, the micropool shall be designed to hold at least 10%–25% of the 85<sup>th</sup> or 95<sup>th</sup> percentile storm event.

**Side Slopes.** Side slopes for ponds should generally have a gradient no steeper than 3H:1V. Mild slopes promote better establishment and growth of vegetation and provide for easier maintenance and a more natural appearance.

**Maximum Extended Detention Levels.** The total storage, including any ponding for larger flooding events (100-year storm) should not extend more than 5 feet above the pond permanent pool unless specific design enhancements to ensure side slope stability, safety, and maintenance are identified and approved.

**Top of Bank.** Storm ponds shall be provided with a 20-ft maintenance access at the top of bank with a maximum cross slope of 48:1.

**Stormwater Pond Benches.** The perimeter of all pool areas greater than 4 feet in depth must be surrounded by two benches, as follows:

- **Safety Bench.** This is a flat bench located just outside of the perimeter of the permanent pool to allow for maintenance access and reduce safety risks. Except when the stormwater pond side slopes are 5H:1V or flatter, provide a safety bench that generally extends 8 to 15 feet outward from the normal water edge to the toe of the stormwater pond side slope. The maximum slope of the safety bench is 5%.
- **Aquatic Bench.** This is a shallow area just inside the perimeter of the normal pool that promotes growth of aquatic and wetland plants. The bench also serves as a safety feature, reduces shoreline erosion, and conceals floatable trash. Incorporate an aquatic bench that generally extends up to 10 feet inward from the normal shoreline, has an irregular configuration, and extends a maximum depth of 18 inches below the normal pool water surface elevation.

**Liners.** When a stormwater pond is located over highly permeable soils, a liner may be needed to sustain a permanent pool of water. If geotechnical tests confirm the need for a liner, acceptable options include the following:

1. a clay liner following the specifications outlined in Table 4.49;
2. a 30-mil- poly-liner;
3. bentonite;
4. use of chemical additives; or
5. an engineering design, as approved on a case-by-case basis by Beaufort County Public Works Department.

A clay liner must have a minimum thickness of 12 inches with an additional 12-inch layer of compacted soil above it, and it must meet the specifications outlined in Table 4.49. Other synthetic liners can be used if the designer can supply supporting documentation that the material will achieve the required performance.

**Table 4.49. Clay Liner Specifications**

Property	Test Method	Unit	Specification
Permeability	ASTM D2434	cm/s	$1 \times 10^{-6}$
Plasticity Index of Clay	ASTM D4318	%	Not less than 15
Liquid Limit of Clay	ASTM D2216	%	Not less than 30
Clay Particles Passing	ASTM D422	%	Not less than 30
Clay Compaction	ASTM D2216	%	95% of standard proctor density

Source: DCR (1999). VA

**Required Geotechnical Testing.** Soil borings must be taken below the proposed embankment, in the vicinity of the proposed outlet area, and in at least two locations within the proposed pond treatment area. Soil boring data is needed to (1) determine the physical characteristics of the excavated material, (2) determine its adequacy for use as structural fill or spoil, (3) provide data for structural designs of the outlet works (e.g., bearing capacity and buoyancy), (4) determine compaction/composition needs for the embankment, (5) determine the depth to groundwater and (6) evaluate potential infiltration losses (and the potential need for a liner).

**Non-clogging Low-Flow (Extended Detention) Orifice.** The low-flow ED orifice shall be adequately protected from clogging by an acceptable external trash rack. The preferred method is a submerged reverse-slope pipe that extends downward from the riser to an inflow point 1 foot below the normal pool elevation. Alternative methods are to employ a broad crested rectangular, V-notch, or proportional weir, protected by a half-round CMP that extends at least 12 inches below the normal pool.

**Riser in Embankment.** The riser should be located within the embankment for maintenance access, safety, and aesthetics. Access to the riser is to be provided by lockable manhole covers and manhole steps within easy reach of valves and other controls. The principal spillway opening can be "fenced" with pipe or rebar at 8-inch intervals for safety purposes.

**Trash Racks.** Trash racks shall be provided for low-flow pipes and for riser openings not having anti-vortex devices.

**Pond Drain.** Ponds should have a drainpipe that can completely or partially drain the permanent pool. In cases where a low-level drain is not feasible (such as in an excavated pond), a pump well must be provided to accommodate a temporary pump intake when needed to drain the pond.

- The drain pipe must have an upturned elbow or protected intake within the pond to help keep it clear of sediment deposition, and a diameter capable of draining the pond within 24 hours.
- The pond drain must be equipped with an adjustable valve located within the riser, where it will not be normally inundated and can be operated in a safe manner.

Care must be exercised during pond drawdowns to prevent downstream discharge of sediments or anoxic water and rapid drawdown. The approving authority shall be notified before draining a pond.



### Safety Features.

- The principal spillway opening must be designed and constructed to prevent access by small children.
- End walls above pipe outfalls greater than 48 inches in diameter must be fenced to prevent a falling hazard.
- Storage practices must incorporate an additional 1 foot of freeboard above the emergency spillway, or 2 feet of freeboard if design has no emergency spillway, for the 100-year storm.
- The emergency spillway must be located so that downstream structures will not be impacted by spillway discharges.
- Both the safety bench and the aquatic bench should be landscaped with vegetation that hinders or prevents access to the pool.
- Warning signs prohibiting swimming must be posted.
- Where permitted, fencing of the perimeter of ponds is discouraged. The preferred method to reduce risk is to manage the contours of the stormwater pond to eliminate drop-offs or other safety hazards. Fencing is required at or above the maximum water surface elevation in the rare situations when the pond slope is a vertical wall.
- Side slopes to the pond shall not be steeper than 3H:1V, and shall terminate on a 15-foot-wide safety bench. Both the safety bench and the aquatic bench may be landscaped to prevent access to the pool. The bench requirement may be waived if slopes are 4H:1V or flatter.

**Maintenance Reduction Features.** Many maintenance issues can be addressed through well designed access. All ponds must be designed for annual maintenance. Good access is needed so crews can remove sediments, make repairs, and preserve pond-treatment capacity. Design for the following:

- ⑦ Adequate maintenance access must extend to the forebay, safety bench, riser, and outlet structure and must have sufficient area to allow vehicles to turn around.
- ⑦ The riser should be located within the embankment for maintenance access, safety, and aesthetics. Access to the riser should be provided by lockable manhole covers and manhole steps within easy reach of valves and other controls.
- ⑦ Access roads must (1) be constructed of load-bearing materials or be built to withstand the expected frequency of use, (2) have a minimum width of 20 feet, and (3) have a profile grade that does not exceed 5H:1V.
- ⑦ A maintenance right-of-way or easement must extend to the stormwater pond from a public or private road.
  - No permanent structures (mechanical, electrical, phone, fences) or landscaping are allowed within the 20' pond maintenance access easement.
- **Material Specifications.** ED ponds are generally constructed with materials obtained on site, except for the plant materials, inflow and outflow devices (e.g., piping and riser materials), possibly stone for inlet and outlet stabilization, and geotextile fabric for lining banks or berms.

- **Pond Sizing.** Stormwater ponds can be designed to capture and treat the remaining stormwater discharged from upstream practices from the design storm (SWR<sub>v</sub>). Additionally, stormwater ponds may be sized to control peak flow rates from the 2- to 25-year frequency storm event or other design storms as required. Design calculations must ensure that the post-development peak discharge does not exceed the predevelopment peak discharge. See Section 3.7.2 Hydrologic and Hydraulic Analysis and Appendix I for a summary of acceptable hydrologic methodologies and models.

For treatment train designs where upland practices are utilized for treatment of the SWR<sub>v</sub>, designers can use a site-adjusted R<sub>v</sub> or NRSC CN that reflects the volume reduction of upland practices to compute the 2- 50-year frequency storm event that must be treated by the stormwater pond.

The pond permanent pool must be sized to store a volume equivalent to the SWR<sub>v</sub> or design volume.

The storage volume (S<sub>v</sub>) of the practice is equal to the volume provided by the pond permanent pool (Equation 4. 26). The total S<sub>v</sub> cannot exceed the design SWR<sub>v</sub>.

#### Equation 4. 26 Pond Storage Volume

$$SSRR = PPDDDDdd ppDDDDDDppDDDDDDDD ppDDDDpp RRDDppvvDDDD$$

- **Water Balance Testing.** A water balance calculation is recommended to document that sufficient inflows to wet ponds and wet ED ponds exist to compensate for combined infiltration and evapotranspiration losses during a 30-day summer drought without creating unacceptable drawdowns (see Equation 4.27, adapted from Hunt et al., 2007). The recommended minimum pool depth to avoid nuisance conditions may vary; however, it is generally recommended that the water balance maintain a minimum 24-inch reservoir.

#### Equation 4. 27 Water Balance Equation for Acceptable Water Depth in a Wet Pond

$$DDPP > EEEE + IIIIII + RREESS - MMMM$$

Where:

<i>DP</i>	=	average design depth of the permanent pool (in.)
<i>ET</i>	=	summer evapotranspiration rate (in.) (assume 8 in.)
<i>INF</i>	=	monthly infiltration loss (assume 7.2 inches at 0.01 in./hour)
<i>RES</i>	=	reservoir of water for a factor of safety (assume 24 in.)
<i>MB</i>	=	measured baseflow rate to the pond, if any convert to pond-inches (in.)

Design factors that will alter this equation are the measurements of seasonal base flow and infiltration rate. The use of a liner could eliminate or greatly reduce the influence of infiltration. Similarly, land use changes in the upstream watershed could alter the base flow conditions over time (e.g., urbanization and increased impervious cover).

Translating the baseflow to inches refers to the depth within the pond. Therefore, Equation 4. 28 can be used to convert the baseflow, measured in cubic feet per second (cfs), to pond-inches:

#### Equation 4. 28 Baseflow Conversion

$$PDDDDd - WDDihDDDD = \frac{MMM \times 2.592 \times 10^6 \times 12}{SSSS}$$

where:

<i>Pond – inches</i>	=	depth within the pond (in.)
<i>MB</i>	=	measured baseflow rate to the pond (cfs)
$2.592 \times 10^6$	=	conversion factor, converting cfs to ft <sup>3</sup> /month
12	=	conversion factor, converting feet to inches
<i>SA</i>	=	surface area of pond (ft <sup>2</sup> )

#### 4.12.5 Pond Landscaping Criteria

**Pond Benches.** The perimeter of all deep pool areas (4 feet or greater in depth) must be surrounded by two benches:

- A safety bench that extends 8 to 15 feet outward from the normal water edge to the toe of the pond side slope. The maximum slope of the safety bench shall be 6%.
- An aquatic bench that extends up to 10 feet inward from the normal shoreline and has a maximum depth of 18 inches below the normal pool water surface elevation.

**Landscaping and Planting Plan.** A landscaping plan must be provided that indicates the methods used to establish and maintain vegetative coverage in the pond and its buffer (see Section 4.3.5 Bioretention Landscaping Criteria for extended landscaping and planting details). Minimum elements of a landscaping plan include the following:

- Delineation of pondscaping zones within both the pond and buffer.
- Selection of corresponding plant species.
- The planting plan.
- The sequence for preparing the wetland benches (including soil amendments, if needed).
- Sources of native plant material.
- The landscaping plan should provide elements that promote diverse wildlife and waterfowl use within the stormwater wetland and buffers.
- Woody vegetation may not be planted or allowed to grow within 15 feet of the toe of the embankment nor within 25 feet from the principal spillway structure.
- A vegetated buffer should be provided that extends at least 25 feet outward from the maximum water surface elevation of the pond. Permanent structures (e.g., buildings) should not be constructed within the buffer area. Existing trees should be preserved in the buffer area during construction.

- The soils in the stormwater buffer area are often severely compacted during the construction process, to ensure stability. The density of these compacted soils can be so great that it effectively prevents root penetration and, therefore, may lead to premature mortality or loss of vigor. As a rule of thumb, planting holes should be three times deeper and wider than the diameter of the root ball for bare root and ball-and-burlap stock, and five times deeper and wider for container-grown stock.
- Avoid species that require full shade or are prone to wind damage. Extra mulching around the base of trees and shrubs is strongly recommended as a means of conserving moisture and suppressing weeds.

For more guidance on planting trees and shrubs in pond buffers, consult Cappiella et al. (2006).

#### 4.12.6 Pond Construction Sequence

The following is a typical construction sequence to properly install a stormwater pond. The steps may be modified to reflect different pond designs; site conditions; and the size, complexity and configuration of the proposed facility.

**1. Use of Ponds for Soil Erosion and Sediment Control.** A pond may serve as a sediment basin during project construction. If this is done, the volume should be based on the more stringent sizing rule (soil erosion and sediment control requirement versus storage volume requirement). Installation of the permanent riser should be initiated during the construction phase, and design elevations should be set with final cleanout of the sediment basin and conversion to the post-construction pond in mind. The bottom elevation of the pond should be lower than the bottom elevation of the temporary sediment basin. Appropriate procedures must be implemented to prevent discharge of turbid waters when the basin is being converted into a pond.

Approval from Beaufort County Public Works Department must be obtained before any sediment pond can be used for stormwater management.

**2. Stabilize the Contributing Drainage Area.** Ponds should only be constructed after the CDA to the pond is completely stabilized. If the proposed pond site will be used as a sediment trap or basin during the construction phase, the construction notes should clearly indicate that the facility will be de-watered, dredged, and regraded to design dimensions after the original site construction is complete.

**3. Assemble Construction Materials on Site.** Inspect construction materials to ensure they conform to design specifications and prepare any staging areas.

**4. Clear and Strip.** Bring the project area to the desired subgrade.

**5. Soil Erosion and Sediment Controls.** Install soil erosion and sediment control measures prior to construction, including temporary de-watering devices and stormwater diversion practices. All areas surrounding the pond that are graded or denuded during construction must be planted with turf grass, native plantings, or other approved methods of soil stabilization.

**6. Excavate the Core Trench and Install the Spillway Pipe.**

**7. Install the Riser or Outflow Structure.** Once riser and outflow structures are installed ensure the top invert of the overflow weir is constructed level at the design elevation.

**8. Construct the Embankment and any Internal Berms.** These features must be installed in 8- to 12-inch lifts; compact the lifts with appropriate equipment.

**9. Excavate and Grade.** Survey to achieve the appropriate elevation and designed contours for the bottom and side slopes of the pond.

**10. Construct the Emergency Spillway.** The emergency spillway must be constructed in cut or structurally stabilized soils.

**11. Install Outlet Pipes.** The installation of outlet pipes must include a downstream riprap protection apron.

**12. Stabilize Exposed Soils.** Use temporary seed mixtures appropriate for the pond buffer to stabilize the exposed soils. All areas above the normal pool elevation must be permanently stabilized by hydroseeding or seeding over straw.

**13. Plant the Pond Buffer Area.** Establish the planting areas according to the pondscaping plan (see Section 4.12.5 Pond Landscaping Criteria).

**Construction Supervision.** Supervision during construction is recommended to ensure that stormwater ponds are properly constructed, especially during the following stages of construction:

- Preconstruction meeting
- Initial site preparation including the installation of soil erosion and sediment control measures
- Excavation/Grading (interim and final elevations)
- Installation of the embankment, the riser/primary spillway, and the outlet structure
- Implementation of the pondscaping plan and vegetative stabilization
- Immediately seed or install vegetated ground cover upon completion of sloping and grading of each stormwater pond within a project.
- Inspect within two weeks to insure vegetation is in fact holding banks and slopes in place.
- Prior to completion of project, mechanically remove erosion deposition from ponds that occurred during the project. Criteria should be based on erosion of designed bank slopes and loss of storage capacity.
- Final inspection (develop a punch list for facility acceptance)

Construction phase inspection checklist for ponds can be found in Appendix E Construction Inspection Checklists.

To facilitate maintenance, contractors should measure the actual constructed pond depth at three areas within the permanent pool (forebay, mid-pond and at the riser), and they should mark and geo-reference them on an as-built drawing. This simple data set will enable maintenance inspectors to determine pond sediment deposition rates in order to schedule sediment cleanouts.

#### **4.12.7 Pond Maintenance Criteria**

Maintenance is needed so stormwater ponds continue to operate as designed on a long-term basis. Ponds normally have fewer routine maintenance requirements than other stormwater control measures. Stormwater pond maintenance activities vary regarding the level of effort and expertise required to perform them. Routine stormwater pond maintenance, such as mowing and removing debris and trash, is needed several times each year (see Table 4.50). More significant maintenance (e.g., removing accumulated sediment) is needed less frequently but requires more skilled labor and special equipment. Inspection and repair of critical structural features (e.g., embankments and risers) needs to

be performed by a qualified professional (e.g., a structural engineer) who has experience in the construction, inspection, and repair of these features.

**Table 4.50. Pond Maintenance Tasks and Frequency.**

Frequency	Maintenance Items
During establishment, as needed (first year)	<ul style="list-style-type: none"> <li>Inspect the site at least twice after storm events that exceed a 1/2 inch of rainfall.</li> <li>Plant the aquatic benches with emergent wetland species, following the planting recommendations contained in Section 4.11.6 Stormwater Wetland Landscaping Criteria.</li> <li>Stabilize any bare or eroding areas in the CDA or around the pond buffer.</li> <li>Water trees and shrubs planted in the pond buffer during the first growing season. In general, consider watering every 3 days for first month, and then weekly during the remainder of the first growing season (April through October), depending on rainfall.</li> </ul>
Quarterly or after major storms (>1 inch of rainfall)	<ul style="list-style-type: none"> <li>Mowing (twice a year)</li> <li>Remove debris and blockages</li> <li>Repair undercut, eroded, and bare soil areas</li> </ul>
Twice a year	<ul style="list-style-type: none"> <li>Mowing of the buffer and pond embankment</li> </ul>
Annually	<ul style="list-style-type: none"> <li>Shoreline cleanup to remove trash, debris, and floatables</li> <li>A full maintenance inspection</li> <li>Open up the riser to access and test the valves</li> <li>Repair broken mechanical components, if needed</li> </ul>
Once—during the second year following construction	<ul style="list-style-type: none"> <li>Pond buffer and aquatic bench reinforcement plantings</li> </ul>
Every 5 to 7 years	<ul style="list-style-type: none"> <li>Forebay sediment removal</li> </ul>
From 5 to 25 years	<ul style="list-style-type: none"> <li>Repair pipes, the riser, and spillway, as needed</li> </ul>

Sediment removal in the pond pretreatment forebay should occur every 5 to 7 years or after 50% of total forebay capacity has been lost. The designer should also check to see whether removed sediments can be spoiled on site or must be hauled away. Sediments excavated from ponds are not usually considered toxic or hazardous. They can be safely disposed of by either land application or land filling. Sediment testing may be needed prior to sediment disposal if the pond serves a pollutant hotspot land use, as the sediment could be potentially toxic or hazardous (Weinstein et al., 2008). In lieu of local regulations for sediment testing, the parameters in Table 4.51 may be used.

**Table 4.51. Ceiling Levels Governing Management of Accumulated Sediment<sup>1</sup>**

Parameter	Ceiling Level (ppm or mg/kg)
Total Arsenic	8
Total Cadmium	10
Total Chromium	100

Total Lead	250
pH	Less than 5 or greater than 10 standard units
Electrical Conductivity	8 deciSiemens/meter (dS/m) at 25°C
<sup>1</sup> Excerpt from Wisconsin Administrative Code NR 528.03, Table 2	

**Maintenance Plans.** Maintenance plans must clearly outline how vegetation in the pond and its buffer will be managed or harvested in the future. Periodic mowing of the stormwater buffer is only required along maintenance rights-of-way and the embankment. The remaining buffer can be managed as a meadow (mowing every other year) or forest. The maintenance plan should schedule a shoreline cleanup at least once a year to remove trash and floatables. For information on chemical control methods for aquatic plants, consult Clemson's fact sheet entitled "Aquatic Weed Control Overview" available online at <http://www.clemson.edu/extension/hgic/plants/other/landscaping/hgic1714.html>.

**Maintenance Inspections.** Maintenance of a pond is driven by annual inspections by a qualified professional who evaluates the condition and performance of the pond. Based on inspection results, specific maintenance tasks will be triggered.

Maintenance inspection checklist for stormwater ponds and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law. However, sediment testing may be needed prior to sediment disposal because sediments excavated from ponds could be contaminated.

#### 4.12.8 Pond Stormwater Compliance Calculations

Stormwater ponds are credited with 0% retention, but they do receive 80% TSS, 30% TN, and 60% bacteria removal for the storage volume (Sv) provided by in the permanent pool (Table 4.52).

**Table 4.52. Pond Retention and Pollutant Removal**

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 30%
Bacteria Removal	= 60%

#### 4.13 Stormwater Wetlands

Stormwater Wetlands				
<b>Definition:</b> Practices that create shallow marsh areas to treat urban stormwater, which often incorporate small permanent pools and/or extended detention storage. Stormwater wetlands are explicitly designed to provide stormwater detention for larger storms (2- to 25-year, or flood control events) above the design storm (SWRv) storage.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Medium	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		80%	25%	60%
		Runoff Reduction		
Construction Costs	Maintenance Burden	Volume		
Moderate	Moderate	Low		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	0%		
At least annually	Every 2 years			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ High removal of typical stormwater pollutants</li><li>▪ Provides habitat for wildlife</li><li>▪ Attractive when integrated into site development</li><li>▪ Good for sites with high water table and/or poorly drained soils</li></ul>		<ul style="list-style-type: none"><li>▪ Requires large amount of flat land (3% of CDA)</li><li>▪ Must be properly designed, installed, and maintained to avoid nuisance problems</li><li>▪ Needs constant source of water</li><li>▪ Routine sediment cleanout may be needed</li><li>▪ Potential for thermal impacts downstream</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Conveyance</li><li>▪ Forebay</li><li>▪ Deep ponding area</li><li>▪ High marsh and transition zones</li><li>▪ Micropool</li><li>▪ Spillway system(s)</li></ul>		<ul style="list-style-type: none"><li>▪ CDA must be large enough to sustain permanent water level</li><li>▪ Flow path through the wetland system should be at least 2L:1W</li><li>▪ 25% of pool depth should be 18-48 inches</li><li>▪ Water balance must be maintained</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Reinforce plantings as needed</li><li>▪ Remove accumulated sediments</li><li>▪ Remove invasive vegetation</li></ul>		<ul style="list-style-type: none"><li>▪ Thin/harvest vegetation every 2 years on embankments and access areas; elsewhere every 5–10 years</li></ul>		

<sup>1</sup>Credited pollutant load removal



Stormwater wetlands, sometimes called constructed wetlands, are shallow depressions that receive stormwater inputs for water quality treatment. Runoff from each new storm displaces runoff from previous storms, and the long residence time allows multiple pollutant removal processes to operate. The wetland environment provides an ideal environment for gravitational settling, biological uptake, and microbial activity. Wetlands include various design adaptations to allow them to be applied in specific settings. For example, some designs incorporate trees within the wetland area.

Stormwater wetlands should be considered for use after all other upland retention opportunities have been exhausted and there is still a remaining treatment volume or runoff from larger storms (i.e., 2- to 25-year or flood control events) to manage. Stormwater wetlands receive no stormwater retention credit and should be considered mainly for management of larger storm events. Stormwater wetlands have both community and environmental concerns (see Section 4.13.1 Stormwater Wetland Feasibility Criteria) that should be considered before choosing stormwater ponds for the appropriate stormwater practice on site.



Figure 4.52 Stormwater Wetland at Carolina Forest Recreation Center, Myrtle Beach (photo: Kathryn Ellis).

**Definition.** Practices that create shallow marsh areas to treat urban stormwater, which often incorporate small permanent pools and/or extended detention storage. Stormwater wetlands are explicitly designed to provide stormwater detention for larger storms (2 – 25-year, or flood control events) above the design storm (SWRv) storage. Wetlands are typically less than 1 foot deep (although they have greater depths at the forebay and in micropools) and possess variable microtopography to promote dense and diverse wetland cover. Design variants include the following:

W-1     Shallow wetland

W-2     Extended detention shallow wetland

Several stormwater wetland design features are illustrated in Figure 4. 48 through Figure 4. 52.

*Note: All of the pond performance criteria presented in Section 4.10-Ponds also apply to the design of stormwater wetlands. Additional criteria that govern the geometry and establishment of created wetlands are presented in this section.*

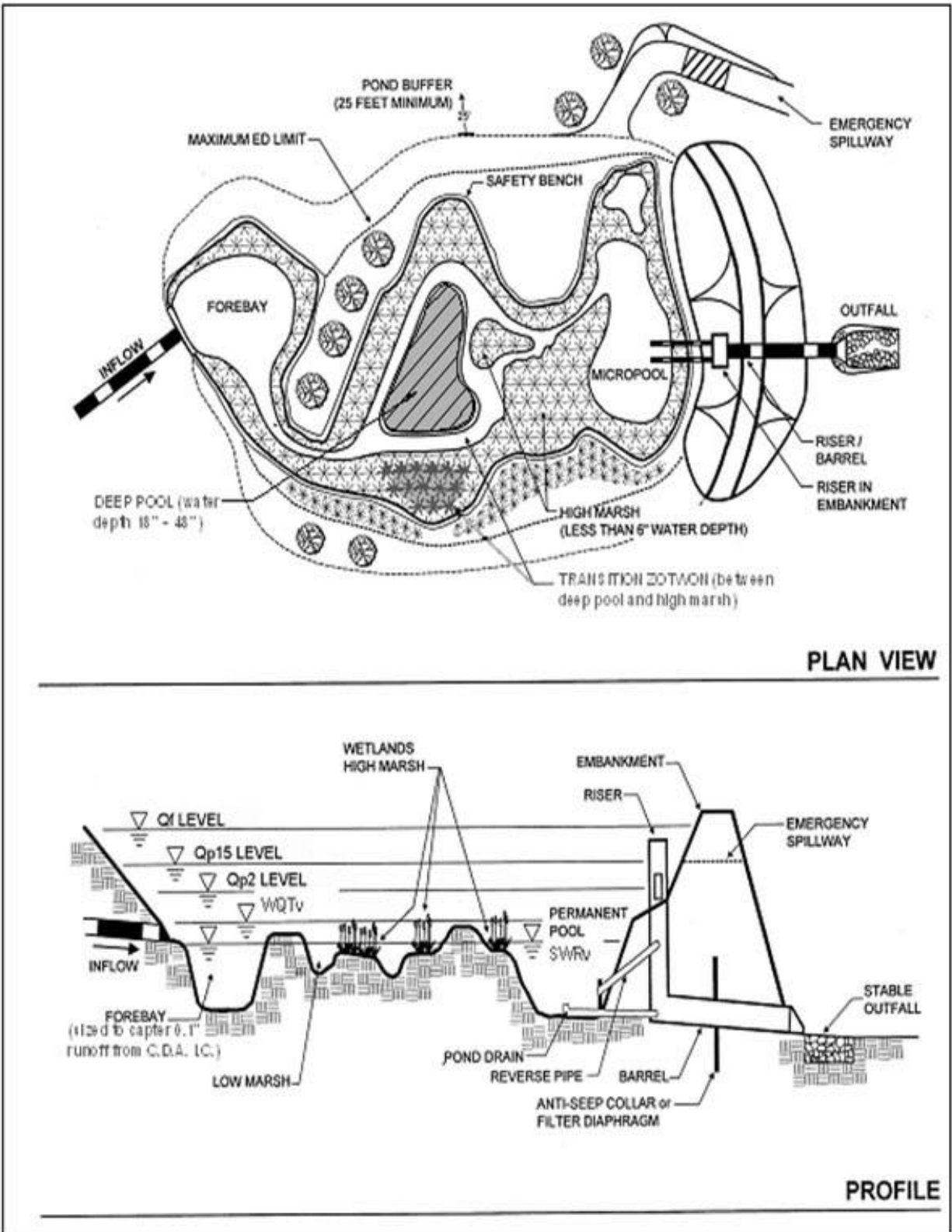
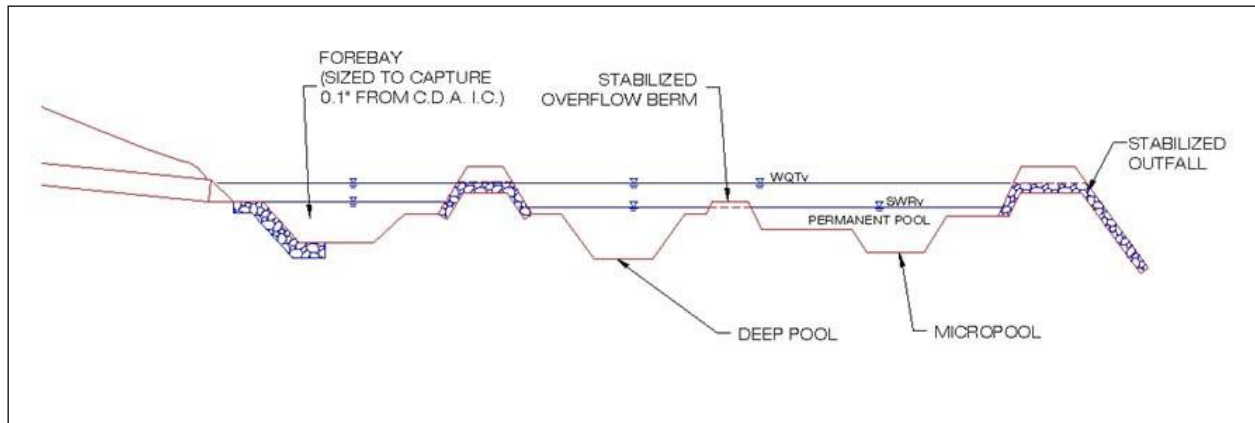
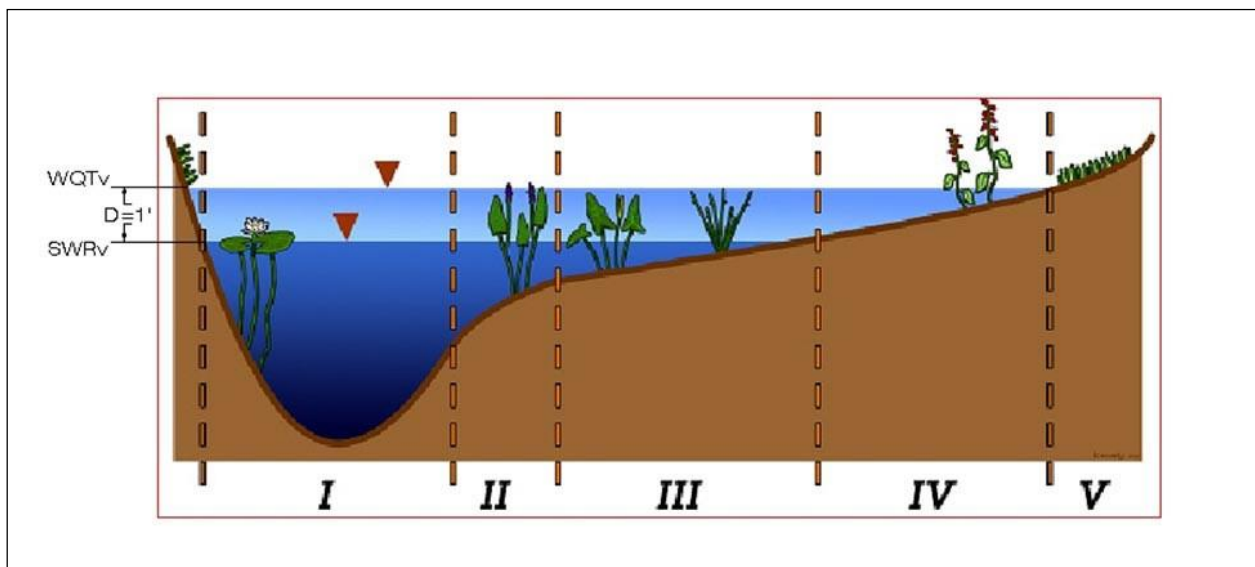


Figure 4.53 Example of extended detention shallow wetland.



**Figure 4.54** Cross section of a typical stormwater wetland.



**Figure 4.55** Interior wetland zones

- (I) Deep Pool (depth -48 to -18 inches),
- (II) Transition Zone (depth -18 to -6 inches),
- (III and IV) High Marsh Zone (depth -6 to +6 inches),
- (IV) Temporary Inundation Area, and
- (V) Upper Bank

Adapted from Hunt et al., 2007

#### 4.13.1 Stormwater Wetland Feasibility Criteria

Constructed wetland designs are subject to the following site constraints:

**Adequate Water Balance.** Stormwater wetlands must have enough water supplied from groundwater, runoff, or baseflow so that the permanent pools will not draw down by more than 2 feet after a 30-day summer drought. A simple water balance calculation must be performed using the equation provided in Section 4.11.4 Stormwater Wetland Design Criteria.

**Contributing Drainage Area.** The CDA must be large enough to sustain a permanent water level within the stormwater wetland. If the only source of wetland hydrology is stormwater runoff, then several dozen acres of CDA are typically needed to maintain constant water elevations. Smaller CDAs are acceptable if the bottom of the stormwater wetland intercepts the groundwater table or if the designer or approving agency is willing to accept periodic wetland drawdown.

**Space Requirements.** Constructed wetlands normally require a footprint that takes up about 3% of the CDA, depending on the average depth of the wetland and the extent of its deep pool features.

**Site Topography.** Stormwater wetlands are best applied when the grade of contributing slopes is less than 8%.

**Steep Slopes.** A modification of the constructed wetland (and linear wetland or wet swale system) is the regenerative stormwater conveyance (RSC) or step pool storm conveyance channel. The RSC can be used to bring stormwater down steeper grades through a series of step pools. This can serve to bring stormwater down outfalls where steep drops on the edge of the tidal receiving system can create design challenges. A description of this practice is provided in Section 4.9 Open Channel Systems.

**Available Hydraulic Head.** The depth of a constructed wetland is usually constrained by the hydraulic head available on the site. The bottom elevation is fixed by the elevation of the existing downstream conveyance system to which the wetland will ultimately discharge. Because constructed wetlands are typically shallow, the amount of head needed (usually a minimum of 2 to 4 feet) is typically less than for wet ponds.

**Setbacks.** Setbacks to structures and property lines must be at least 10 feet and adequate waterproofing protection must be provided for foundations and basements.

**Depth to Water Table.** The depth to the groundwater table is not a major constraint for constructed wetlands, since a high water table can help maintain wetland conditions. However, designers should keep in mind that high groundwater inputs may increase excavation costs (refer to Section 4.12 Ponds).

**Soils.** Soil tests should be conducted to determine the saturated hydraulic conductivity and other subsurface properties of the soils underlying the proposed stormwater wetland. Highly permeable soils will make it difficult to maintain a healthy permanent pool. Underlying soils of HSG C or D should be adequate to maintain a permanent pool. Most HSG A soils and some HSG B soils will require a liner (see Table 4.49 in Section 4.12 Ponds).

**Use of or Discharges to Natural Wetlands.** Constructed wetlands may not be located within jurisdictional waters, including wetlands, without obtaining a Section 404 permit from the appropriate federal regulatory agency. In addition, designer should investigate the status of adjacent wetlands to determine if the discharge from the constructed wetland will change the hydroperiod of a downstream natural wetland. See Cappiella et al. (2006) for guidance on minimizing stormwater discharges to existing wetlands.

**Regulatory Status.** Constructed wetlands built for the express purpose of stormwater treatment are generally not considered jurisdictional wetlands, but designers should check with their wetland regulatory authorities to ensure the status.

**Perennial Streams.** Locating a constructed wetland along or within a perennial stream will require both Section 401 and Section 404 permits from the state or federal regulatory authority.

**Economic Considerations.** If space is available, wetlands can be a very cost-effective stormwater practice.

**Community and Environmental Concerns.** In addition to the community and environmental concerns that exist for stormwater ponds, the following must be addressed during design of stormwater wetlands:

- **Aesthetics and Habitat.** Constructed wetlands can create wildlife habitat and can also become an attractive community feature. Designers should think carefully about how the wetland plant community will evolve over time, since the future plant community seldom resembles the one initially planted.
- **Existing Forests.** Given the large footprint of a constructed wetland, there is a strong chance that the construction process may result in extensive tree clearing. The designer should preserve mature trees during the facility layout and may consider creating a wooded wetland (see Cappiella et al., 2006).
- **Safety Risk.** Constructed wetlands are safer than other types of ponds, although forebays and micropools must be designed with aquatic benches to reduce safety risks.
- **Mosquito Risk.** Mosquito control can be a concern for stormwater wetlands if they are under-sized or have a small CDA. Deepwater zones serve to keep mosquito populations in check by providing habitat for fish and other pond life that prey on mosquito larvae. Few mosquito problems are reported for well-designed, properly sized, and frequently maintained constructed wetlands; however, no design can eliminate them completely. Simple precautions can be taken to minimize mosquito breeding habitat within constructed wetlands (e.g., constant inflows, benches that create habitat for natural predators, and constant pool elevations—MSSC, 2005).

#### 4.13.2 Stormwater Wetland Conveyance Criteria

- The slope profile within individual stormwater wetland cells should generally be flat from inlet to outlet (adjusting for microtopography). The recommended maximum elevation drop between wetland cells is 1 foot or less.
- Since most constructed wetlands are on-line facilities, they need to be designed to safely pass the maximum design storm (e.g., the 25-year and 100-year design storms). While the ponding depths for the more frequent 2-year storm are limited in order to avoid adverse impacts to the planting pallet, the overflow for the less frequent 25-100-year storms must likewise be carefully designed to minimize the depth of ponding. A maximum depth of 4 feet over the wetland pool is recommended.
- While many options are available for setting the normal pool elevation, it is strongly recommended that removable flashboard risers be used, given their greater operational flexibility to adjust water levels following construction (see Hunt et al., 2007). Also, a weir can be designed to accommodate passage of the larger storm flows at relatively low ponding depths.

#### 4.13.3 Stormwater Wetland Pretreatment Criteria

Sediment regulation is critical to sustain stormwater wetlands. Consequently, a forebay shall be located at the inlet and a micropool shall be located at the outlet. A micropool is a 3- to 6-foot-deep pool used to protect the low-flow pipe from clogging and to prevent sediment resuspension. Forebays are

designed in the same manner as stormwater ponds (see Section 4.12.3 Pond Pretreatment Criteria). The design of forebays should consider the possibility of heavy trash loads from public areas.

#### 4.13.4 Stormwater Wetland Design Criteria

**Internal Design Geometry.** Research and experience have shown that the internal design geometry and depth zones are critical in maintaining the pollutant removal capability and plant diversity of stormwater wetlands. Stormwater wetland performance is enhanced when the wetland has multiple cells, longer flowpaths, and a high ratio of surface area to volume. Whenever possible, constructed wetlands should be irregularly shaped with long, sinuous flow paths. The following design elements are required for stormwater wetlands:

**Multiple-Cell Wetlands.** Stormwater wetlands can be divided into at least four internal sub-cells of different elevations: the forebay, a micro-pool outlet, and two additional cells. Cells can be formed by sand berms (anchored by rock at each end), back-filled coir fiber logs, or forested peninsulas (extending as wedges across 95% of the wetland width). The vegetative target is to ultimately achieve a 50-50 mix of emergent and forested wetland vegetation within all four cells.

The first cell (the forebay) is deeper and is used to receive runoff from the pond cell or the inflow from a pipe or open channel and distribute it as sheetflow into successive wetland cells. The surface elevation of the second cell is the normal pool elevation. It may contain a forested island or a sand wedge channel to promote flows into the third cell, which is 3 to 6 inches lower than the normal pool elevation. The purpose of the wetland cells is to create an alternating sequence of aerobic and anaerobic conditions to maximize pollutant removal. The fourth wetland cell is located at the discharge point and serves as a micro-pool with an outlet structure or weir.

**Extended Detention Ponding Depth.** When extended detention is provided for management of larger storm events, the total ED volume shall not comprise more than 50% of the total volume stored by the stormwater wetland, and its maximum water surface elevation shall not extend more than 3 feet above the normal pool.

**Deep Pools.** Approximately 25% of the stormwater surface area must be provided in at least three deeper pools—located at the inlet (forebay), center, and outlet (micropool) of the wetland—with each pool having a depth of from 18 to 48 inches. Refer to the sizing based on water balance below for additional guidance on the minimum depth of the deep pools.

**High Marsh Zone.** Approximately 70% of the stormwater wetland surface area must exist in the high marsh zone (-6 inches to +6 inches, relative to the normal pool elevation).

**Transition Zone.** The low marsh zone is no longer an acceptable wetland zone, and is only allowed as a short transition zone from the deeper pools to the high marsh zone (-6 to -18 inches below the normal pool elevation). In general, this transition zone should have a maximum slope of 5H:1V (or preferably flatter) from the deep pool to the high marsh zone. It is advisable to install biodegradable erosion control fabrics or similar materials during construction to prevent erosion or slumping of this transition zone.

**Flow Path.** In terms of the flow path, there are two design objectives:

- The overall flow path through the stormwater wetland can be represented as the length-to-width ratio OR the flow path ratio. A minimum overall flow path of 2:1 must be provided across the stormwater wetland.
- The shortest flow path represents the distance from the closest inlet to the outlet. The ratio of the shortest flow path to the overall length must be at least 0.5. In some cases—due to site geometry, storm sewer infrastructure, or other factors—some inlets may not be able to meet these ratios. However, the CDA served by these “closer” inlets must constitute no more than 20% of the total CDA.

**Side Slopes.** Side slopes for the stormwater wetland should generally have gradients of 4H:1V or flatter. These mild slopes promote better establishment and growth of the wetland vegetation. They also contribute to easier maintenance and a more natural appearance.

**Micro-Topographic Features.** Stormwater wetlands must have internal structures that create variable micro-topography, which is defined as a mix of above-pool vegetation, shallow pools, and deep pools that promote dense and diverse vegetative cover.

**Stormwater Wetland Material Specifications.** Stormwater wetlands are generally constructed with materials obtained on site, except for the plant materials, inflow and outflow devices (e.g., piping and riser materials), possibly stone for inlet and outlet stabilization, and geotextile fabric for lining banks or berms. Plant stock should be nursery grown, unless otherwise approved (e.g. by the local regulatory authority), and must be healthy and vigorous native species free from defects, decay, disfiguring roots, sun-scald, injuries, abrasions, diseases, insects, pests, and all forms of infestations or objectionable disfigurements, as determined during the local plan review.

**Stormwater Wetland Sizing.** Stormwater wetlands can be designed to capture and treat the remaining stormwater discharged from upstream practices from the design storm (SWR<sub>v</sub>). Additionally, stormwater wetlands can be sized to control peak flow rates from the 2- 50-year frequency storm event or other design storm. Design calculations must ensure that the post-development peak discharge does not exceed the predevelopment peak discharge. See Section 3.7.2 Hydrologic and Hydraulic Analysis for a summary of acceptable hydrologic methodologies and models.

For treatment train designs where upland practices are utilized for treatment of the SWR<sub>v</sub>, designers can use a site-adjusted R<sub>v</sub> or NRCS CN that reflects the volume reduction of upland practices to compute the 2- 100-year frequency storm event that must be treated by the stormwater wetland.

The wetland permanent pools (volume stored in deep pools and pool depths) must be sized to store a volume equivalent to the SWR<sub>v</sub> or design volume.

The storage volume (S<sub>v</sub>) of the practice is equal to the volume provided by the wetland permanent pool (Equation 4.29). The total S<sub>v</sub> cannot exceed the SWR<sub>v</sub>.

#### Equation 4. 29 Stormwater Wetland Storage Volume

$$SSRR = SS000000DDSSpp000000 SS0000pppDDd pp0000DDpp000000 pp0000pp RRDDppvvDDDD$$



**Sizing for Minimum Pool Depth.** Initially, it is recommended that there be no minimum CDA requirement for the system, although it may be necessary to calculate a water balance for the wet pond cell when its CDA is less than 10 acres (Refer to Section 4.12 Ponds).

Similarly, if the hydrology for the constructed wetland is not supplied by groundwater or dry weather flow inputs, a simple water balance calculation must be performed, using Equation 4.30 (Hunt et al., 2007), to assure the deep pools will not go completely dry during a 30-day summer drought.

Equation 4.30 Water Balance for Acceptable Water Depth in a Stormwater Wetland

$$DDPP = \frac{RR_{bb}}{WWSS} \times \frac{EF}{WWLL} (EEEE - IIIIII - RREESS)$$

Where:

<i>DP</i>	=	depth of pool (in.)
<i>RF<sub>m</sub></i>	=	monthly rainfall during drought (in.)
<i>EF</i>	=	fraction of rainfall that enters the stormwater wetland (in.) (CDA × Rv)
<i>WS/WL</i>	=	ratio of contributing drainage area to stormwater wetland surface area
<i>ET</i>	=	summer evapotranspiration rate (in.) (assume 8 in.)
<i>INF</i>	=	monthly infiltration loss (assume 7.2 inches at 0.01 in./hr)
<i>RES</i>	=	reservoir of water for a factor of safety (assume 6 in.)

Using Equation 4.30, setting the groundwater and (dry weather) base flow to zero and assuming a worst-case summer rainfall of 0 inches, the minimum depth of the pool calculates as follows (Equation 4.31):

**Equation 4.31 Minimum Depth of the Permanent Pool**

$$DDPP = \frac{RR_{bb}}{WWSS} - EEEEE - IIIIII - RREESS = 21.2$$

Where:

<i>DP</i>	=	depth of pool (in.)
<i>RF<sub>m</sub></i>	=	monthly rainfall during drought (in.)
<i>ET</i>	=	summer evapotranspiration rate (in.) (assume 8 in.)
<i>INF</i>	=	monthly infiltration loss (assume 7.2 inches at 0.01 in./hr)
<i>RES</i>	=	reservoir of water for a factor of safety (assume 6 in.)

Therefore, unless there is other input, such as base flow or groundwater, the minimum depth of the pool should be at least 22 inches (rather than the 18-inch minimum depth noted in Section 4.11.4 Stormwater Wetland Design Criteria).

#### 4.13.5

##### **Stormwater Wetland Construction Sequence**

The construction sequence for stormwater wetlands depends on site conditions, design complexity, and the size and configuration of the proposed facility. The following two-stage construction sequence is recommended for installing an on-line stormwater wetland facility and establishing vigorous plant cover.

##### **Stage 1 Construction Sequence: Wetland Facility Construction.**

1. **Stabilize Contributing Drainage Area.** Stormwater wetlands should only be constructed after the CDA to the wetland is completely stabilized. If the proposed stormwater wetland site will be used as a sediment trap or basin during the construction phase, the construction notes must clearly indicate that the facility will be de-watered, dredged, and re-graded to design dimensions after the original site construction is complete.
2. **Assemble Construction Materials on Site.** Inspect construction materials to ensure they conform to design specifications and prepare any staging areas.
3. **Clear and Strip.** Bring the project area to the desired subgrade.
4. **Install Soil Erosion and Sediment Control Measures** prior to construction, including sediment basins and stormwater diversion practices. All areas surrounding the stormwater wetland that are graded or denuded during construction of the wetland are to be planted with turf grass, native plant materials, or other approved methods of soil stabilization. Grass sod is preferred over seed to reduce seed colonization of the stormwater wetland. During construction, the stormwater wetland must be separated from the CDA so that no sediment flows into the wetland areas. In some cases, a phased or staged soil erosion and sediment control plan may be necessary to divert flow around the stormwater wetland area until installation and stabilization are complete.
5. **Excavate the Core Trench for the Embankment and Install the Spillway Pipe.**
6. **Install the Riser or Outflow Structure** and ensure that the top invert of the overflow weir is constructed level and at the proper design elevation (flashboard risers are strongly recommended by Hunt et al., 2007).
7. **Construct the Embankment and any Internal Berms** in 8- to 12-inch lifts and compact them with appropriate equipment.
8. **Excavate and Grade.** Survey to achieve the appropriate elevation and designed contours for the bottom and side slopes of the stormwater wetland. This is normally done by “roughing up” the interim elevations with a skid loader or other similar equipment to achieve the desired topography across the wetland. Spot surveys should be made to ensure that the interim elevations are 3 to 6 inches below the final elevations for the wetland.
9. **Install Micro-Topographic Features and Soil Amendments** within the stormwater wetland area. Since most stormwater wetlands are excavated to deep sub-soils, they often lack the nutrients and organic matter needed to support vigorous growth of wetland plants. It is therefore essential to add sand, compost, topsoil, or wetland mulch to all depth zones in the stormwater wetland. The importance of soil amendments in excavated stormwater wetlands cannot be over-emphasized; poor survival and future wetland coverage are likely if soil amendments are not added. The planting soil should be a high organic content loam or sandy loam, placed by mechanical methods, and spread by hand. Planting soil depth should be at least 4 inches for shallow wetlands. No machinery should be allowed to traverse over the planting soil during or after construction. Planting soil should be tamped as directed in the design

specifications, but it should not be overly compacted. After the planting soil is placed, it should be saturated and allowed to settle for at least one week prior to installation of plant materials.

**10. Construct the Emergency Spillway** in cut or structurally stabilized soils.

**11. Install Outlet Pipes.** The installation of outlet pipes must include a downstream riprap protection apron.

**12. Stabilize Exposed Soils** with temporary seed mixtures appropriate for a wetland environment. All wetland features above the normal pool elevation should be temporarily stabilized by hydro-seeding or seeding over straw.

## **Stage 2 Construction Sequence: Establishing the Wetland Vegetation.**

**13. Finalize the Stormwater Wetland Landscaping Plan.** At this stage the engineer, landscape architect, and wetland expert work jointly to refine the initial wetland landscaping plan after the stormwater wetland has been constructed. Several weeks of standing time is needed so that the designer can more precisely predict the following:

- Where the inundation zones are located in and around the stormwater wetland; and
- Whether the final grade and wetland microtopography will persist over time.

This allows the designer to select appropriate species and additional soil amendments, based on field confirmation of soils properties and the actual depths and inundation frequencies occurring within the stormwater wetland.

**14. Open Up the Stormwater Wetland Connection.** Once the final grades are attained, the pond and/or CDA connection should be opened to allow the wetland cell to fill up to the normal pool elevation. Gradually inundate the stormwater wetland to avoid erosion of unplanted features. Inundation must occur in stages so that deep pool and high marsh plant materials can be placed effectively and safely. Wetland planting areas should be at least partially inundated during planting to promote plant survivability.

**15. Measure and Stake Planting Depths** at the onset of the planting season. Depths in the stormwater wetland should be measured to the nearest inch to confirm the original planting depths of the planting zone. At this time, it may be necessary to modify the plan to reflect altered depths or a change in the availability of wetland plant stock. Surveyed planting zones should be marked on the as-built or design plan, and their locations should also be identified in the field, using stakes or flags.

**16. Propagate the Stormwater Wetland.** Two techniques are used in combination to propagate the emergent community over the wetland bed:

**17. Initial Planting of Container-Grown Wetland Plant Stock.** The transplanting window extends from early March through May. Planting after these dates can decrease the chance of survival, since emergent wetland plants need a full growing season to build the root reserves needed to get through the winter. It is recommended that plants be ordered at least 6 months in advance to ensure the availability and on-time delivery of desired species.

**18. Broadcasting Wetland Seed Mixes.** The higher wetland elevations should be established by broadcasting wetland seed mixes to establish diverse emergent wetlands. Seeding of switchgrass or wetland seed mixes as a ground cover is recommended for all zones above 3 inches below the normal pool elevation. Hand broadcasting or hydroseeding can be used to spread seed, depending on the size of the wetland cell.

**19. Install Goose Protection to Protect Newly Planted or Newly Growing Vegetation.** This is particularly critical for newly established emergent and herbaceous plants, as predation by Canada geese can quickly decimate wetland vegetation. Goose protection can consist of netting, webbing, or string installed in a crisscross pattern over the surface area of the stormwater wetland, above the level of the emergent plants.

**20. Plant the Stormwater Wetland Fringe and Buffer Area.** This zone generally extends from 1 to 3 feet above the normal pool elevation (from the shoreline fringe to about half of the maximum water surface elevation for the 2-year storm). Consequently, plants in this zone are infrequently inundated (5 to 10 times per year) and must be able to tolerate both wet and dry periods.

**Construction Supervision.** Supervision during construction is recommended to ensure that stormwater wetlands are properly constructed and established. Multiple site visits and inspections by a qualified professional are recommended during the following stages of the stormwater wetland construction process:

- Preconstruction meeting
- Initial site preparation including the installation of soil erosion and sediment control measures
- Excavation/Grading (interim and final elevations)
- Installation of the embankment, the riser/primary spillway, and the outlet structure
- Implementation of the pondscaping plan and vegetative stabilization
- Immediately seed or install vegetated ground cover upon completion of sloping and grading, where applicable, of each stormwater wetland within a project.
- Inspect within two weeks to ensure vegetation is in fact holding banks and slopes in place.
- Prior to completion of project, mechanically remove erosion deposition from ponds that occurred during the project. Criteria should be based on erosion of designed bank slopes and loss of storage capacity.
- Final inspection (develop a punch list for facility acceptance)

Construction inspection checklist for Stormwater Wetlands can be found in Appendix E Construction Inspection Checklists.

#### **4.13.6 Stormwater Wetland Landscaping Criteria**

An initial stormwater wetland landscaping plan is required for any stormwater wetland and should be jointly developed by the engineer and a wetlands expert or experienced landscape architect. The plan should outline a detailed schedule for the care, maintenance, and possible reinforcement of vegetation in the wetland and its buffer for up to 10 years after the original planting.

The plan should outline a realistic, long-term planting strategy to establish and maintain desired wetland vegetation. The plan should indicate how wetland plants will be established within each inundation zone (e.g., wetland plants, seed-mixes, volunteer colonization, and tree and shrub stock) and whether soil amendments are needed to get plants started. At a minimum, the plan should contain the following:

- Plan view(s) with topography at a contour interval of no more than 1 foot and spot elevations throughout the cell showing the stormwater wetland configuration, different planting zones (e.g.,

high marsh, deep water, upland), microtopography, grades, site preparation, and construction sequence.

- A plant schedule and planting plan specifying emergent, perennial, shrub and tree species, quantity of each species, stock size, type of root stock to be installed, and spacing. To the degree possible, the species list for the constructed wetland should contain plants found in similar local wetlands.

The following general guidance is provided:

- **Use Native Species Where Possible.** Table 4.53 provides a list of common native shrub and tree species and Table 4.54 provides a list of common native emergent, submergent, and perimeter plant species, all of which have proven to do well in stormwater wetlands in the mid-Atlantic region and are generally available from most commercial nurseries. Other native species can be used that appear in state-wide plant lists. The use of native species is strongly encouraged, but in some cases, non-native ornamental species may be added as long as they are not invasive. Invasive species such as cattails (*Typha latifolia*), common reed (*Phragmites australis*), and purple loosestrife (*Lythrum salicaria*) must not be planted.
- **Match Plants to Inundation Zones.** The various plant species shown in Table 4.53 and Table 4.54 should be matched to the appropriate inundation zone. The first four inundation zones are particularly applicable to stormwater wetlands, as follows:

**Zone 1** -6 inches to -12 inches below the normal pool elevation

**Zone 2** -6 inches to the normal pool elevation

**Zone 3** From the normal pool elevation to +12 inches above

**Zone 4** +12 inches to +36 inches above the normal pool elevation (i.e., above ED Zone)

Note: The Low Marsh Zone (-6 to -18 inches below the normal pool elevation) has been dropped since experience has shown that few emergent wetland plants flourish in this deeper zone.

- **Aggressive Colonizers.** To add diversity to the stormwater wetland, five to seven species of emergent wetland plants should be planted, using at least four emergent species designated as aggressive colonizers (shown in bold in Table 4.54). No more than 25% of the high marsh wetland surface area needs to be planted. If the appropriate planting depths are achieved, the entire stormwater wetland should be colonized within 3 years. Individual plants should be planted 18 inches on center within each single species “cluster.”
- **Suitable Tree Species.** The major shift in stormwater wetland design is to integrate trees and shrubs into the design, in tree islands, peninsulas, and fringe buffer areas. Deeper-rooted trees and shrubs that can extend to the stormwater wetland’s local water table are important for creating a mixed wetland community. Table 4. 53 above presents some recommended tree and shrub species for different inundation zones. A good planting strategy includes varying the size and age of the plant stock to promote a diverse structure. Using locally grown container or bare root stock is usually the most successful approach if planting in the spring. It is recommended that buffer planting areas be over-planted with a small stock of fast-growing successional species to achieve quick canopy closure and shade out invasive plant species. Trees may be planted in clusters to share rooting space on compacted wetland side-slopes. Planting holes should be amended with compost (a 2:1 ratio of loose soil to compost) prior to planting.
- **Pre- and Post-Nursery Care.** Plants should be kept in containers of water or moist coverings to protect their root systems and keep them moist when in transporting them to the planting location.

As much as 6 to 9 months of lead time may be needed to fill orders for wetland plant stock from aquatic plant nurseries. Consult local regulatory authorities for information on area suppliers.

**Table 4.53. Popular, Versatile, and Available Native Trees and Shrubs for Stormwater Wetlands**

Shrubs		Trees	
Common and <i>Scientific</i> Names	Zone <sup>1</sup>	Common and <i>Scientific</i> Names	Zone <sup>1</sup>
Button Bush ( <i>Cephalanthus occidentalis</i> )	2, 3	Atlantic White Cedar ( <i>Chamaecyparis thyoides</i> )	2, 3
Common Winterberry ( <i>Ilex verticillata</i> )	3, 4	Bald Cypress ( <i>Taxodium distichum</i> )	2, 3
Elderberry ( <i>Sambucus canadensis</i> )	3	Black Willow ( <i>Salix nigra</i> )	3, 4
Indigo Bush ( <i>Amorpha fruticosa</i> )	3	Box Elder ( <i>Acer Negundo</i> )	2, 3
Inkberry ( <i>Ilex glabra</i> )	2, 3	Green Ash ( <i>Fraxinus pennsylvanica</i> )	3, 4
Smooth Alder ( <i>Alnus serrulata</i> )	2, 3	Grey Birch ( <i>Betula populifolia</i> )	3, 4
Spicebush ( <i>Lindera benzoin</i> )	3, 4	Red Maple ( <i>Acer rubrum</i> )	3, 4
Swamp Azalea ( <i>Azalea viscosum</i> )	2, 3	River Birch ( <i>Betula nigra</i> )	3, 4
Swamp Rose ( <i>Rosa palustris</i> )	2, 3	Swamp Tupelo ( <i>Nyssa biflora</i> )	2, 3
Sweet Pepperbush ( <i>Clethra alnifolia</i> )	2, 3	Sweetbay Magnolia ( <i>Magnolia virginiana</i> )	3, 4
		Sweetgum ( <i>Liquidambar styraciflua</i> )	3, 4
		Sycamore ( <i>Platanus occidentalis</i> )	3, 4
		Water Oak ( <i>Quercus nigra</i> )	3, 4
		Willow Oak ( <i>Quercus phellos</i> )	3, 4

<sup>1</sup>Zone 1: -6 to -12 inches below the normal pool elevation

Zone 2: -6 inches to the normal pool elevation

Zone 3: From the normal pool elevation to +12 inches

Zone 4: +12 to +36 inches; above ED zone

Source: Virginia DCR Stormwater Design Specification No. 13: Constructed Wetlands Version 1.8. 2010.

Table 4.54. Popular, Versatile, and Available Native Emergent and Submergent Vegetation for Stormwater Wetlands

Plant	Zone <sup>1</sup>	Form	Inundation Tolerance	Wildlife Value	Notes
Arrow Arum ( <i>Peltandra virginica</i> )	2	Emergent	Up to 1 ft	High; berries are eaten by wood ducks	Full sun to partial shade
<b>Broad-Leaf Arrowhead (Duck Potato)</b> ( <i>Sagittaria latifolia</i> )	2	Emergent	Up to 1 ft	Moderate; tubers and seeds eaten by ducks	Aggressive colonizer
Blueflag Iris* ( <i>Iris versicolor</i> )	2, 3	Emergent	Up to 6 in.	Limited	Full sun (to flower) to partial shade
Broomsedge ( <i>Andropogon virginianus</i> )	2, 3	Perimeter	Up to 3 in.	High; songbirds and browsers; winter food and cover	Tolerant of fluctuating water levels and partial shade
<b>Bulltongue Arrowhead</b> ( <i>Sagittaria lancifolia</i> )	2, 3	Emergent	0 to 24 in.	Waterfowl, small mammals	Full sun to partial shade
<b>Burreed</b> ( <i>Sparganium americanum</i> )	2, 3	Emergent	0 to 6 in.	Waterfowl, small mammals	Full sun to partial shade
Cardinal Flower* ( <i>Lobelia cardinalis</i> )	3	Perimeter	Periodic inundation	Attracts hummingbirds	Full sun to partial shade
<b>Common Rush</b> ( <i>Juncus spp.</i> )	2, 3	Emergent	Up to 12 in.	Moderate; small mammals, waterfowl, songbirds	Full sun to partial shade
<b>Common Three Square</b> ( <i>Scirpus pungens</i> )	2	Emergent	Up to 6 in.	High; seeds, cover, waterfowl, songbirds	Fast colonizer; can tolerate periods of dryness; full sun; high metal removal
Duckweed ( <i>Lemna sp.</i> )	1, 2	Submergent / Emergent	Yes	High; food for waterfowl and fish	May biomagnify metals beyond concentrations found in the water
Joe Pye Weed ( <i>Eupatorium purpureum</i> )	2, 3	Emergent	Drier than other Joe-Pye Weeds; dry to moist areas; periodic inundation	Butterflies, songbirds, insects	Tolerates all light conditions
<b>Lizard's Tail</b> ( <i>Saururus cernus</i> )	2	Emergent	Up to 1 ft	Low; except for wood ducks	Rapid growth; shade-tolerant

Plant	Zone <sup>1</sup>	Form	Inundation Tolerance	Wildlife Value	Notes
Marsh Hibiscus ( <i>Hibiscus moscheutos</i> )	2, 3	Emergent	Up to 3 in.	Low; nectar	Full sun; can tolerate periodic dryness
<b>Pickerelweed</b> ( <i>Pontederia cordata</i> )	2, 3	Emergent	Up to 1 ft	Moderate; ducks, nectar for butterflies	Full sun to partial shade
Pond Weed ( <i>Potamogeton pectinatus</i> )	1	Submergent	Yes	Extremely high; waterfowl, marsh and shore birds	Removes heavy metals from the water
Rice Cutgrass ( <i>Leersia oryzoides</i> )	2, 3	Emergent	Up to 3 in.	High; food and cover	Prefers full sun, although tolerant of shade; shoreline stabilization
<b>Sedges</b> ( <i>Carex spp.</i> )	2, 3	Emergent	Up to 3 in.	High; waterfowl, songbirds	Wetland and upland species
<b>Softstem Bulrush</b> ( <i>Scirpus validus</i> )	2, 3	Emergent	Up to 2 ft	Moderate; good cover and food	Full sun; aggressive colonizer; high pollutant removal
<b>Smartweed</b> ( <i>Polygonum spp.</i> )	2	Emergent	Up to 1 ft	High; waterfowl, songbirds; seeds and cover	Fast colonizer; avoid weedy aliens, such as <i>P. Perfoliatum</i>
<b>Spatterdock</b> ( <i>Nuphar luteum</i> )	2	Emergent	Up to 1.5 ft	Moderate for food, but High for cover	Fast colonizer; tolerant of varying water levels
Switchgrass ( <i>Panicum virgatum</i> )	2, 3, 4	Perimeter	Up to 3 in.	High; seeds, cover; waterfowl, songbirds	Tolerates wet/dry conditions
Sweet Flag* ( <i>Acorus calamus</i> )	2, 3	Perimeter	Up to 3 in.	Low; tolerant of dry periods	Tolerates acidic conditions; not a rapid colonizer
Waterweed ( <i>Elodea canadensis</i> )	1	Submergent	Yes	Low	Good water oxygenator; high nutrient, copper, manganese, and chromium removal
Wild celery ( <i>Valisneria americana</i> )	1	Submergent	Yes	High; food for waterfowl; habitat for fish and invertebrates	Tolerant of murky water and high nutrient loads
Wild Rice ( <i>Zizania aquatica</i> )	2	Emergent	Up to 1 ft	High; food, birds	Prefers full sun
<b>Woolgrass Bulrush</b> ( <i>Scirpus cyperinus</i> )	3, 4	Emergent	Yes	High: waterfowl, small mammals	Fresh tidal and non-tidal, swamps, forested wetlands, meadows, ditches

Aggressive colonizers are shown in bold type

<sup>1</sup>Zone 1: -6 to -12 inches below the normal pool elevation



Plant	Zone <sup>1</sup>	Form	Inundation Tolerance	Wildlife Value	Notes
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Zone 2: -6 inches to the normal pool elevation

Zone 3: From the normal pool elevation to +12 inches

Zone 4: +12 to +36 inches; above ED zone

\*Not a major colonizer, but adds color

Source: Virginia DCR Stormwater Design Specification No. 13: Constructed Wetlands Version 1.8. 2010.

#### 4.13.7 Stormwater Wetland Maintenance Criteria

Successful establishment of constructed wetland areas requires that the following tasks be undertaken in the first 2 years:

- **Initial Inspections.** During the first 6 months following construction, the site should be inspected by a qualified professional at least twice after storm events that exceed 0.5 inch of rainfall.
- **Spot Reseeding.** Inspections should include looking for bare or eroding areas in the CDA or around the wetland buffer and make sure they are immediately stabilized with grasscover.
- **Watering.** Trees planted in the buffer and on wetland islands and peninsulas need watering during the first growing season. In general, consider watering every 3 days for first month, and then weekly during the first growing season (April through October), depending on rainfall.
- **Reinforcement Plantings.** Regardless of the care taken during the initial planting of the stormwater wetland and buffer, it is probable that some areas will remain unvegetated and some species will not survive. Poor survival can result from many unforeseen factors, such as predation, poor quality plant stock, water level changes, and drought. Thus, it is advisable to budget for an additional round of reinforcement planting after one or two growing seasons. Construction contracts should include a care and replacement warranty extending at least two growing seasons after initial planting, to selectively replant portions of the stormwater wetland that fail to fill in or survive. If a minimum coverage of 50% is not achieved in the planted wetland zones after the second growing season, a reinforcement planting will be required.

Managing vegetation is an important ongoing maintenance task at every constructed wetland and for each inundation zone. Following the design criteria above should result in a reduced need for regular mowing of the embankment and access roads. Vegetation within the stormwater wetland, however, will require some annual maintenance.

Designers should expect significant changes in wetland species composition to occur over time. Inspections should carefully track changes in wetland plant species distribution over time. Invasive plants should be dealt with as soon as they begin to colonize the stormwater wetland. As a general rule, control of undesirable invasive species (e.g., cattails and Phragmites) should commence when their coverage exceeds more than 15% of a wetland cell area. Although the application of herbicides is not recommended, some types (e.g., Glyphosate) have been used to control cattails with some success. Extended periods of dewatering may also work, since early manual removal provides only short-term relief from invasive species. While it is difficult to exclude invasive species completely from stormwater wetlands, their ability to take over the entire wetland can be reduced if the designer creates a wide range of depth zones and a complex internal structure within the wetland.

- ☐ For more information on invasive plants, consult the South Carolina Exotic Pest Plant Council. Resources are available online at <http://www.se-eppc.org/southcarolina/invasivePlants.cfm>.
- For more information related to chemical control methods for aquatic plants, please review the fact sheet “Aquatic Weed Control Overview” provided by Clemson’s Cooperative Extension Service and available online at <http://www.clemson.edu/extension/hgic/plants/other/landscaping/hgic1714.html>.

Thinning or harvesting of excess forest growth may be periodically needed to guide the forested stormwater wetland into a more mature state. Vegetation may need to be harvested periodically if the constructed wetland becomes overgrown. Thinning or harvesting operations should be scheduled to occur approximately 5 and 10 years after the initial stormwater wetland construction. Removal of woody species on or near the embankment and maintenance access areas should be conducted every 2 years.

Designers should refer to Section 4.12.7 Pond Maintenance Criteria for additional maintenance responsibilities associated with stormwater wetlands. Ideally, maintenance of constructed wetlands should be driven by annual inspections by a qualified professional that evaluates the condition and performance of the stormwater wetland. Based on inspection results, specific maintenance tasks will be triggered.

Maintenance inspection checklist for stormwater wetlands and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### 4.13.8 Stormwater Wetland Stormwater Compliance Calculations

Stormwater wetlands are credited with 0% retention, but they do receive 80% TSS, 30% TN, and 60% bacteria removal for the storage volume (Sv) provided by in the permanent pool (Table 4.55).

**Table 4.55. Stormwater Wetland Retention and Pollutant Removal**

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 25%
Bacteria Removal	= 60%

#### 4.14 Tree Planting & Preservation

Tree Planting and Preservation						
Definition: Existing trees can be preserved or new trees can be planted to reduce stormwater runoff.						
Site Applicability		BMP Performance Summary				
Land Uses	Required Footprint	WQ Improvement: Moderate to High				
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>		Bacteria <sup>1</sup>	
		N/A	N/A		N/A	
		Runoff Reductions				
Construction Costs	Maintenance Burden	Volume				
Low	Low	Low				
Maintenance Frequency:		SWR <sub>v</sub> *				
Routine	Non-Routine	T-1 Small	T-1 Large	T-2 Small	T-2 Large	T-2 Special
At least annually	Every 10–15 years	5 ft <sup>3</sup>	10 ft <sup>3</sup>	10 ft <sup>3</sup>	20 ft <sup>3</sup>	30 ft <sup>3</sup>
Advantages/Benefits		Disadvantages/Limitation				
<ul style="list-style-type: none"><li>▪ High community acceptance</li><li>▪ Relatively low maintenance requirements</li><li>▪ Increases property value</li><li>▪ Easily incorporated with other practices</li><li>▪ Excellent for soils</li></ul>		<ul style="list-style-type: none"><li>▪ Preserved trees must be protected during construction</li><li>▪ Must be within LOD</li><li>▪ Must maintain tree health</li></ul>				
Components		Design considerations				
<ul style="list-style-type: none"><li>▪ Inventory of existing trees</li><li>▪ Identification of trees to preserve or plant</li><li>▪ Preference for Special trees</li><li>▪ Average tree spread</li></ul>		<ul style="list-style-type: none"><li>▪ Inventory of existing trees</li><li>▪ Identification of trees to preserve or plant</li><li>▪ Preference for Special trees</li><li>▪ Slope-steep slopes must be terraced/benched</li><li>▪ Maintenance access</li></ul>				
Maintenance Activities						
<ul style="list-style-type: none"><li>▪ If staked during establishment, remove stakes within 1 year of planting</li></ul>		<ul style="list-style-type: none"><li>▪ Maintain appropriate mulch cover</li><li>▪ Ensure tree health</li></ul>				

<sup>1</sup>Credited pollutant load removal

\*Per planted/preserved tree

Easily combined with other practices, tree planting and preservation provide stormwater interception, beauty, and shade, thereby increasing aesthetics and property values. See Figure 4. 57



**Figure 4. 56 Tree Planting and Preservation in Bioretention**  
**Photo: Center for Watershed Protection**

**Definition.** Existing trees can be preserved or new trees can be planted to reduce stormwater runoff. The design includes the following:

- T-1 Tree planting
- T-2 Tree preservation

Tree canopy can intercept a significant amount of rainfall before it becomes runoff, particularly if the tree canopy covers impervious surfaces, as in the case of street trees. Through the processes of evapotranspiration and nutrient uptake, trees—even when located on a development site—have the capacity to reduce stormwater runoff volumes and improve water quality. Further, through root growth, trees can improve the infiltration capacity of the soils in which they grow.

Both tree planting and tree preservation can contribute to stormwater management on a site. Note that retention credit is available for preserved trees only when they are within the limits of disturbance of a project. Preserved trees outside of the limits of disturbance may offer an opportunity for additional retention when they constitute an area of natural cover and stormwater is conveyed to that area.

#### 4.14.1 Preserving Existing Trees during Construction

The preferred method for increasing tree cover at a development site is to preserve existing trees during construction, particularly where mature trees are present. Existing trees are preserved during construction through a four-step process:

1. Inventory existing trees.
2. Identify trees to preserve.
3. Protect trees and soil during construction.
4. Protect trees after construction.

**Inventory Existing Trees.** An inventory of existing trees and forested areas at the development site must be conducted before any site design, clearing, or construction takes place, as specified by the DDOT UFD. The inventory must be conducted by one of the following qualified professionals, which includes, but is not limited to:

- South Carolina Licensed Forester
- South Carolina Licensed Tree Expert
- South Carolina Experienced Forester
- South Carolina Licensed Landscape Architect
- International Society of Arboriculture (ISA) Certified Arborist

The inventory must include a survey of existing trees and determine their size, species, condition, and ecological value. Locations of trees and forest stands must be recorded.

**Identify Trees to Preserve.** From the tree inventory, individual trees can be identified for preservation and protection during site development. Preserved trees fall into three categories of retention credit: tree species with an average mature spread less than or equal to 40 feet ("small" trees) receive 10 cubic feet of retention credit; trees species with an average mature spread greater than or equal to 40 feet ("large" trees) receive 20 cubic feet of retention credit; and trees with an existing diameter greater than 14" ("Special" trees) receive 30 cubic feet of retention credit, regardless of mature spread size. Additional selection criteria may include tree species, size, condition, and location (see Table 4.56).

**Table 4.56. Selecting Priority Trees and Forests for Preservation**

Selection Criteria	Examples of Priority Tree and Forests to Conserve
Species	<ul style="list-style-type: none"> <li>▪ Rare, threatened, or endangered species</li> <li>▪ Specimen trees</li> <li>▪ High quality tree species (e.g., white oaks and sycamores because they are structurally strong and live longer than trees such as silver maple and cottonwood)</li> <li>▪ Species that are tolerant of specific site conditions and soils</li> </ul>
Size	<ul style="list-style-type: none"> <li>▪ Trees over a specified diameter at breast height (DBH) or other size measurement</li> <li>▪ Trees designated as national, state, or local champions</li> <li>▪ Contiguous forest stands</li> </ul>

Selection Criteria	Examples of Priority Tree and Forests to Conserve
Condition	<ul style="list-style-type: none"> <li>▪ Healthy trees that are structurally sound in “fair” or better condition</li> <li>▪ High quality forest stands with high forest structural diversity</li> </ul>
Location	<ul style="list-style-type: none"> <li>▪ Trees located where they will provide direct benefits at the site (e.g., shading, privacy, windbreak, buffer from adjacent land use)</li> <li>▪ Forest stands that are connected to off-site forests that create wildlife habitat and corridors</li> <li>▪ Trees located in protected natural areas such as floodplains, stream buffers, wetlands, erodible soils, critical habitat areas, and steep slopes.</li> <li>▪ Forest stands that are connected to off-site non-forested natural areas or protected land (e.g., has potential to provide wildlife habitat)</li> </ul>

Trees selected for preservation and protection must be clearly marked both on construction drawings and at the actual site. Flagging or fencing is typically used to protect trees at the construction site. Areas of trees to preserve should be marked on the site map and walked during preconstruction meetings.

**Protect Trees and Soil During Construction.** Physical barriers must be properly installed around the Critical Root Zone (CRZ) of trees to be preserved. The CRZ shall be determined by a landscape professional from the above list, and in general is equal to 1.5 feet of tree protection (radius of circle) for every 1 inch in tree diameter. For example, a 10-inch diameter tree would have a CRZ radius extending 15 feet from the tree. The barriers must be maintained and enforced throughout the construction process. Tree protection barriers include highly visible, well-anchored temporary protection devices, such as 6-foot-tall chain link fencing.

All protection devices must remain in place throughout construction.

When excavation is proposed immediately adjacent to the CRZ, roots must first be pruned at the edge of the excavation with a trenching machine, vibratory knife or rock saw to a depth of 18 inches. Any requirements here may be superseded by the requirements of the CDC.

**Protect Trees After Construction.** Maintenance covenants, as described below, are required to ensure that preserved trees are protected.

#### 4.14.2 Planting Trees

**Considerations at Development Sites.** New development sites provide many opportunities to plant new trees. Planting trees at development sites is done in three steps:

1. Select tree species.
2. Evaluate and improve planting sites.
3. Plant and maintain trees.

**Tree Species.** Planted trees fall into two categories of retention: tree species with an average mature spread less than or equal to 40 feet (“small” trees) receive 5 cubic feet of retention and trees species with an average mature spread greater than or equal to 40 feet (“large” trees) receive 10 cubic feet of retention. Trees to be planted must have a minimum caliper size of 1.5 inches.

**Planting Sites.** Ideal planting sites within a development are those that create interception opportunities around impervious surfaces. These include areas along pathways, roads, islands and median strips, and parking lot interiors and perimeters. Other areas of a development site may benefit from planting trees (including stream valleys and floodplains, areas adjacent to existing forest, steep slopes, and portions of the site where trees would provide buffers, screening, noise reduction, or shading).

It is important to evaluate and record the conditions, such as soil type, soil pH, soil compaction, and the hydrology of proposed planting sites to ensure they are suitable for planting. These evaluations provide a basis for species selection and determination of the need for any special site preparation techniques.

A minimum of 1,500 cubic feet of rootable soil volume must be provided per large tree. In planting arrangements that allow for shared rooting space amongst multiple trees, a minimum of 1,000 cubic feet of rootable soil volume must be provided for each large tree. Rootable soil volume must be within 3 feet of the surface.

Smaller trees with an average mature spread of less than or equal to 40 feet must have a minimum of 600 cubic feet of rootable soil volume. In planting arrangements that permit shared rooting space amongst multiple trees, a minimum of 400 cubic feet of rootable soil volume must be provided for each tree. Rootable soil volume must be within 3 feet of the surface.

Site characteristics determine what tree species will flourish there and whether any of the conditions, such as soils, can be improved through the addition of compost or other amendments. Table 4.57 presents methods for addressing common constraints to urban tree planting.

**Table 4.57. Methods for Addressing Urban Planting Constraints**

Potential Impact	Potential Resolution
Limited Soil Volume	<ul style="list-style-type: none"> <li>Provide 1,500 cubic feet of rootable soil volume per large tree (greater than or equal to 40-foot spread) and 600 cubic feet of rootable soil volume per small tree (less than or equal to 40-foot spread). This soil must be within 3 feet of the surface.</li> <li>Use planting arrangements that allow shared rooting space. A minimum of 1,000 cubic feet of rootable soil volume must be provided for each tree in shared rooting space arrangements. A minimum of 400 cubic feet of rootable soil volume must be provided for each small tree in shared rooting arrangements.</li> </ul>
Poor Soil Quality	<ul style="list-style-type: none"> <li>Test soil and perform appropriate restoration.</li> <li>Select species tolerant of soil pH, compaction, drainage, etc.</li> <li>Replace very poor soils if necessary.</li> </ul>
Air Pollution	<ul style="list-style-type: none"> <li>Select species tolerant of air pollutants.</li> </ul>
Damage from Lawnmowers	<ul style="list-style-type: none"> <li>Use mulch to protect trees.</li> </ul>
Damage from Vandalism	<ul style="list-style-type: none"> <li>Use tree cages or benches to protect trees.</li> <li>Select species with inconspicuous bark or thorns.</li> <li>Install lighting nearby to discourage vandalism.</li> </ul>
Damage from Vehicles	<ul style="list-style-type: none"> <li>Provide adequate setbacks between vehicle parking stalls and trees.</li> </ul>

Potential Impact	Potential Resolution
Damage from animals such as deer, rodents, rabbits, and other herbivores	<ul style="list-style-type: none"> <li>▪ Use protective fencing or chemical retardants.</li> </ul>
Exposure to pollutants in stormwater runoff	<ul style="list-style-type: none"> <li>▪ Select species that are tolerant of specific pollutants, such as oils and metals.</li> </ul>
Soil moisture extremes	<ul style="list-style-type: none"> <li>▪ Select species that are tolerant of inundation or drought.</li> <li>▪ Install underdrains if necessary.</li> <li>▪ Select appropriate backfill soil and mix thoroughly with site soil.</li> <li>▪ Improve soil drainage with amendments and tillage if needed.</li> </ul>
Increased temperature	<ul style="list-style-type: none"> <li>▪ Select drought tolerant species.</li> </ul>
Increased wind	<ul style="list-style-type: none"> <li>▪ Select drought tolerant species.</li> </ul>
Abundant populations of invasive species	<ul style="list-style-type: none"> <li>▪ Control invasive species prior to planting.</li> <li>▪ Continually monitor for and remove invasive species.</li> </ul>
Conflict with infrastructure	<ul style="list-style-type: none"> <li>▪ Design the site to keep trees and infrastructure separate.</li> <li>▪ Provide appropriate setbacks from infrastructure.</li> <li>▪ Select appropriate species for planting near infrastructure.</li> <li>▪ Use alternative materials to reduce conflict.</li> </ul>
Disease or insect infestation	<ul style="list-style-type: none"> <li>▪ Select resistant species</li> </ul>

Planting trees at development sites requires prudent species selection, a maintenance plan, and careful planning to avoid impacts from nearby infrastructure, runoff, vehicles or other urban elements.

**Trees Along Streets and in Parking Lots.** When considering a location for planting, clear lines of sight must be provided, as well as safe travel surfaces, and overhead clearance for pedestrians and vehicles. Also, ensure enough soil volume for healthy tree growth. Usable soil must be uncompacted and may not be covered by impervious material. Having at least a 6-foot-wide planting strip or locating sidewalks between the trees and street allows more rooting space for trees in adjacent property.

Select tree species that are drought tolerant, can grow in poor or compacted soils, and are tolerant to typical urban pollutants (oil and grease, metals, and chlorides). Additionally, select species that do not produce excessive fruits, nuts, or leaf litter, that have fall color, spring flowers or some other aesthetic benefit, and can be limbed up to 6 feet to provide pedestrian and vehicle traffic underneath.

**Planting Techniques.** Prepare a hole no deeper than the root ball or mass but two to three times wider than the spread of the root ball or mass. The majority of the roots on a newly planted tree will develop in the top 12 inches of soil and spread out laterally. There are some additional considerations depending on the type of plant material being used (Table 4.58).



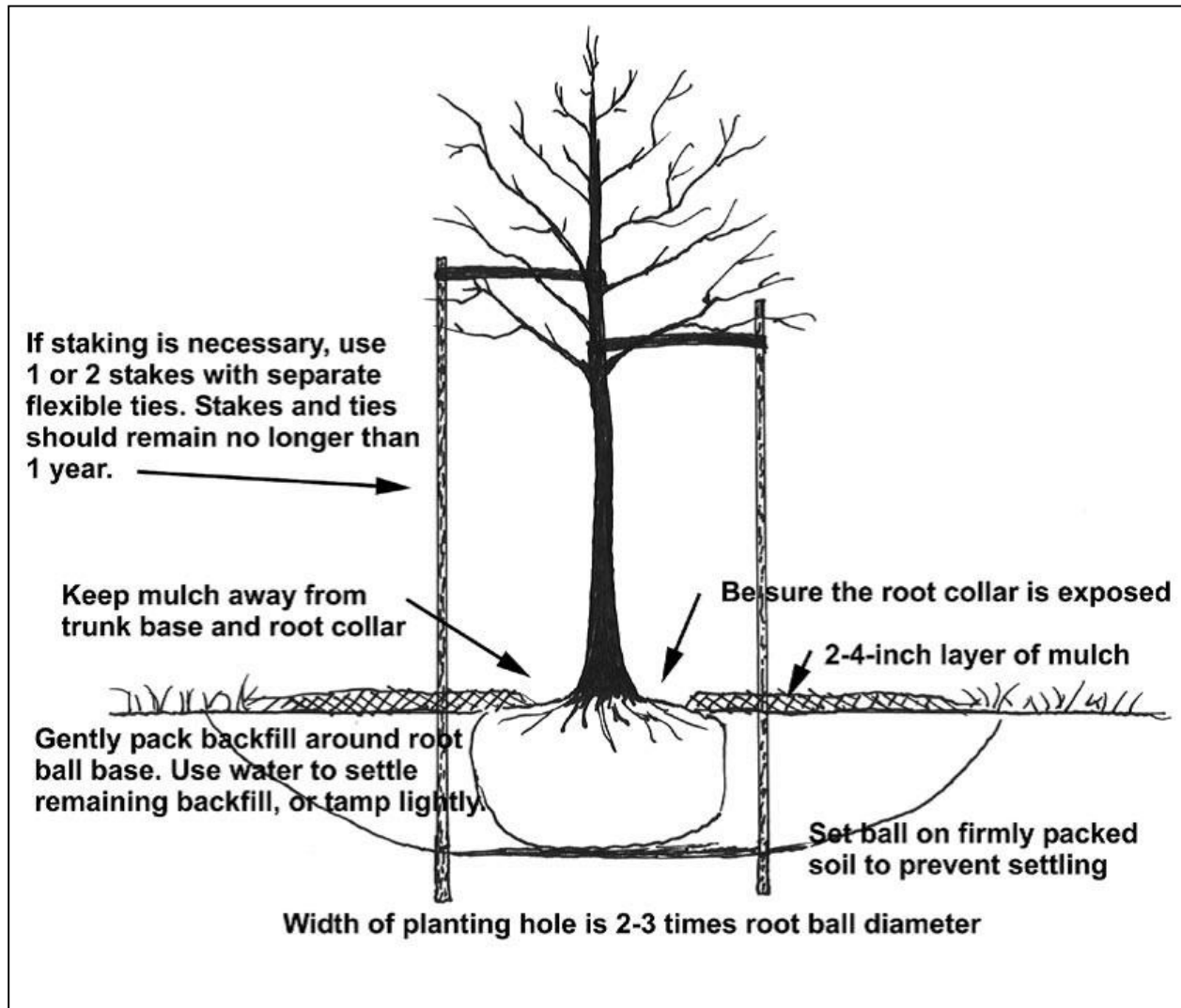
**Table 4.58. Tree Planting Techniques**

Plant Material	Planting Technique	Planting Season
Bare root	Hand plant	Spring or fall when tree is dormant
Container grown	Hand plant or use mechanical planting tools (e.g., auger)	Spring or fall, summer if irrigated
Balled and burlapped	Use backhoe (or other specialized equipment) or hand plant	Spring or fall

Sources: Palone and Todd (1998), WSAHGP (2002)

One of the most important planting guidelines is to make sure the tree is not planted too deeply. The root collar, the lowest few inches of trunk just above its junction with the roots (often indicated by a flare), should be exposed. Trees planted too deeply have buried root collars, and are weakened, stressed, and predisposed to pests and disease. Trees planted too deeply can also form adventitious roots (roots that form from non-root tissue) near the soil surface in an attempt to compensate for the lack of available oxygen to buried roots. Adventitious roots are not usually large enough to provide support for a large tree and may eventually lead to collapse. ISA (2005) provides additional guidance on how to avoid planting too deeply. It is generally better to plant the tree a little high, that is, with the base of the trunk flare 2 to 3 inches above the soil, rather than at or below the original growing level.

Proper handling during planting is essential to avoid prolonged transplant shock and ensure a healthy future for new trees and shrubs. Trees should always be handled by the root ball or container, never by the trunk. Specifications for planting a tree are illustrated in Figure 4.58. Trees must be watered well after planting.



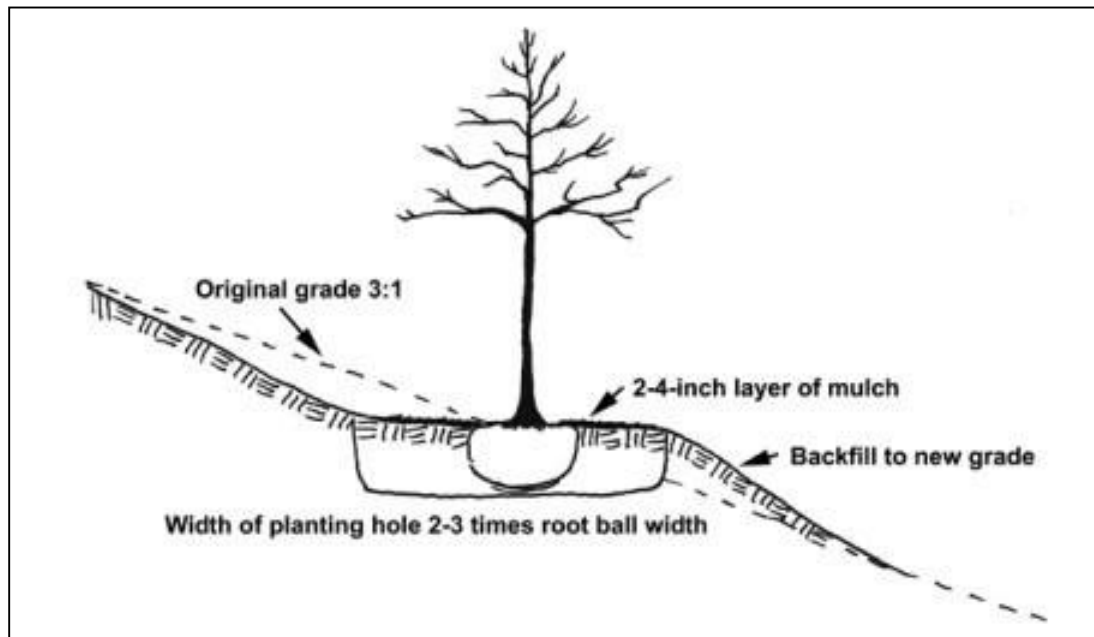
**Figure 4.57. Tree planting guidelines. Adapted from Flott, 2004 and ISA, 2003b.**

Steep slopes require additional measures to ensure planting success and reduce erosion, especially if the slope receives stormwater runoff from upland land uses. Depending on the steepness of the slope and the runoff volume, rill or gully erosion may occur on these slopes, requiring a twofold approach: controlling the stormwater and stabilizing the slope.

Erosion control blankets are recommended to temporarily stabilize soil on slopes until vegetation is established. Erosion control fabrics come in a variety of weights and types and should be combined with vegetation establishment such as seeding. Other options for stabilizing slopes include applying compost or bark mulch, plastic sheeting, or sodding.

Trees will add stability to slopes because of their deep roots, provided they are not planted by digging rows of pits across a slope. Required maintenance will include mowing (if slopes are not too steep) and establishing cover on bare or eroded areas.

Planting methods for slopes steeper than 3H:1V involve creating a level planting space on the slope (see Figure 4.59). A terrace can be dug into the slope in the shape of a step by cutting into the existing slope and using the excavated soil as fill to create the step area. A low soil berm (or rock berm) can be formed at the front edge of each step or terrace to slow the flow of water. Trees can also be planted in clusters on slopes (using the above method) to limit potential for desiccation. Staggering tree placement and mulching will prevent water from running straight downhill.



**Figure 4.58** Trees planted on steep slopes require a constructed level planting surface.

#### **Post-Planting Tree Protection**

**Mulching:** Once the tree has been properly planted, 2 to 4 inches (maximum) of organic mulch must be spread over the soil surface out to the drip line (the outermost circumference of the tree canopy) of the tree. A mulch-free area, 2 to 3 inches wide at the base of the tree, must be provided to avoid moist bark conditions and prevent decay.

If planting a cluster of trees, mulch the entire planting area, ensuring a 2- to 3-inch wide mulch free area at the base of each tree.

Slow-decomposing organic mulches, such as shredded bark, compost, leaf mulch, or wood chips provide many added benefits for trees. Mulch that contains a combination of chips, leaves, bark, and twigs is ideal for reforestation sites. Grass clippings and sawdust are not recommended as mulches because they decompose rapidly and require frequent application, resulting in reduced benefits.

For well-drained sites, up to 4 inches of mulch may be applied. For poorly drained sites, a thinner layer of mulch should be applied. Mulch should never be more than 4 inches deep or applied right next to the tree trunk; however, a common sight in many landscaped areas is the “mulch volcano.” This over-mulching technique can cause oxygen and moisture-level problems, and decay of the living bark at the base of the tree.

**Staking:** Studies have shown that trees will establish more quickly and develop stronger trunk and root systems if they are not staked at the time of planting. Staking for support may be necessary only for top-heavy trees or at sites where vandalism or windy exposure are a concern.

If staking is necessary for support, two stakes used in conjunction with a wide flexible tie material will hold the tree upright, provide flexibility, and minimize injury to the trunk. To prevent damage to the root ball, stakes should be placed in undisturbed soil beyond the outer edges of the root ball.

Perhaps the most important part of staking is its removal. Over time, guy wires (or other tie material) can cut into the growing trunk bark and interfere with the movement of water and nutrients within the tree. Staking material should be removed within 1 year of planting.

#### **4.14.3 Tree Inspection Criteria**

An initial inspection by a qualified professional should be done to ensure the tree has been planted, watered, and protected correctly with locations flagged if appropriate. For newly planted trees, transplant shock is common and causes stress on the tree. For this reason, newly planted trees should be inspected more frequently than established trees. The time it takes for a tree to become established varies with the size at planting, species, stock, and site conditions, but generally, trees should be inspected every few months during the first 3 years after planting, to identify problems and implement repairs or modify maintenance strategies.

After the first 3 years, annual inspections are sufficient to check for problems. Trees should also be inspected after major storm events for any damage that may have occurred. The inspection should take only a few minutes per tree, but prompt action on any problems encountered results in healthier, stronger trees. Inspections should include an assessment of overall tree health, an assessment of survival rate of the species planted, cause of mortality, if maintenance is required, insect or disease problems, tree protection adjustment, and weed control condition.

Construction inspection checklist for tree planting and preservation can be found in Appendix E Construction Inspection Checklists.

#### **4.14.4 Tree Maintenance Criteria**

Water newly planted trees regularly (at least once a week) during the first growing season. Water trees less frequently (about once a month) during the next two growing seasons. After 3 growing seasons, water trees only during drought. The exact watering frequency will vary for each tree and site.

A general horticultural rule of thumb is that trees need 1 inch of rainfall per week during the growing season. This means new trees need a minimum of 25 gallons of water a week to stay alive (<http://caseytrees.org/get-involved/water/>). Water trees deeply and slowly near the roots. Light, frequent watering of the entire plant can encourage roots to grow at the surface. Soaker hoses and drip irrigation work best for deep watering of trees. It is recommended that slow leak watering bags or tree buckets are installed to make watering easier and more effective. Continue watering until mid-fall, tapering off during lower temperatures.

Pruning is usually not needed for newly planted trees but may be beneficial for tree structure. If necessary, prune only dead, diseased, broken or crossing branches at planting. As the tree grows, lower branches may be pruned to provide clearance above the ground, or to remove dead or damaged limbs.

Maintenance inspection checklist for tree planting and preservation and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### 4.15 Proprietary Practices

Proprietary Practices				
<b>Definition:</b> Manufactured stormwater treatment practices that utilize settling, filtration, absorptive/adsorptive materials, vortex separation, vegetative components, and/or other appropriate technology to manage the impacts stormwater runoff. Performance varies based on manufacturer’s design.				
Site Applicability		BMP Performance Summary		
Land Uses	Required Footprint	WQ Improvement: Moderate to High		
<ul style="list-style-type: none"><li>▪ Urban</li><li>▪ Suburban</li><li>▪ Rural</li></ul>	Small	TSS <sup>1</sup>	Total N <sup>1</sup>	Bacteria <sup>1</sup>
		Varies*	Varies*	Varies*
		Runoff Reductions		
Construction Costs	Maintenance Burden	Volume		
Moderate	Moderate	Varies*		
Maintenance Frequency:		SWRv		
Routine	Non-Routine	Refer to Device Manufacturers Specifications		
At least annually	Variable			
Advantages/Benefits		Disadvantages/Limitation		
<ul style="list-style-type: none"><li>▪ On- or off-line treatment</li><li>▪ Useful in challenging stormwater site designs</li><li>▪ Water quality treatment</li></ul>		<ul style="list-style-type: none"><li>▪ Devices can be costly</li><li>▪ Most devices do not provide retention</li></ul>		
Components		Design considerations		
<ul style="list-style-type: none"><li>▪ Pretreatment</li><li>▪ Conveyance</li><li>▪ Bypass mechanism</li></ul>		<ul style="list-style-type: none"><li>▪ Must safely overflow or bypass flow from 2- to 25-year design storms.</li><li>▪ Manufacturer’s specifications</li><li>▪ Adequate maintenance access required</li></ul>		
Maintenance Activities				
<ul style="list-style-type: none"><li>▪ Based on manufacturer’s specifications</li></ul>		<ul style="list-style-type: none"><li>▪ Routine inspection for proper function</li></ul>		

<sup>1</sup>Credited pollutant load removal

\*Varies according to proprietary practice

**Definition.** Proprietary practices are manufactured stormwater treatment practices that utilize settling, filtration, absorptive/adsorptive materials, vortex separation, vegetative components, and/or other appropriate technology to manage the impacts stormwater runoff. The design includes the following:

#### M-1 Proprietary practices

Proprietary practices may be used to achieve treatment compliance, provided they have been approved by the State and meet the performance criteria outlined in this specification. Historically, proprietary practices do not provide retention volume. A proprietary practice will not be valued for retention volume unless the practice can demonstrate the occurrence of retention processes.

##### **4.15.1 Proprietary Practice Feasibility Criteria**

Individual proprietary practices will have different site constraints and limitations. Manufacturer's specifications should be consulted to ensure that proprietary practices are feasible for application on a site-by-site basis.

##### **4.15.2 Proprietary Practice Conveyance Criteria**

All proprietary practices must be designed to safely overflow or bypass flows from larger storm events to downstream drainage systems. The overflow associated with the 2- to 25-year design storms must be controlled so that velocities are non-erosive at the outlet point (i.e., to prevent downstream erosion).

Manufactured treatment devices may be constructed on-line or off-line. On-line systems receive upstream runoff from all storms, providing runoff treatment for the stormwater quality design storm and conveying the runoff from larger storms through an overflow. In off-line devices, most, or all, of the runoff from storms larger than the stormwater quality design storm bypass the device through an upstream diversion or other mechanism.

##### **4.15.3 Proprietary Practice Pretreatment Criteria**

Individual proprietary practices may require pretreatment or may be appropriate for use as pretreatment devices. Manufacturer's specifications should be consulted to determine the device-specific pretreatment requirements.

##### **4.15.4 Proprietary Practice Design Criteria**

The basic design parameters for a proprietary practice will depend on the techniques it employs to control stormwater runoff and remove particulate and dissolved pollutants from runoff. In general, the design of devices that treat runoff with no significant storage and flow rate attenuation must be based upon the peak design flow rate. However, devices that do provide storage and flow rate attenuation must be based, at a minimum, on the design storm runoff volume and, in some instances, on a routing of the design runoff hydrograph. Hydrologic design is discussed further in Appendix I Hydrology and Hydraulics Design Requirements.

Proprietary practices approval is contingent on adherence to the New Jersey Department of Environmental Protection Certification (NJDEP) protocols and testing. The NJDEP Certification Process includes details of the verification process and the required data submittals for determination of proprietary practice performance. The current NJDEP version should be followed and is included in the References below.

Adequate maintenance access must be provided for all proprietary practice systems. Access, with access steps, as applicable, must be provided for the inlet pipe, outflow structure, and over any other functional components.

#### **4.15.5 Proprietary Practice Landscaping Criteria**

Proprietary devices may or may not require landscaping considerations. Manufacturer's specifications should be consulted to determine any landscaping requirements for the device.

#### **4.15.6 Proprietary Practice Construction Sequence**

The construction and installation of individual proprietary practices will vary based on the specific proprietary practice. Manufacturer's specifications should be consulted to determine the device specific construction sequencing requirements.

Construction inspection checklist for generic structural BMPs can be found in Appendix E Construction Inspection Checklists.

#### **4.15.7 Proprietary Practice Maintenance Criteria**

In order to ensure effective and long-term performance of a proprietary practice, regular maintenance tasks and inspections are required.

All proprietary practices should be inspected by a qualified professional and maintained in accordance with the manufacturer's instructions and/or recommendations and any maintenance requirements associated with the device's verification by Beaufort County Public Works Department.

Maintenance inspection checklist for generic structural BMPs and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

**Waste Material.** Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

#### **4.15.8 Proprietary Practice Stormwater Compliance Calculations**

Proprietary practices receive retention credit when explicitly approved by the Beaufort County Public Works Department. Pollutant removal (TSS EMC reduction) may be awarded for specific practices provided they meet the performance criteria outlined in Section 4.15.4 Proprietary Practice Design Criteria.



#### **4.16 Conservation Area**

If a site includes a Conservation Area which is protected under a conservation easement or equivalent form of protection, a portion of the conservation area may be “removed” from the site for the purposes of calculating the stormwater retention volume (SWRv). There are four scenarios that could qualify for a conservation area credit.

##### **4.16.1 Scenario 1: Natural Conservation Area**

Scenario 1 is applicable if a portion of the post-developed area is left in its natural condition and protected, in perpetuity, by a conservation easement or equivalent form of protection. If this scenario is applicable, subtract 100% of the protected natural area from the total site area when calculating the SWRv.

##### **4.16.2 Scenario 2: Reforestation/Revegetation**

Scenario 2 is applicable if a portion of the post-developed area employs site reforestation/revegetation and is protected, in perpetuity, by a conservation easement or equivalent form of protection. If this application is used alone, subtract 50% of the reforested/revegetated area from the total site area when calculating the SWRv.

##### **4.16.3 Scenario 3: Soil Restoration**

Scenario 3 is applicable if a portion of the post-developed area employs soil restoration and is protected, in perpetuity, by a conservation easement or equivalent form of protection. If this application is used alone, subtract 50% of the soil restoration area from the total site area when calculating the SWRv.

##### **4.16.4 Scenario 4: Reforestation/Revegetation & Soil Restoration**

Scenario 4 is applicable if the same portion of the post-developed area employs site reforestation/revegetation as well as soil restoration and is protected, in perpetuity, by a conservation easement or equivalent form of protection, subtract 100% of the acres of development with restored soils in a reforested and revegetated area from the total site area when calculating the SW

## Chapter 5. Erosion & Sediment Control

Sedimentation involves three basic geologic processes: erosion, transportation, and deposition. These are natural geologic phenomena; however, land development activities may initiate severe, highly undesirable and damaging alterations in the natural sedimentation cycle by drastically accelerating the erosion and transportation process. Receiving waters are the final destination for sediment transport and deposition. However, natural streams and lakes are not capable of handling the excessive sediments created by this accelerated cycle. Therefore, excessive sediment loads result in turbid waters and heavy deposition over the substrate. The impact of these events directly affects the propagation of aquatic life, which relies on clear substrates and water to feed and reproduce. Sediment-laden waters affect human activities through the degradation of waters used for aquatic recreation and sport fishing and complicate water treatment processes. Consequently, minimizing the occurrence of erosion and effective control of sediment transport is imperative to all.

### 5.1 Sedimentation Cycle

Soil erosion is usually caused by the impact force of raindrops and by the sheer stress of runoff flowing in rills and streams. Raindrops falling on bare or sparsely vegetated soil detach soil particles; runoff, in the form of sheet flow along the ground, picks up and carries these particles to surface waters. As the runoff gains velocity and concentration, it detaches more soil particles, cuts deeper rills and gullies into the surface of the soil, and adds to its own sediment load. Coalescing rivulets produce streams which have a larger volume and usually an increased velocity. These increasing streams have a greater capacity to remove sediment and transport it downstream. The further the runoff runs uncontrolled, the greater its erosive force and the greater the resulting damage. As the distance and volume of uncontrolled flow increase, the control becomes increasingly difficult. At some point, the energy in the stream dissipates to level that can no longer support the transport of the sediment. At this time, the sediment falls out of the water column and deposits. Over time the sediment will either be incorporated into the substrate or be re-suspended for further transport.

### 5.2 Factors Influencing Erosion

The erosion potential of a site is principally determined by the soil type, vegetative cover, topography, climate, and season. These factors contribute to the detachment of soil particles and their transport off-site.

- **Soil Type** – Erodibility, the amount of energy needed to break down soil structure, is dependent on soil composition and texture. Soils with high erodibility require less energy to detach soil particles.
- **Vegetative Cover** – Vegetation shields soils from the impact energy of raindrops and traps suspended sediment from runoff.
- **Topography** – Steeper and longer slopes generate runoff with more velocity and energy to erode and transport more sediment.
- **Climate** – Rainfall frequency and intensity cumulatively contribute energy in the form of raindrop impact and runoff volume to detach and transport soil particles.
- **Season** – Seasonal variations in wind, temperature, humidity, and rainfall may create more ideal conditions for erosion.

### 5.3 Concepts of Erosion & Sediment Control

Principles of erosion and sedimentation control are based on minimizing the effects of the soil and climatologic factors just discussed. None of the following concepts provide a singular solution for controlling those factors, nor can they all be performed at every site. However, the integration of as many concepts as possible provides the most effective erosion and sedimentation control:

- A. Compatible Site Planning
  - Minimize development within sensitive areas (e.g. highly erosive soils).
  - Limit the length and steepness of the designed slopes.
  - Maintain natural vegetative cover when possible.
- B. Disturbed Areas Reduction
  - Minimize the extent of the disturbed area and the duration of exposure.
  - Phase or stage development so that only the areas that are actively being developed are disturbed.
  - Minimize large or critical area grading during the season of maximum erosion potential.
- C. Disturbed Areas Protection
  - Complete grading as quickly as possible.
  - Establish permanent vegetation as soon as possible on disturbed areas.
  - Divert runoff from disturbed areas.
- D. Sediment Retention within Site Boundaries
  - Filter runoff as it flows from a disturbed area.
  - Impound sediment-laden runoff temporarily so that the soil particles are deposited onsite.

The NPDES Phase II storm water regulations enacted by the Clean Water Act of 1972 and promulgated by Stormwater Phase II Final Rule (1999) require that any activity disturbing an acre or greater of land, or a smaller project part of a larger common plan for development or sale, obtain NPDES construction permit coverage. This regulation differs somewhat from the South Carolina state regulations relating to areas of disturbance. Any land disturbing activity in the *Beaufort County* that meets the aforementioned criteria of one acre or more of disturbance will need to will comply with the state process for permitting. Application and issuance of an approved permit under the South Carolina state regulations for erosion and sedimentation control will meet the requirements for coverage under NPDES Phase II as well (DHEC, 2012).

### 5.4 General Criteria

All construction site activities must adhere to the SCDHEC General Permit SC0010000 for Large and Small Site Construction Activities. In addition, the *Beaufort County* will require as a minimum, implementation of the following construction site BMPs:

#### Single Family Development, not part of a larger common plan of development:

1. Silt Fencing buried a minimum of 6 inches below disturbed grade, where applicable;
2. In areas where more than two feet of fill material has been placed or in areas adjacent to all wetlands, silt fencing meeting the requirements of SCDOT must be used;

3. Temporary gravel driveways a minimum of 15 feet by 10 feet, where applicable; and
4. Sediment barriers surrounding all catch basins or drop inlets on site and sediment socks on all catch basins or drop inlets adjoining to the site.

**Single Family and Multi-Family Development, part of a larger common plan of development, and Non-residential Development:**

1. Silt Fencing buried a minimum of 6 inches below disturbed grade;
2. Temporary gravel driveways a minimum of 15 feet by 10 feet;
3. Sediment barriers surrounding all catch basins or drop inlets on site and sediment socks on all catch basins or drop inlets adjoining to the site;
4. Flow dissipation devices, such as check dams, in all swales and ditches;
5. Temporary stabilization shall be placed within 7 days after construction activity is complete unless construction activity is going to resume within 21 days;
6. Floating pump suctions for all temporary or permanent ponds or pumping of excavations;
7. Discharge velocities shall be reduced to provide non-erosive flows from dewatering for all temporary or permanent ponds or pumping of excavations;
8. Site inspections must be performed by a *Beaufort County* qualified individual. Copies of inspection reports shall be provided to the *Beaufort County* within 7 days of inspection;
9. Temporary stockpile areas and appropriate BMPs to be identified on plans; and
10. Two rows of silt fence are required between land disturbing activities and adjacent wetlands.

## Ch 6. Enforcement and Violations

Beaufort County is required to conform to the most recent revisions of the NPDES General Permit for Discharges from Regulated SMS4, permit #SCR03000, NPDES General Permit for Stormwater Discharges from Construction Activities, Permit #SCR100000, and the Southern Lowcountry Design Manual and Ordinance. Stormwater runoff can carry pollutants to our local waterways through a variety of means. In order to control these discharges, Beaufort County is required to enforce and issue violations to property owners, contractors, subcontractors, developers, etc that have land disturbance or BMP's installed on property to ensure they are maintained and in compliance with the permits and ordinances cited above.

The escalating enforcement plan (EEP) was developed to help contractors manage and reduce potential impacts on active construction sites to the maximum extent practicable (MEP) through effective enforcement procedures.

- Any deficiencies or non-compliance issues identified during a County inspection will be reported to the project contractor, on-site supervisor, property owner, and/or engineer for addressing. Some corrective measures may require immediate, 48-hr, 72-hr, or 96-hr action depending on the nature of the violation.
- BMP's experiencing frequent failures can be required by staff to be replaced with alternative control methods. All changes should be communicated with the Stormwater Management Department and documented in the OS-SWPPP.
- Failure to address concerns or implement required changes may result in notices of violation, stop work orders, or fines.
- Sites with repeated violations may be subject to additional compliance actions, special inspection schedules or inspections as determined by the Stormwater Management Department.

### 2. Enforcement

If the County determines a project is in noncompliance with the Stormwater Ordinance or SoLoCo Manual, then the inspector may direct conformity by proceeding with an appropriate enforcement action. The County uses enforcement actions that include verbal warnings, Notices of Violation, Stop Work Orders, and/or civil penalties. The enforcement mechanism to be utilized will depend on the circumstances as described in the following sections.

### 3. Notice of Violation

The inspector will issue a Notice of Violation (NOV) for the first offenses of non-compliance with the County Stormwater Ordinance. The purpose of the NOV is to give notice of the deficiencies, identify expected corrective results and provide a reasonable timeframe to the contractor/land owner/developer prior to the County taking further action to ensure compliance. All NOV's shall be issued shall be issued per the ordinance and noted in the project file. A Notice of Violation may be issued in the following cases, but not limited to, when there is:

- Failure to coordinate an initial inspection (residential) or pre-construction meeting (commercial) prior to construction.

- Failure comply with the approved Stormwater design plans to include failure to properly install and maintain BMP measures.
- Failure to properly maintain permanent Stormwater management structures.
- Failure to comply with any portion of the Stormwater ordinance.

The contractor and land owner will be informed the inspection has failed inspection within 48-hrs of the failure. The inspector may issue a verbal Notice of Violation, but will also make the NOV available via an emailed PDF. Based on the severity of the failure and the discretion of the inspector, the contractor will be given 48 – 96 hrs to make corrective actions. The contractor may request an on-site meeting within the specified time frame to review site deficiencies and corrective actions taken. The contractor may request an extension to resolve violation issues, but it is at the discretion of the inspector to approve the request.

NOV's do not have to be issued for the same compliance failures before escalating to a Stop Work Order. A NOV will be void upon the next passed inspection.

#### 4. Stop Work Order

An inspector will issue a Stop Work Order if compliance cannot be obtained through the issuance of NOV's or a violation is so severe immediate action must be taken. These actions can include, but are not limited to, the following:

- Construction Activities are occurring without County permits and/or an approved SWPPP.
- Past enforcement actions taken by the County have not been addressed with appropriate and prompt action to the satisfaction of the Stormwater Manager.
- Non-compliance with the approved plans has resulted in a health or safety issue.
- Offsite sedimentation resulting from non-compliance with the approved SWPPP has eliminated or severely degraded a use in a downstream water body or that such degradation is imminent.
- Non-compliance with the approved SWPPP has caused severe damage to adjacent land.
- Failure to comply with any other provisions of the Stormwater Ordinance.

If a Stop Work Order is issued, a sign will be placed at the main entrance of the site. All construction activities must immediately cease and will not begin again until the violation has been mitigated. A Stop Work Order will remain in effect for a minimum of 24 hours. The contractor or land owner must call the inspector to schedule a re-inspection. In the event the inspector is not satisfied with efforts of compliance, a fine may be issued in accordance with the Stormwater Ordinance. A stop work order will be void after the next passed inspection.

#### 5. Civil Penalties

Violations may be subject the contractor/land owner to civil penalties outlined in the Stormwater Ordinance for each violation. Each day a violation continues constitutes a new and separate violation.

#### 6. Criminal Penalties

In addition to any applicable civil penalties, and person who negligently, willfully, or intentionally violates any provision of the Ordinance shall be guilty of a misdemeanor and shall be punished within the jurisdictional limits of the magistrate's court. The Stormwater Manager may issue a notice to appear

for a violation of this ordinance. Civil penalties imposed are outlined in the Stormwater Ordinance. Each day a violation continues constitutes a new and separate violation.

PART II - BUILDING AND LAND DEVELOPMENT ORDINANCES  
Chapter 99 STORMWATER MANAGEMENT

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## **Chapter 99 STORMWATER MANAGEMENT<sup>1</sup>**

### ***ARTICLE I. IN GENERAL***

**Secs. 99-1—99-100. Reserved.**

### ***ARTICLE II. STORMWATER MANAGEMENT UTILITY***

**Sec. 99-101. Findings of fact.**

The county council of Beaufort County, South Carolina, makes the following findings of fact:

- (a) The professional engineering and financial analyses conducted on behalf of and submitted to the county properly assesses and defines the stormwater management problems, needs, goals, program priorities, costs of service, need for interlocal cooperation, and funding opportunities of the county.
- (b) Given the problems, needs, goals, program priorities, costs of service, needs for interlocal cooperation, and funding opportunities identified in the professional engineering and financial analyses submitted to the county, it is appropriate to authorize the establishment of a separate enterprise accounting unit which shall be dedicated specifically to the management, construction, maintenance, protection, control, regulation, use, and enhancement of stormwater systems and programs in Beaufort County in concert with other water resource management programs.
- (c) Stormwater management is applicable and needed throughout the unincorporated portions of Beaufort County, but interlocal cooperation between the county and the incorporated cities and towns within the county is also essential to the efficient provision of stormwater programs, services, systems, and facilities. Intense urban development in some portions of the county has radically altered the natural hydrology of the area and the hydraulics of stormwater systems, with many natural elements having been replaced or augmented by manmade facilities. Other areas of the county remain very rural in character, with natural stormwater systems predominating except along roads where ditches and culverts have been installed. As a result, the specific program, service, system, and facility demands differ from area to area in the county. While the county manages, operates, and improves stormwater programs, services, systems and facilities in the rural as well as urban areas, the need for improved stormwater management is greatest in the urban areas and nearby, including areas within incorporated cities and towns. Therefore, a stormwater utility service area subject to stormwater service fees should encompass, in so far as possible through interlocal agreements, the entirety of Beaufort County and the stormwater management utility service fee rate structure should reflect the amount of impervious area on individual properties and the runoff impact from water quantity and water quality.

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<sup>1</sup>Editor's note(s)—Ord. No. 2015/24 , adopted Sept. 28, 2015, amended and replaced ch. 99 to read as herein set out. Former ch. 99 pertained to the same subject matter, and derived from Ord. No. 2005/33 , adopted Sept. 22, 2005; and Ord. No. 2009/21 , adopted May 26, 2009.





- (d) The stormwater needs in Beaufort County include, but are not limited to, protecting the public health, safety, and welfare. Provision of stormwater management programs, services, systems, and facilities therefore renders and/or results in both service and benefit to individual properties, property owners, citizens, and residents of the county and to properties, property owners, citizens, and residents of the county concurrently in a variety of ways as identified in the professional engineering and financial analyses.
- (e) The service and benefit rendered or resulting from the provision of stormwater management programs, services, systems, and facilities may differ over time depending on many factors and considerations, including, but not limited to, location, demands and impacts imposed on the stormwater programs, systems, and facilities, and risk exposure. It is not practical to allocate the cost of the county's stormwater management programs, services, systems, and facilities in direct and precise relationship to the services or benefits rendered to or received by individual properties or persons over a brief span of time, but it is both practical and equitable to allocate the cost of stormwater management among properties and persons in proportion to the long-term demands they impose on the county's stormwater programs, services, systems, and facilities which render or result in services and benefits.
- (f) Beaufort County presently owns and operates stormwater management systems and facilities that have been developed, installed, and acquired through various mechanisms over many years. The future usefulness and value of the existing stormwater systems and facilities owned and operated by Beaufort County, and of future additions and improvements thereto, rests on the ability of the county to effectively manage, construct, protect, operate, maintain, control, regulate, use, and enhance the stormwater systems and facilities in the county, in concert with the management of other water resources in the county and in cooperation with the incorporated cities and towns. In order to do so, the county must have adequate and stable funding for its stormwater management program operating and capital investment needs.
- (g) The county council finds, concludes, and determines that a stormwater management utility provides the most practical and appropriate means of properly delivering stormwater management services and benefits throughout the county, and the most equitable means to fund stormwater services in the county through stormwater service fees and other mechanisms as described in the professional engineering and financial analyses prepared for the county.
- (h) The county council finds, concludes, and determines that a schedule of stormwater utility service fees be levied upon and collected from the owners of all lots, parcels of real estate, and buildings that discharge stormwater or subsurface waters, directly or indirectly, to the county stormwater management system and that the proceeds of such charges so derived be used for the stormwater management system.
- (i) The county council finds that adjustments and credits against stormwater utility service fees are an appropriate means to grant properties providing stormwater management program services that would otherwise be provided by the county and will afford Beaufort County cost savings. These reductions will be developed by the public works director and will be reviewed on an annual basis to allow for any modifications to practices required by Beaufort County.

The county council finds that both the total gross area and impervious area on each property are the most important factors influencing the cost of stormwater management in Beaufort County and, the runoff impact from water quantity and water quality.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-102. Establishment of a stormwater management utility and a utility enterprise fund.**

There is hereby established within the environmental engineering division of Beaufort County a stormwater management utility for the purpose of conducting the county's stormwater management program. The county administrator shall establish and maintain a stormwater management utility enterprise fund in the county budget and accounting system, which shall be and remain separate from other funds. All revenues of the utility shall be placed into the stormwater management utility enterprise fund and all expenses of the utility shall be paid from the fund, except that other revenues, receipts, and resources not accounted for in the stormwater management utility enterprise fund may be applied to stormwater management programs, services, systems, and facilities as deemed appropriate by the Beaufort County Council. The county administrator may designate within the stormwater management utility enterprise fund such sub-units as necessary for the purpose of accounting for the geographical generation of revenues and allocation of expenditures pursuant to interlocal governmental agreements with the cities and towns of Beaufort County.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2020/18, 5-26-2020 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-103. Purpose and responsibility of the utility.**

The Beaufort County Stormwater Management Utility is established for the purpose of managing, acquiring, constructing, protecting, operating, maintaining, enhancing, controlling, and regulating the use of stormwater drainage systems in the county. The utility shall, on behalf of the county and the citizens of the county: administer the stormwater management program; perform studies and analyses as required; collect service fees; system development fees, in-lieu of construction fees and other funding as allowed by law, and obtain and administer grants and loans as authorized by the county council; prepare capital improvement plans and designs; perform routine maintenance and remedial repair of the stormwater systems; acquire, construct, and improve stormwater systems; acquire necessary lands, easements, rights-of-way, rights-of-entry and use, and other means of access to properties to perform its duties; regulate the on-site control, conveyance, and discharge of stormwater from properties; obtain federal and state permits required to carry out its purpose; enter into operating agreements with other agencies; allocate funds pursuant to interlocal governmental agreements; educate and inform the public about stormwater management; and perform, without limitation except by law, any stormwater management functions and activities necessary to ensure the public safety, protect private and public properties and habitat, and enhance the natural environment and waters of the county.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-104. Limitation of scope of responsibility.**

The purpose and responsibility of the stormwater management utility shall be limited by the following legal and practical considerations:

- (a) Beaufort County owns or has legal access for purposes of operation, maintenance and improvement only to those stormwater systems and facilities which:
  - (1) Are located within public streets, other rights-of-way, and easements;
  - (2) Are subject to easements, rights-of-entry, rights-of-access, rights-of-use, or other permanent provisions for adequate access for operation, maintenance, monitoring, and/or improvement of systems and facilities; or
  - (3) Are located on public lands to which the county has adequate access for operation, maintenance, and/or improvement of systems and facilities.

- (b) Operation, maintenance, and/or improvement of stormwater systems and facilities which are located on private property or public property not owned by Beaufort County and for which there has been no public dedication of such systems and facilities for operation, maintenance, monitoring, and/or improvement of the systems and facilities shall be and remain the legal responsibility of the property owner, except as that responsibility may be otherwise affected by the laws of the State of South Carolina and the United States of America.
- (c) It is the express intent of this article to protect the public health, safety, and welfare of all properties and persons in general, but not to create any special duty or relationship with any individual person or to any specific property within or outside the boundaries of the county. Beaufort County expressly reserves the right to assert all available immunities and defenses in any action seeking to impose monetary damages upon the county, its officers, employees and agents arising out of any alleged failure or breach of duty or relationship as may now exist or hereafter be created.
- (d) To the extent any permit, plan approval, inspection or similar act is required by the county as a condition precedent to any activity or change upon property not owned by the county, pursuant to this or any other regulatory ordinance, regulation, or rule of the county or under federal or state law, the issuance of such permit, plan approval, or inspection shall not be deemed to constitute a warranty, express or implied, nor shall it afford the basis for any action, including any action based on failure to permit or negligent issuance of a permit, seeking the imposition of money damages against the county, its officers, employees, or agents.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-105. Boundaries and jurisdiction.**

The boundaries and jurisdiction of the stormwater management utility shall encompass all those portions of unincorporated Beaufort County, as they may exist from time to time and such additional areas lying inside the corporate limits of those cities and towns in Beaufort County as shall be subject to interlocal agreements for stormwater management as approved by county council and participating municipal councils.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-106. Definitions.**

Unless the context specifically indicates otherwise, the meaning of words and terms used in this article shall be as set forth in S.C. Code § 48-14-20, and 26 S.C. Code Regulation 72-301, mutatis mutandis.

*Abatement.* Any action deemed necessary by the county or its officers or agents to remedy, correct, control, or eliminate a condition within, associated with, or impacting a stormwater drainage system or the water quality of receiving waters shall be deemed an abatement action.

*Adjustments.* Adjustments shall mean a change in the amount of a stormwater service fee predicated upon the determination reached by the public works director and referenced to the adjustments and credit manual.

*Bill class.* Every property falls into one of several bill classes. The bill class determines the fee calculation of that property.

*Condominiums.* Properties with individual ownership of a particular dwelling unit in a building and the common right to share, with other co-owners, in the general and limited common elements of the real property.

*Countywide infrastructure operation and maintenance and capital projects.* The county maintains some typically larger infrastructure within each of the four municipalities in addition to within the unincorporated area.

The rate structure will allocate the costs for the county to maintain just the countywide drainage infrastructure across the entire rate base in all jurisdictions based on infrastructure linear feet per jurisdiction.

*Customers of the stormwater management utility.* Customers of the stormwater management utility shall be broadly defined to include all persons, properties, and entities served by and/or benefiting, directly and indirectly, from the utility's acquisition, management, construction, improvement, operation, maintenance, extension, and enhancement of the stormwater management programs, services, systems, and facilities in the county, and by its control and regulation of public and private stormwater systems, facilities, and activities related thereto.

*Developed land.* Developed land shall mean property altered from its natural state by construction or installation of improvements such as buildings, structures, or other impervious surfaces, or by other alteration of the property that results in a meaningful change in the hydrology of the property during and following rainfall events. Existing county maintained dirt roads which are improved and/or paved as part of Beaufort County's Dirt Road Paving Program as set forth in Beaufort County Policy Statement 15 and Policy Statement 17 and existing private dirt roads which are improved or paved and where the project is not related to a pending or proposed development of adjacent land are deemed not to constitute "developed land".

*Exemption.* Exemption shall mean not applying to or removing the application of the stormwater management utility service fee from a property. No permanent exemption shall be granted based on taxable or non-taxable status or economic status of the property owner.

*Fixed costs.* Costs associated with the public service provided equally to each property owner. These costs include, but are not limited to, the following: billing and collections, data management and updating, programming, and customer support.

*Gross area.* Gross area is the acreage of a parcel as identified by the Beaufort County Assessor records.

*Hydrologic response.* The hydrologic response of a property is the manner whereby stormwater collects, remains, infiltrates, and is conveyed from a property. It is dependent on several factors including, but not limited to, the size and overall intensity of development of each property, its impervious area, shape, topographic, vegetative, and geologic conditions, antecedent moisture conditions, and groundwater conditions and the nature of precipitation events. Extremely large undeveloped properties naturally attenuate but do not eliminate entirely the discharge of stormwater during and following rainfall events.

*Jurisdictional infrastructure operations, maintenance and capital projects.* Each of the five jurisdictions maintains its own stormwater drainage infrastructure and funds those costs from utility revenue. Revenue from this fee component will be returned to the service provider, the individual jurisdiction.

*Impervious surfaces.* Impervious surfaces shall be a consideration in the determination of the development intensity factor. Impervious surfaces are those areas that prevent or impede the infiltration of stormwater into the soil as it entered in natural conditions prior to development. Common impervious surfaces include, but are not limited to, rooftops, sidewalks, walkways, patio areas, driveways, parking lots, storage areas, compacted gravel and soil surfaces, awnings and other fabric or plastic coverings, and other surfaces that prevent or impede the natural infiltration of stormwater runoff that existed prior to development.

*Minimum charge.* A charge that reflects the minimum amount of demand a property will place on the service provider.

*MS4 permit.* Each jurisdiction within Beaufort County will be subject to the federally mandated MS4 permit requirements. Compliance requirements include, but are not limited to, monitoring, plan review, inspections, outreach and public education.

*Nonresidential properties.* Properties developed for uses other than permanent residential dwelling units and designated by the assigned land use code in the Beaufort County tax data system.

*Other developed lands.* Other developed lands shall mean, but not be limited to, mobile home parks, commercial and office buildings, public buildings and structures, industrial and manufacturing buildings, storage

buildings and storage areas covered with impervious surfaces, parking lots, parks, recreation properties, public and private schools and universities, research facilities and stations, hospitals and convalescent centers, airports, agricultural uses covered by impervious surfaces, water and wastewater treatment plants, and lands in other uses which alter the hydrology of the property from that which would exist in a natural state. Properties that are used for other than single-family residential use shall be deemed other developed lands for the purpose of calculating stormwater service fees.

*Residential dwelling classifications.* The following categories will identify the appropriate dwelling unit classifications to be utilized in applying the stormwater utility fee structure to the designations contained in the Beaufort County tax data system:

- Single-family
- Apartments
- Townhouses
- Condominiums
- Mobile home

*Salt water marsh.* Those parcels, typically contiguous to water, identified as inundated daily due to tidal action and unbuildable. These properties are 100 percent below mean high tide and/or beyond established critical line as defined by the South Carolina Department of Health and Environmental Control's Office of Coastal Resource Management (DHEC-OCRM). The county tax assessor's office shall make this determination based on best available data.

*Stormwater management programs, services, systems and facilities.* Stormwater management programs, services, systems and facilities are those administrative, engineering, operational, regulatory, and capital improvement activities and functions performed in the course of managing the stormwater systems of the county, plus all other activities and functions necessary to support the provision of such programs and services. Stormwater management systems and facilities are those natural and manmade channels, swales, ditches, swamps, rivers, streams, creeks, branches, reservoirs, ponds, drainage ways, inlets, catch basins, pipes, head walls, storm sewers, lakes, and other physical works, properties, and improvements which transfer, control, convey or otherwise influence the movement of stormwater runoff and its discharge to and impact upon receiving waters.

*Stormwater service fees.* Stormwater service fees shall mean the service fee imposed pursuant to this article for the purpose of funding costs related to stormwater programs, services, systems, and facilities. These fees will be calculated based upon the impervious and gross area at an 80/20 allocation; stormwater service fee categories; any state agricultural exemptions or caps; an account administrative fee, countywide jurisdiction operation maintenance and capital project fees; and jurisdictional operation, maintenance and capital project fee.

*Single-family unit (SFU).* The single-family unit shall be defined as the impervious area measurements obtained from a statistically representative sample of all detached single-family structures within Beaufort County. The representative value will be 4,906 square feet.

*Stormwater service fee categories.* The appropriate categories for determining SFUs will be as follows:

	SFU Calculation (SFUs equal)
Tier 1: Single-family unit ( $\leq 2,521$ square feet)	Dwelling units x 0.5
Tier 2: Single-family unit (2,522 to 7,265 square feet)	Dwelling units x 1
Tier 3: Single-family unit ( $\geq 7,266$ square feet)	Dwelling units x 1.5
Mobile home	Dwelling units x 0.36
Apartments	Dwelling units x 0.39
Townhouses	Dwelling units x 0.60

Condominiums	Dwelling units x 0.27
Commercial	Impervious area * 4,906 sq. ft.*

\* Commercial billed at a rate of one SFU per 4,906 square feet or a portion thereof.

*Submerged property.* Those parcels, typically contiguous to water, identified as eroded due to tidal action and unbuildable. These properties are 100 percent below mean low tide and/or beyond established critical line as defined by South Carolina Department of Health and Environment Control's Office of Coastal Resource Management (DHEC-OCRM). The county tax assessor's office shall make this determination based on best available data.

*Townhomes.* See Condominiums.

*Variable costs.* An impervious and gross area rate structure that allocates some cost to each of the two variables based on the amount of impervious surface and gross area.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2016/26, 9-26-2016 ; Ord. No. 2018/6, 3-12-2018 ; Ord. No. 2021/04, 1-11-2021)

### **Sec. 99-107. Reserved.**

Editor's note(s)—Ord. No. 2016/38 , adopted Oct. 24, 2016, deleted § 99-107, which pertained to requirements for on-site stormwater systems; enforcement, methods, and inspections, and derived from Ord. No. 2015/24 , adopted Sept. 28, 2015.

### **Sec. 99-108. General funding policy.**

- (a) It shall be the policy of Beaufort County that funding for the stormwater management utility program, services, systems, and facilities shall be equitably derived through methods which have a demonstrable relationship to the varied demands and impacts imposed on the stormwater program, services, systems, and facilities by individual properties or persons and/or the level of service rendered by or resulting from the provision of stormwater programs, systems and facilities. Stormwater service fee rates shall be structured so as to be fair and reasonable, and the resultant service fees shall bear a substantial relationship to the cost of providing services and facilities throughout the county. Similarly situated properties shall be charged similar rentals, rates, fees, or licenses. Service fee rates shall be structured to be consistent in their application and shall be coordinated with the use of any other funding methods employed for stormwater management within the county, whether wholly or partially within the unincorporated portions of the county or within the cities and towns. Plan review and inspection fees, special fees for services, fees in-lieu of regulatory requirements, impact fees, system development fees, special assessments, general obligation and revenue bonding, and other funding methods and mechanisms available to the county may be used in concert with stormwater service fees and shall be coordinated with such fees in their application to ensure a fair and reasonable service fee rate structure and overall allocation of the cost of services and facilities.
- (b) The cost of stormwater management programs, systems, and facilities subject to stormwater service fees may include operating, capital investment, and non-operating expenses, prudent operational and emergency reserve expenses, and stormwater quality as well as stormwater quantity management programs, needs, and requirements.
- (c) To the extent practicable, adjustments to the stormwater service fees will be calculated by the Beaufort County Public Works Director or his/her designee in accordance with the standards and procedures adopted by the public works director's office.

- (d) The stormwater service fee rate may be determined and modified from time to time by the Beaufort County Council so that the total revenue generated by said fees and any other sources of revenues or other resources allocated to stormwater management by the county council to the stormwater management utility shall be sufficient to meet the cost of stormwater management services, systems, and facilities, including, but not limited to, the payment of principle and interest on debt obligations, operating expense, capital outlays, nonoperating expense, provisions for prudent reserves, and other costs as deemed appropriate by the county council.

Beaufort County service fee rate will be based on impervious and gross area at an 80/20 allocation; stormwater service fee categories; any state agricultural exemptions or caps; an account administrative fee, countywide jurisdiction operation maintenance and jurisdictional operation, maintenance and capital project fee. The rates are set by the Beaufort County Stormwater Rate Study adopted August 24, 2015.

The gross area charge for all parcels, except master account properties for condominiums, is calculated in equivalent units as follows:

First 2 acres	\$X
For every acre above 2 acres and up to 10 acres	0.5 x \$X
For every acre above 10 acres, and up to 100 acres	0.4 x \$X
For every acre above 100 acres	0.3 x \$X

Condominium accounts will receive a minimum gross area charge of 0.2 x \$X. The master account associated with the condominium subdivision will not receive a gross area charge.

Each municipal jurisdiction may have a different fee predicated upon the municipal jurisdiction's revenue needs. The stormwater service fee rates shall be adopted by the municipal jurisdictions and may be amended from time to time by the individual governing body.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2016/26, 9-26-2016 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-109. Exemptions and credits applicable to stormwater service fees.**

Except as provided in this section, no public or private property shall be exempt from stormwater utility service fees. No exemption, credit, offset, or other reduction in stormwater service fees shall be granted based on the age, tax, or economic status, race, or religion of the customer, or other condition unrelated to the stormwater management utility's cost of providing stormwater programs, services, systems, and facilities. A stormwater management utility service fee credit manual shall be prepared by the public works director specifying the design and performance standards of on-site stormwater services, systems, facilities, and activities that qualify for application of a service fee credit, and how such credits shall be calculated.

- (a) *Credits.* The following types of credits against stormwater service fees shall be available:
- (1) Freshwater wetlands. All properties except those classified as detached single-family dwelling units may receive a credit against the stormwater service fee applicable to the property based on granting and dedicating a perpetual conservation easement on those portions of the property that are classified as freshwater wetlands and as detailed in the stormwater management utility service fee credit manual. The conservation easement shall remove that portion of the subject property from any future development.
  - (2) Salt water marsh. All properties except those classified as detached single-family dwelling units may receive a credit against the stormwater service fee applicable to the property based on those portions of the property that are classified as salt water marsh and as detailed in the stormwater management utility service fee credit manual.



- (3) Submerged properties. All properties may receive a credit against the stormwater service fee applicable to the property based on those portions of the property that are classified as submerged and as detailed in the stormwater management utility service fee credit manual.
  - (4) Those properties that apply for consideration of an adjustment shall satisfy the requirements established by the Beaufort County Public Works Director or his/her designee and approved reduced stormwater service fee.
- (b) *Exemptions.* The following exemptions from the stormwater service fees shall be allowed:
- (1) Improved public road rights-of-way that have been conveyed to and accepted for maintenance by the state department of transportation and are available for use in common for vehicular transportation by the general public.
  - (2) Improved public road rights-of-way that have been conveyed to and accepted for maintenance by Beaufort County and are available for use in common for vehicular transportation by the general public.
  - (3) Improved private roadways that are shown as a separate parcel of land on the most current Beaufort County tax maps and are used by more than one property owner to access their property.
  - (4) Improved private roadways that are not shown as a separate parcel of land on the most current Beaufort County tax maps but are used by more than one property owner to access their property.
  - (5) Railroad tracks shall be exempt from stormwater service fees. However, railroad stations, maintenance buildings, or other developed land used for railroad purposes shall not be exempt from stormwater service fees.
  - (6) Condominium boat slips shall be exempt from stormwater service fees.
  - (7) Properties determined by the assessor having 100 percent of the gross area of the property submerged, salt water marsh, or freshwater wetland will not receive an administrative charge, if applicable in the utility rate structure, after the applicable credit defined in paragraph (a) above has been applied to the account.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2016/26, 9-26-2016 ; Ord. No. 2020/18, 5-26-2020 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-110. Stormwater service fee billing, delinquencies and collections.**

- (a) *Method of billing.* A stormwater service fee bill may be attached as a separate line item to the county's property tax billing or may be sent through the United States mail or by alternative means, notifying the customer of the amount of the bill, the date the fee is due (January 15), and the date when past due (March 17 - see Title 12, Section 45-180 of the South Carolina State Code). The stormwater service fee bill may be billed and collected along with other fees, including, but not limited to, the Beaufort County property tax billing, other Beaufort County utility bills, or assessments as deemed most effective and efficient by the Beaufort County Council. Failure to receive a bill is not justification for non-payment. Regardless of the party to whom the bill is initially directed, the owner of each parcel of land shall be ultimately obligated to pay such fees and any associated fines or penalties, including, but not limited to, interest on delinquent service fees. If a customer is under-billed or if no bill is sent for a particular property, Beaufort County may retroactively bill for a period of up to one-year, but shall not assess penalties for any delinquency during that previous unbilled period.

- (b) *Declaration of delinquency.* A stormwater service fee shall be declared delinquent if not paid within 60 days of the date of billing or upon the date (March 17) of delinquency of the annual property tax billing if the stormwater service fee is placed upon the annual property tax billing or enclosed with or attached to the annual property tax billing.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-111. Appeals.**

Any customer who believes the provisions of this article have been applied in error may appeal in the following manner and sequence:

- (a) An appeal of a stormwater service fee must be filed in writing with the Beaufort County Public Works Director, or his/her designee within 30 days of the fee being mailed or delivered to the property owner and stating the reasons for the appeal. In the case of stormwater service fee appeals, the appeal shall include a survey prepared by a registered land surveyor or professional engineer containing information on the impervious surface area and any other feature or conditions that influence the development of the property and its hydrologic response to rainfall events.
- (b) Using information provided by the appellant, the county public works director or his/her designee shall conduct a technical review of the conditions on the property and respond to the appeal in writing within 30 days after receipt of the appeal. In response to an appeal, the county public works director or his/her designee may adjust the stormwater service fee applicable to the property in conformance with the general purposes and intent of this article.
- (c) A decision of the public works director or his/her designee that is adverse to an appellant may be further appealed to the county administrator or his/her designee within 30 days of the adverse decision. The appellant, stating the grounds for further appeal, shall deliver notice of the appeal to the county administrator or his designee. The county administrator or his designee shall issue a written decision on the appeal within 30 days. All decisions by the county administrator or his designee shall be served on the customer personally or by registered or certified mail, sent to the billing address of the customer. All decisions of the county administrator or his designee shall be final.
- (d) The appeal process contained in this section shall be a condition precedent to an aggrieved customer seeking judicial relief. Any decisions of the county administrator or his designee may be reviewed upon application for writ of certiorari before a court of competent jurisdiction, filed within 30 days of the date of the service of the decision.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-112. No suspension of due date.**

No provision of this article allowing for an administrative appeal shall be deemed to suspend the due date of the service fee with payment in full. Any adjustment in the service fee for the person pursuing an appeal shall be made by refund of the amount due.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-113. Enforcement and penalties.**

Any person who violates any provision of this article may be subject to a civil penalty of not more than \$1,000.00, or such additional maximum amount as may become authorized by state law, provided the owner or

other person deemed to be in violation has been notified of a violation. Notice shall be deemed achieved when sent by regular United States mail to the last known address reflected on the county tax records, or such other address as has been provided by the person to the county. Each day of a continuing violation may be deemed a separate violation. If payment is not received or equitable settlement reached within 30 days after demand for payment is made, a civil action may be filed on behalf of the county in the circuit court to recover the full amount of the penalty. This provision on penalties shall be in addition to and not in lieu of other provisions on penalties, civil or criminal, remedies and enforcement that may otherwise apply.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-114. Investment and reinvestment of funds and borrowing.**

Funds generated for the stormwater management utility from service fees, fees, rentals, rates, bond issues, other borrowing, grants, loans, and other sources shall be utilized only for those purposes for which the utility has been established as specified in this article, including, but not limited to: regulation; planning; acquisition of interests in land, including easements; design and construction of facilities; maintenance of the stormwater system; billing and administration; water quantity and water quality management, including monitoring, surveillance, private maintenance inspection, construction inspection; public information and education, and other activities which are reasonably required. Such funds shall be invested and reinvested pursuant to the same procedures and practices established by Title 12, Section 45-70 of the South Carolina State Code for investment and reinvestment of funds. County council may use any form of borrowing authorized by the laws of the State of South Carolina to fund capital acquisitions or expenditures for the stormwater management utility. County council, in its discretion and pursuant to standard budgetary procedures, may supplement such funds with amounts from the general fund.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-115. Responsibilities of the stormwater management utility.**

The county stormwater management utility shall perform adequate studies throughout the area served by the utility to determine the following:

- (1) Baseline study of water quality in the receiving waters;
- (2) Identification of pollutants carried by stormwater runoff into the receiving waters;
- (3) Recommended mitigation efforts to address pollutants carried by stormwater runoff into the receiving waters;
- (4) Inventory of the existing drainage system;
- (5) Recommended maintenance practices and standards of the existing drainage system;
- (6) Identification of capital improvements to the system to include construction or installation of appropriate BMPs;
- (7) A five-year spending plan;
- (8) Ensure compliance with the federally mandated MS4 permit requirements;
- (9) Efficient utility administration including, but not limited to, billing, collection, defining rate structures, data management and customer support.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

## Sec. 99-116. Stormwater management utility board.

- (1) *Purpose.* In compliance with and under authority of Beaufort County Ordinance 2001/23, the Beaufort County Council hereby establishes the stormwater management utility board (hereinafter referred to as the "SWU board") to advise the council as follows:
- (a) To determine appropriate levels of public stormwater management services for residential, commercial, industrial and governmental entities within Beaufort County;
  - (b) To recommend appropriate funding levels for provision of services in the aforementioned sectors;
  - (c) To advise the staff of the stormwater management utility on master planning efforts and cost of service/rate studies; and
  - (d) To support and promote sound stormwater management practices that mitigates non-point source pollution and enhances area drainage within Beaufort County.

Municipal councils are encouraged to organize similar boards to advise them on stormwater management programs and priorities within their boundaries.

In keeping with discussions held during the formation of the stormwater utility, it is anticipated that the municipalities will appoint staff professionals as their representative on the advisory board.

- (2) *Stormwater districts.* Stormwater districts are hereby established as follows:

District 1 - City of Beaufort

District 2 - Town of Port Royal

District 3 - Town of Hilton Head Island

District 4 - Town of Bluffton

District 5 - Unincorporated Sheldon Township

District 6 - Unincorporated Port Royal Island

District 7 - Unincorporated Lady's Island

District 8 - Unincorporated St. Helena Island Islands East

District 9 - Unincorporated Bluffton Township and Daufuskie Island

- (3) *Membership.*

- (a) The SWU board is formed in accordance with Beaufort County Ordinance 92-28 and shall consist of a total of seven voting representatives from each of the following districts as noted below:

No. of Reps.	Stormwater District	Area
1	5	Unincorporated Sheldon Township
1	6	Unincorporated Port Royal Island
1	7	Unincorporated Lady's Island
1	8	Unincorporated St. Helena Island Islands East
2	9	Unincorporated Bluffton Township and Daufuskie Island
1	—	"At large"

All members of the SWU board will be appointed by county council and shall be residents of those districts or "at large" members from unincorporated Beaufort County.

- (b) The SWU board shall also consist of one nonvoting (ex officio) representative from the following districts:

Stormwater District	Municipality
1	City of Beaufort
2	Town of Port Royal
3	Town of Hilton Head Island
4	Town of Bluffton

All ex officio members from municipalities shall be appointed by their respective municipal councils for four-year terms.

- (c) All citizen members shall be appointed for a term of four years. The terms shall be staggered with one or two members appointed each year.
- (d) While no other eligibility criteria is established, it is recommended that members possess experience in one or more of the following areas: Stormwater management (drainage and water quality) issues, strategic planning, budget and finance issues or established professional qualifications in engineering, construction, civil engineering, architectural experience, commercial contractor or similar professions.

(4) *Officers.*

- (a) *Officers.* Selection of officers and their duties as follows:

1. *Chairperson and vice-chair.* At an annual organizational meeting, the members of the SWU board shall elect a chairperson and vice-chairperson from among its members. The chair's and vice-chair's terms shall be for one year with eligibility for reelection. The chair shall be in charge of all procedures before the SWU board, may administer oaths, may compel the attendance of witnesses, and shall take such action as shall be necessary to preserve order and the integrity of all proceedings before the SWU board. In the absence of the chair, the vice-chair shall act as chairperson.
2. *Secretary.* The county professional staff member shall appoint a secretary for the SWU board. The secretary shall keep minutes of all proceedings. The minutes shall contain a summary of all proceedings before the SWU board, which include the vote of all members upon every question, and its recommendations, resolutions, findings and determinations, and shall be attested to by the secretary. The minutes shall be approved by a majority of the SWU board members voting. In addition, the secretary shall maintain a public record of SWU board meetings, hearings, proceedings, and correspondence.
3. *Staff.* The public works director shall be the SWU board's professional staff.

- (b) *Quorum and voting.* Four SWU board members shall constitute a quorum of the SWU board necessary to take action and transact business. All actions shall require a simple majority of the number of SWU board members present.
- (c) *Removal from office.* The county council, by a simple majority vote, shall terminate the appointment of any member of the SWU board and appoint a new member for the following reasons:
1. Absent from more than one-third of the SWU board meetings per annum, whether excused or unexcused;
  2. Is no longer a resident of the county;
  3. Is convicted of a felony; or

4. Violated conflict of interest rules.

Moreover, a member shall be removed automatically for failing to attend any three consecutive regular meetings.

- (d) *Vacancy.* Whenever a vacancy occurs on the SWU board, the county council shall appoint a new member within 60 days of the vacancy, subject to the provisions of this section. A new member shall serve out the former member's term.
- (e) *Compensation.* The SWU board members shall serve without compensation, but may be reimbursed for such travel, mileage and/or per diem expenses as may be authorized by the county council-approved budget.

(5) *Responsibilities and duties.*

- (a) Review and recommend to the county council for approval, a comprehensive Beaufort County Stormwater Management Master Plan and appropriate utility rate study which is in accordance with the South Carolina Stormwater Management and Sediment Reduction Act; and
- (b) Review and comment to the county administrator on the annual stormwater management utility enterprise fund budget; and
- (c) Cooperate with the South Carolina Department of Health and Environmental Control (DHEC), Office of Coastal Resource Management (OCRM), the Oversight Committee of the Special Area Management Plan (SAMP), the Beaufort County Clean Water Task Force as well as other public and private agencies having programs directed toward stormwater management programs; and
- (d) Review and make recommendations concerning development of a multiyear stormwater management capital improvement project (CIP) plan; and
- (e) Review and advise on proposed stormwater management plans and procurement procedures; and
- (f) Provide review and recommendations on studies conducted and/or funded by the utility; and
- (g) Review and advise on actions and programs to comply with regulatory requirements, including permits issued under the State of South Carolina National Pollutant Discharge Elimination System (NPDES) general permit for stormwater discharges from regulated small municipal separate storm sewer systems (MS4).

(6) *Meetings.* Meetings of the SWU board shall be held as established by the SWU board and county staff on a quarterly and an as needed basis and a calendar will be prepared giving the date, time and location of such meetings. Additionally, meetings may be called by the chairperson or at the request of county staff. The location of all SWU board meetings shall be held in a public building in a place accessible to the public. The following shall apply to the conduct of all meetings:

- (a) *Meeting records.* The SWU board shall keep a record of meetings, resolutions, findings, and determinations. The SWU board may provide for transcription of such hearings and proceedings, or portions of hearings and proceedings, as may be deemed necessary.
- (b) *Open to public.* All meetings and public hearings of the SWU board shall be open to the public.
- (c) *Recommendations or decisions.* All recommendations shall be by show of hands of all members present. A tie vote or failure to take action shall constitute a denial recommendation. All recommendations shall be accompanied by a written summary of the action and recommendations.
- (d) *Notice and agenda.* The SWU board must give written public notice of regular meetings at the beginning of each calendar year. The SWU board must post regular meeting agendas at the meeting place 24 hours before any meeting. Notices and agenda for call, special or rescheduled meetings must

be posted at least 24 hours before such meetings. The SWU board must notify any persons, organizations and news media that request such notification of meetings.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

**Secs. 99-117—99-199. Reserved.**

### ***ARTICLE III. REGULATORY GENERAL PROVISIONS***

#### **Sec. 99-200. Authority.**

This article is adopted pursuant to the authority conferred upon the Beaufort County (county) by the South Carolina Constitution, the South Carolina General Assembly and in accordance with Federal Clean Water Act, the South Carolina Pollution Control Act, and regulations promulgated there under.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-201. Findings.**

The county council makes the following findings:

- (a) Beaufort County's waters contain some of the few remaining pristine shellfish harvesting areas in the southern coastal counties of South Carolina. Many of its waters have been designated by the State of South Carolina as Outstanding Resource Waters. This use has historical and traditional significance to the area. It is in the public interest that the condition of these areas be maintained and preserved for future generations. Uncontrolled stormwater runoff may have significant, adverse impact on the health, safety and general welfare of the county and the quality of life of its citizens by transporting pollutants into receiving waters and by causing erosion and/or flooding. Development and redevelopment may alter the hydrologic response of local watersheds and increases stormwater runoff rates and volumes, flooding, soil erosion, stream channel erosion, non-point pollution, and sediment transport and deposition, as well as reducing groundwater recharge. These changes in stormwater runoff may contribute to increased quantities of water-borne pollutants and alterations in hydrology which are harmful to public health, safety, and welfare, as well as to the natural environment.
- (b) Point source pollution may have significant, adverse impact on the health, safety and general welfare of the county and the quality of life of its citizens by transporting pollutants into receiving waters. The allowance of discharge pipes and outfalls for non-stormwater discharges, illegal dumping, and improper handling of accidental spills and intentional disposals increase the quantities of water-borne pollutants which are harmful to public health, safety, and welfare, as well as to the natural environment.
- (c) The effects of point and non-point source pollution, such as uncontrolled runoff, have shown evidence of degradation of the county's receiving waters; thereby adversely affecting the unique qualities of the county's receiving waters, its recreational opportunities and commercial, oystering, boating and fishing, the ecosystem's ability to naturally reproduce and thrive, and the general ability of the area to sustain its natural estuarine resources.
- (d) These deleterious effects can be managed and minimized by applying proper design and well-planned controls to manage stormwater runoff from development and redevelopment sites, manage existing natural features that maintain hydrology and provide water quality control, and eliminate potential sources of pollution to receiving waters. Public education regarding the cause and effect of these types

of pollutions and the implementation of the controls and management policies is key to fundamentally changing public behavior.

- (e) This article is not in conflict with any development agreements to which the county is a party and does not prevent the development set forth in any development agreement unless impairments to the county's receiving waters is linked to this development.
- (f) This article is essential to the public health, safety or welfare and shall apply to any development that is subject to a development agreement.
- (g) Laws of general application throughout the county necessary to protect health, safety and welfare are anticipated and are provided for in development agreements.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-202. Purpose.**

- (a) It is the purpose of this article to guide development in Beaufort County to protect, maintain, and enhance the environment of the county and the short- and long-term public health, safety, and general welfare of the citizens of the county by establishing requirements and procedures to control the potential adverse effects of increased stormwater runoff associated with both future development, re-development, and existing developed land. Proper management of stormwater runoff will minimize damage to public and private property, ensure a functional drainage system, reduce the effects of development on land and stream channel erosion, attain and maintain water quality standards, enhance the local environment associated with the drainage system, reduce local flooding, reduce pollutant loading to the maximum extent practicable and maintain to the extent practicable the pre-developed runoff characteristics of the area, and facilitate economic development while minimizing associated pollutant, flooding, and drainage impacts.
  - (b) This article specifically authorizes and enables the county to:
    - (1) Prohibit illicit discharges to the stormwater system and receiving waters.
    - (2) Define procedures for site plan design, review, inspection, and enforcement relative to stormwater management. Establish decision-making processes surrounding land development or redevelopment activities that protect the integrity of local aquatic resources.
    - (3) Control the discharge of spills, dumping or disposal of materials other than stormwater to the stormwater system and receiving waters.
    - (4) Address specific categories of non-stormwater discharges and similar other incidental non-stormwater discharges.
    - (5) Control importation of water that adversely impacts our receiving waters.
    - (6) Require temporary erosion and sediment controls to protect water quality to the maximum extent practicable during construction activities, in accordance with current state regulations.
    - (7) Define procedures for receipt and consideration of information submitted by the public.
    - (8) Address runoff, particularly volume, rate, and quality through the control and treatment of stormwater with stormwater management facilities and/or best management practices (BMPs).
    - (9) Develop post-construction stormwater quality performance standards, through enforcement of minimum design standards for BMPs.
    - (10) Ensure effective long-term operation and maintenance of BMPs.



- (11) Carry out all inspection, surveillance, monitoring, and enforcement procedures necessary to determine compliance and noncompliance with this article and stormwater permit conditions including the prohibition of illicit discharges to the county's stormwater system and the protection of water quality of the receiving waters.
  - (12) Development, implement, and enforce regulations any and all other programs or policies to comply with the Municipal Separate Stormsewer System (MS4) permit issued by South Carolina Department of Health and Environmental Control (DHEC).
  - (13) Establish design criteria in the most current version of the Southern Lowcountry Stormwater Design Manual for structural and nonstructural stormwater management practices that can be used to meet the minimum post-development stormwater management standards and design criteria;
  - (14) Establish that Better Site Design (BSD) and site planning has been incorporated, documented, and presented in the development/redevelopment design process.
  - (15) Maintain structural and nonstructural stormwater management practices to ensure that they continue to function as designed and pose no threat to public safety.
  - (16) Streamline administrative procedures for the submission, review, approval and disapproval of stormwater management plans and for the inspection of approved land development projects.
  - (17) If any of the stormwater management standards, as defined in this chapter and in the most current version of the Southern Lowcountry Stormwater Design Manual cannot be attained on the site (due to impractical site characteristics or constraints), a maximum extent practicable analysis shall be prepared and submitted by the applicant for review, discussion, and ultimate approval or rejection of the jurisdiction. Any uncontrolled post-development stormwater quantity or quality volume shall be intercepted and treated in one or more off-site stormwater management practices or a fee-in-lieu shall be required.
  - (18) The stormwater management practices of approved plans shall provide volume control and at least an 80 percent reduction in total suspended solids loads, 30 percent reduction of total nitrogen load, and 60 percent reduction in bacteria load.
  - (c) The article requires prudent site planning, including special considerations for the purposes of preserving natural drainage ways incorporating on-site stormwater detention and infiltration to minimize runoff from individual sites to receiving waters by use of effective runoff management, structural and non-structural BMPs, drainage structures, and stormwater facilities. Establish that better site design (BSD) and site planning has been incorporated, documented, and presented in the development/redevelopment design process.
- ( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

## Sec. 99-203. Definitions.

The following definitions shall apply in articles III, IV, V, and VI this chapter. Any term not herein defined shall be given the definition, if any, as is found elsewhere in the Code of Ordinances of Beaufort County, including the community development code (CDC) ordinance.

*Administrators.* The public works director, the stormwater manager and other individuals designated by the county administrator, from time to time, to administer interpret and enforce this article.

*Best management practices ("BMP").* Stormwater management practices, either structural, non-structural or natural that has been demonstrated to effectively control movement of stormwater, pollutants, prevent degradation of soil and water resources, and that are compatible with the planned land use.

*Clean Water Act.* The Federal Water Pollution Control Act, as amended, codified at 33 U.S.C § 1251 et seq.

*Community development code ("CDC").* A form based code to regulate zoning and development in Beaufort County.

*County.* The Beaufort County, South Carolina.

*County council.* The publicly elected official of Beaufort County, South Carolina.

*Department.* The stormwater department, or any duly authorized representatives thereof as designated by the county administrator.

*Development.* All project construction, modification, or use of any lot, parcel, building, or structure on land and on water. Existing dirt roads which are improved and/or paved as part of Beaufort County's Dirt Road Paving Program as set forth in Beaufort County Policy Statement 15 and Policy Statement 17 and existing private dirt roads which are improved or paved and where the project is not related to a pending or proposed development of adjacent land are deemed not to constitute "development".

*Disconnected impervious areas or disconnected impervious surfaces.* Those non-contiguous impervious areas or impervious surfaces which produce stormwater runoff that discharges through or across a pervious area or surface (i.e. vegetated cover), of sufficient width to reduce or eliminate pollutants associated with stormwater runoff, prior to discharge to the stormwater system.

*Environment.* The complex of physical, chemical, and biotic factors that act upon an ecological community and ultimately determine its form and survival.

*Evapotranspiration.* The sum of evaporation and plant transpiration from the earth's land surface to atmosphere.

*Excess stormwater volume.* The additional volume of stormwater runoff leaving the site over and above the runoff volume which existed pre-development.

*Illicit connection.* A connection to the county's stormwater system or receiving water which results in a discharge that is not composed entirely of stormwater runoff and has a detrimental effect on the stormwater system or receiving water except, those granted coverage by an active NPDES permit.

*Illicit discharge.* Any activity, which results in a discharge to the county's stormwater system or receiving waters that is not composed entirely of stormwater except:

- (a) Discharge pursuant to an NPDES permit; and
- (b) Other allowable discharges as defined and exempted in this article.

*Impervious surface.* As defined in the county's best management practices (BMP) manual.

*Improper disposal.* Any disposal through an illicit discharge, including, but not limited to, the disposal of used oil and toxic materials resulting from the improper management of such substances.

*Land disturbance or land disturbing activity.* The use of land by any person that results in a change in the natural vegetated cover or topography, including clearing that may contribute to or alters the quantity and/or quality of stormwater runoff.

*Maintenance.* Any action necessary to preserve stormwater management facilities in proper working condition, in order to serve the intended purposes set forth in this article and to prevent structural failure of such facilities.

*MS4.* Municipal separate storm sewer system.

*NPDES.* National Pollutant Discharge Elimination System (see "Clean Water Act.")

*Natural resources.* Land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources.

*Outfall.* The point where county's stormwater system discharges to waters of the United States or the State of South Carolina.

*Person.* Any and all persons, natural or artificial and includes any individual, association, firm, corporation, business trust, estate, trust, partnership, two or more persons having a joint or common interest, or an agent or employee thereof, or any other legal entity.

*Pollutant.* Those manmade or naturally occurring constituents that when introduced to a specific environment creates a deleterious effect. Typical pollutants found in stormwater include, but are not limited to, sediment (suspended and dissolved), nutrients (nitrogen and phosphorus, etc.), oxygen demanding organic matter, heavy metals (iron, lead, manganese, etc.), bacteria and other pathogens, oil and grease, household hazardous waste (insecticide, pesticide, solvents, paints, etc.) and polycyclic aromatic hydrocarbons (PAHs).

*Property owner or owner.* The legal or equitable owner of land.

*Receiving waters.* All natural water bodies, including oceans, salt and freshwater marsh areas, lakes, rivers, streams, ponds, wetlands, and groundwater which are located within the jurisdictional boundaries of the county. Stormwater management ponds, manmade wetlands, ditches, and swales constructed for the sole purpose of controlling and treating stormwater are not considered receiving waters.

*Record drawings.* A set of drawings prepared by and certified by a South Carolina registered professional engineer or landscape architect that accurately represents the actual final configuration of the stormwater and other related infrastructure constructed in a development.

*Redevelopment.* As defined in the county's best management practices (BMP) manual.

*Regulation.* Any regulation, rule or requirement and promulgated by the county pursuant to this article.

*Southern Lowcountry Stormwater Design Manual.* "The Manual for Stormwater Best Management and Design Practices (BMP)" establishes technical standards as referenced and incorporated into the community development code (CDC).

*Stormwater.* Stormwater runoff, precipitation runoff, and surface runoff.

*Stormwater management.* The collection, conveyance, storage, treatment and disposal of stormwater in a manner to meet the objectives of this article and its terms, including, but not limited to, measures that control the increased volume and rate of stormwater runoff and water quality impacts caused by manmade changes to the land.

*Stormwater management program, services, systems facilities.* Those administrative, engineering, operational, regulatory, and capital improvement activities and functions performed in the course of managing the stormwater systems of the county, plus all services. Stormwater management systems and facilities are those natural and manmade channels, swales, ditches, swamps, rivers, streams, creeks, branches, reservoirs, ponds, drainage ways, inlets, catch basins, pipes, head walls, storm sewers, lakes, and other physical works, properties, and improvements which transfer, control, convey or otherwise influence the movement of stormwater runoff and its discharge to and impact upon receiving waters.

*Stormwater management plan or SWMP.* The set of drawings and other documents that comprise all of the information and specifications for the programs, drainage systems, structures, BMPs, concepts, and techniques for the control of stormwater.

*Stormwater pollution prevention plan or SWPPP.* Erosion prevention and sediment control (EPSC). Also see "stormwater management plan".

*Stormwater system.* The conveyance or system of conveyances (including roads with drainage systems, highways, right-of-way, private streets, catch basins, curbs, gutters, ditches, manmade channels, storm drains, detention ponds, and other stormwater facilities) which is designed or used for collecting or conveying stormwater.

*Structural best management practices ("BMP").* A device designed and constructed to trap and filter pollutants from runoff.

*Total impervious surface.* All impervious surfaces on a site regardless if they are directly connected to another and that is not constructed using permeable pavement technology.

*Utility.* Beaufort County Stormwater Utility as established by county article chapter 99, article II.

*Waiver.* The modification of the minimum stormwater management requirements contained in these articles and the [most current version of the](#) Southern Lowcountry Stormwater Design Manual for specific circumstances where strict adherence of the requirements would result in unnecessary hardship and not fulfill the intent of this article.

*Water quality.* Those characteristics of stormwater runoff that relate to the physical, chemical, biological, or radiological integrity of water.

*Water quantity.* Those characteristics of stormwater runoff that relate to the rate and volume of the stormwater runoff.

*Wetlands.* As defined by the Army Corps of Engineers and generally means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar type areas.

*Working day.* Monday through Friday, excluding all county-observed holidays.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2018/6 , 3-12-2018; Ord. No. 2020/18 , 5-26-2020; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-204. Applicability.**

Beginning with and subsequent to its effective date, this article shall be applicable to:

- (a) All development and redevelopment.
- (b) Any illicit discharges.
- (c) The provisions of this article shall apply throughout the unincorporated areas of the county.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-205. Regulations.**

The county council, may, in its discretion, amend or change this article, or adopt additional regulations to implement this article in order to comply with the state regulations, administer the stormwater management department, or to otherwise further the goal of protecting the quality of the receiving waters into which the stormwater system discharges.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-206. County stormwater management administration.**

Stormwater management will be administered by the public works department and the stormwater department to administer and implement the regulations of this article as set forth in the [most current version of the](#) Southern Lowcountry Stormwater Design Manual. The manual may include design standards, procedures and

criteria for conducting hydrologic, hydraulic, pollutant load evaluations, and downstream impact for all components of the stormwater management system. It is the intention of the manual to establish uniform design practices; however, it neither replaces the need for engineering judgment nor precludes the use of information not submitted. Other accepted engineering procedures may be used to conduct hydrologic, hydraulic and pollutant load studies if approved by the public works director.

The manual will contain at a minimum the following components:

- (a) Construction activity application contents and approval procedures;
- (b) Construction completion and closeout processes;
- (c) Hydrologic, hydraulic, and water quality design criteria (i.e., design standards) for the purposes of controlling the runoff rate, volume, and pollutant load. Suggested reference material shall be included for guidance in computations needed to meet the design standards;
- (d) Information and requirements for new and re-development projects in special protection areas necessary to address TMDLs, known problem areas and other areas necessary to protect, maintain, and enhance water quality and the environment of Beaufort County and the public health, safety, and general welfare of the citizens of Beaufort County.
- (e) Construction document requirements;
- (f) Long-term maintenance and maintenance plan;
- (g) Minimum easement requirements;
- (h) Required and recommended inspection schedules and activities for all components of the stormwater management system, including construction related BMPs.

The manual will be updated periodically to reflect the advances in technology and experience.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2020/18 , 5-26-2020; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-207. Administrators of operations, power and duties.**

- (a) The administrators, or designee, shall administer, implement, and enforce provisions of this article on behalf of the county.
- (b) In addition to the powers and duties that may be conferred by other provisions of the county and other laws, the administrators shall have the following powers and duties under this article:
  - (1) To create the Southern Lowcountry Stormwater Design Manual. The manual may be used to convey design and engineering standards, construction management processes and procedures, and other aspects necessary for compliance with this chapter;
  - (2) To review and approve, approve with conditions, or disapprove applications for approval of a stormwater management plan pursuant to this article;
  - (3) To make determinations and render interpretations of this article;
  - (4) To establish application requirements, schedules and fees for submittal and review of applications, receipt of appeals, in accordance with the standards for county development permits and stormwater permits under the county's CDC ordinance and this article;
  - (5) To review and make recommendations to the applications for development or redevelopment approvals;
  - (6) To enforce the provisions of this article in accordance with its enforcement provisions;

- (7) To maintain records, maps, and official materials related enforcement, or administration of this article;
  - (8) To provide expertise and technical assistance;
  - (9) To take any other action necessary to administer the provisions of this article.
- ( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-208. Coordination with other agencies.**

The administrators will coordinate the county's activities with other federal, state, and local agencies, which manage and perform functions relating to the protection of receiving waters.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-209. Cooperation with other governments.**

The county may enter into agreements with other governmental and private entities to carry out the purposes of this article. These agreements may include, but are not limited to, enforcement, resolution of disputes, cooperative monitoring, and cooperative management of stormwater systems and cooperative implementation of stormwater management programs.

Nothing in this article or in this section shall be construed as limitation or repeal of any ordinances of these local governments or of the powers granted to these local governments by the South Carolina Constitution or statutes, including, without limitation, the power to require additional or more stringent stormwater management requirements within their jurisdictional boundaries.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-210. Stormwater management standards.**

- (a) Reference to best management practices can be found in the most current version of the Southern Lowcountry Stormwater Design Manual. The administrators shall use the policy, criteria, and information, including technical specifications and standards, in the most current version of the Southern Lowcountry Stormwater Design Manual as the basis for decisions about stormwater plans and about the design, implementation and performance of structural and non-structural stormwater systems. The stormwater management standards shall describe in detail how post-development stormwater runoff will be controlled and managed, the design of all stormwater facilities and practices, and how the proposed project will meet the requirements of this article. The most current version of the Southern Lowcountry Stormwater Design Manual includes a list of acceptable stormwater treatment practices, including the specific design criteria for each stormwater practice. These standards will be updated as technology improves.
- (b) Relationship of stormwater management standards to other laws and regulations. If the specifications or guidelines of the standards are more restrictive or apply a higher standard than other laws or regulations, that fact shall not prevent application of the specifications or guidelines in the standards.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-211. Review of stormwater management plans.**

Stormwater management plans shall be reviewed as a component of the development plan review process by the administrators. They will be reviewed for compliance with standards in this article and requirements in the

CDC and [the most current version of the](#) Southern Lowcountry Stormwater Design Manual Procedures are outlined in [the most current version of the](#) Southern Lowcountry Stormwater Design Manual. Requests for meetings and submission of plans will be submitted to stormwater department. The expected process will be in accordance with the standard procedures for applications described in the community development code.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-212. Approvals.**

- (a) *Effect of approval.* Approval authorizes the applicant to go forward with only the specific plans and activity authorized in the plan. The approval shall not be construed to exempt the applicant from obtaining other applicable approvals from local, state, and federal authorities.
- (b) *Time limit/expiration.* Time limit, expiration and extensions shall be in accordance with the county's community development code.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-213. Appeals.**

- (a) *Scope of appeal.* Any person aggrieved by a decision of the administrators may appeal the same by filing an interim written notice of appeal, with the administrators within 30 days of the issuance of said decision or notice of violation. The interim notice of appeal must specify with reasonable practicality the grounds of the appeal and relief sought. The stormwater management utility board (SWUB) will review and provide a decision within 15 days after the next scheduled board meeting following the appeal. The decision of the SWUB shall be final. Appeals to SWUB's decision shall be processed in accordance with state law.
- (b) *Standards.*
  - (1) The SWUB is limited to the following determinations for an administrative appeal:
    - a. The administrators made an error in reviewing whether a standard was met. The record must indicate that an error in judgment occurred or facts, plans, or regulations were misread in determining whether the particular standard was met.
    - b. Where conflicting evidence exists, the appeal is limited to determining what evidence or testimony bears the greatest credibility in terms of documentation and qualifications of those making the determination.
    - c. The administrators made the decision on standards not contained in this chapter or other county ordinances, regulations, or state law, or a standard more strict or broad was applied. This chapter does not permit administrators to consider or create standards not officially adopted.
    - d. An error in applying a standard or measuring a standard was made.
  - (2) The board, on an appeal, shall not hear any evidence or make any decision based on financial hardships.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Secs. 99-214—99-299. Reserved.**

## **ARTICLE IV. STORMWATER MANAGEMENT STANDARDS TO BE APPLIED**

### Sec. 99-300. General requirements.

- (a) All development and redevelopment, including highways, shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume and duration of flow.
- (b) All development shall connect impervious surfaces to vegetative surfaces to the maximum extent practicable.
- (c) Stormwater runoff shall be controlled in a manner that:
  - (1) Promotes positive drainage from structures resulting from development.
  - (2) Includes the use of vegetated conveyances, such as swales and existing natural channels to promote infiltration and evapotranspiration.
  - (3) Reduces runoff velocities and maintains sheet flow condition to prevent erosion and promote infiltration.
  - (4) Limits its interaction with potential pollutant sources that may become water-borne and create non-point source pollution.
  - (5) Promotes reuse of excess stormwater volume to increase evapotranspiration.
- (d) Natural vegetative buffers play an integral part in minimizing the volume of stormwater runoff by promoting infiltration and increasing evapotranspiration to reduce stormwater volume to receiving waters and acting as a first line of treatment of water quality pollution. Development shall observe the buffer requirements of the county's CDC ordinance or if applicable the relevant development agreement, concept plan, and/or approved master plan.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### Sec. 99-301. Stormwater design requirements for development.

Developments which incorporates engineered stormwater collection, conveyance, and storage systems shall be designed to the criteria established in the ~~latest-most current~~ version of county's Southern Lowcountry Stormwater Design Manual.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### Sec. 99-302. BMP requirements.

- (a) Effectiveness of infiltration practices is dependent on the site conditions. The most current version of the Southern Lowcountry Stormwater Design Manual outlines guidance for properly siting infiltration practices and shall be reviewed prior to the design phase.
- (b) The owners of all new developments that receive a stormwater permit from the county shall be required to perform stormwater quantity monitoring at their expense to ensure compliance with the provisions of this article and ensure that volume reduction plans are operated as intended.
- (c) All construction and implementation of erosion and sediment control BMPs shall comply with the requirements of the South Carolina Stormwater Management and Sediment Reduction Act and submit reports in accordance with the most current version of the Southern Lowcountry Stormwater Design Manual.



- (d) The county reserves the right to perform other monitoring as it deems appropriate to determine compliance with the State Sediment and Erosion Control Act.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-303. Reserved.**

( Ord. No. 2016/38 , 10-24-2016)

### **Sec. 99-304. Waiver.**

Individuals seeking a waiver in connection with a stormwater plan may submit to the public works director a request for a waiver from the requirements of this article if exceptional circumstances applicable to a site exist, such that the applicant can provide rational documentation and justification to support a waiver.

Waivers may be granted for water quantity control only and best management practices to achieve water quality goals will still be required.

- (a) *Request of waiver at staff level.* A written request for a waiver is required and shall state the specific waiver sought and the reasons, with supporting data, a waiver should be granted. The request shall include all information necessary to evaluate the proposed waiver. Requests must outline the need for such a waiver, such as site constraints, soil characteristics, or similar engineering limitations. Cost shall not be considered cause for a waiver. The applicant will address the four areas of consideration for waiver approval as follows:
  - (1) What exceptional circumstances to the site are evident?
  - (2) What unnecessary hardship is being caused?
  - (3) How will denial of the waiver be inconsistent with the intent of the ordinance?
  - (4) How will granting waiver comply with intent of ordinance?
- (b) *Review of waivers.* The administrators will conduct a review of the request and will issue a decision within 15 working days of receiving the request.
- (c) *Appeal of decision.* Any person aggrieved by the decision of the administrators concerning a waiver request may appeal such decision in accordance with section 99-213 above.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-305. Maintenance; general requirements.**

- (a) *Function of BMPs as intended.* The owner of each structural BMP installed pursuant to this article shall maintain and operate it to preserve and continue its function in controlling stormwater quality and quantity at the degree or amount of function for which the structural BMP was designed.
- (b) *Right of county to inspection.* Every structural BMP installed pursuant to this article shall be made accessible for adequate inspection by the county.
- (c) *Annual maintenance inspection and report.* The person responsible for maintenance of any structural BMP installed pursuant to this article shall submit to the administrator(s) an inspection report from a qualified inspector or registered South Carolina Professional Engineer. The inspection report, at a minimum, shall contain all of the following:

- (1) The name and address of the land owner;
- (2) The recorded book and page number of the lot of each structural BMP or a digital representation of the geographic location of each structural BMP;
- (3) A statement that an inspection was made of all structural BMPs;
- (4) The date the inspection was made;
- (5) A statement that all inspected structural BMPs are performing properly and comply with the terms and conditions of the approved maintenance agreement required by this article;
- (6) The original signature and seal of the engineer inspecting the structural BMPs; and
- (7) Digital photographs of the structural BMPs and pertinent components integral to its operation, including, but not limited to, inlet/outlet control structures, downstream receiving channel/area, embankments and spillways, safety features, and vegetation.

An original inspection report shall be provided to the administrators beginning one year from the date of final inspection of the completed structural BMP and each year thereafter on or before the date of the record drawings certification.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-306. Operation and maintenance agreement.**

- (a) Prior to the conveyance or transfer of any lot or building site requiring a structural BMP pursuant to this article, the applicant or owner of the site must execute an operation and maintenance agreement (see [the most current version of the](#) Southern Lowcountry Stormwater Design Manual for form) that shall be binding on all subsequent owners of the site, portions of the site, and lots or parcels served by the structural BMP. Until the transference of all property, sites, or lots served by the structural BMP, the original owner or applicant shall have primary responsibility for carrying out the provisions of the maintenance agreement.
- (b) The operation and maintenance agreement must be approved by the administrators prior to plan approval, and it shall be referenced on the final plat and shall be recorded with the county register of deeds upon final plat approval. If no subdivision plat is recorded for the site, then the operations and maintenance agreement shall be recorded upon the approval of a certificate of completion with the county register of deeds to appear in the chain of title of all subsequent purchasers under generally accepted searching principles. A copy of the recorded maintenance agreement shall be given to the administrators within 14 days following its recordation.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-307. Deed recordation and indications on plat.**

The applicable operations and maintenance agreement pertaining to every structural BMP shall be referenced on the final plat and in covenants and shall be recorded with the county register of deeds upon final plat approval.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-308. Records of installation and maintenance activities.**

The owner of each structural BMP shall keep records of inspections, maintenance, and repairs for at least five years from the date of the record and shall submit the same upon reasonable request to the administrator(s).  
( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-309. Nuisance.**

The owner of each stormwater BMP shall maintain it so as not to create or result in a nuisance condition, such as, but not limited to, flooding, erosion, excessive algal growth, overgrown vegetation, mosquito breeding habitat, existence of unsightly debris, or impairments to public safety and health. Maintenance practices must not lead to discharges of harmful pollutants.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Secs. 99-310—99-399. Reserved.**

## ***ARTICLE V. ILLICIT DISCHARGES AND CONNECTIONS TO THE STORMWATER SYSTEM***

### **Sec. 99-400. Illicit discharges.**

No person shall cause or allow the discharge, emission, disposal, pouring, or pumping directly or indirectly to any stormwater conveyance, receiving water, or upon the land in manner and amount that the substance is likely to reach a stormwater conveyance or the receiving waters, any liquid, solid, gas, or other substance (including animal waste), other than stormwater.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-401. Non-stormwater discharges.**

(a) Non-stormwater discharges associated with the following activities are allowed provided that acceptable BMPs are followed:

- (1) Water line and hydrant flushing;
- (2) Landscape irrigation, unless it leads to excess SW volume discharge;
- (3) Diverted stream flows;
- (4) Rising ground waters;
- (5) Uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20));
- (6) Uncontaminated pumped ground water;
- (7) Discharges from potable water sources (with dechlorination BMP utilized);
- (8) Foundation drains;
- (9) Air conditioning condensation;

- (10) Reuse water;
  - (11) Springs;
  - (12) Water from crawl space pumps;
  - (13) Footing drains;
  - (14) Individual residential car washing;
  - (15) Flows from riparian habitats and wetlands;
  - (16) Dechlorinated swimming pool discharges: typically less than one part per million;
  - (17) Street wash water;
  - (18) Other non-stormwater discharge permitted under an NPDES permit, waiver, or waste discharge order issued to the discharger and administered under EPA authority, provided that the discharger is in full compliance with all requirements of the permit, waiver, or order and other applicable laws and regulations, and provided that written approval has been granted for any discharge to the storm drain system;
  - (19) Discharges specified in writing by the authorized agency/entity, as being necessary to protect public health and safety;
  - (20) Dye testing is an allowable discharge, but requires a verbal notification to the authorized enforcement agency prior to the test; and
  - (21) Firefighting.
  - (22) The public works director may develop procedures for allowing other non-stormwater discharges.
- (b) Prohibited substances include, but are not limited to: Oil, anti-freeze, chemicals, animal waste, paints, garbage, and litter.
- ( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-402. Illicit connections.**

- (a) Connections to a receiving water and/or stormwater conveyance system that allow the discharge of non-stormwater, other than the exclusions described in subsection 99-401(a) above are unlawful. Prohibited connections include, but are not limited to, floor drains, waste water from washing machines or sanitary sewers, wash water from commercial vehicle washing or steam cleaning, and waste water from septic systems.
  - (b) Where such connections exist in violation of this section and said connections were made prior to the adoption of this article or any other article prohibiting such connections, the property owner or the person using said connection shall remove or correct the connection immediately upon notice.
- ( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-403. Spills.**

- (a) Spills or leaks of polluting substances released, discharged to, or having the potential to released or discharged to a receiving water or the stormwater conveyance system, shall be immediately contained, controlled, collected, and properly disposed. All affected areas shall be restored to their preexisting condition.

- (b) Persons in control of the polluting substances shall immediately report the release or discharge to persons owning the property on which the substances were released or discharged, shall within two hours of such an event notify the nearest fire department (which will also notify the administrators), and all required federal and state agencies of the release or discharge. Notification shall not relieve any person of any expenses related to the restoration, loss, damage, or any other liability which may be incurred as a result of said spill or leak, nor shall such notification relieve any person from other liability which may be imposed by state or other law.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-404. Nuisance.**

Illicit discharges and illicit connections which exist within the unincorporated county are hereby found, deemed, and declared to be dangerous and prejudicial to the public health, and welfare, and are found, deemed, and declared to be public nuisances. Such public nuisances shall be abated in accordance with the procedures set forth in subsection 99-503(c) and (d).

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-405. Suspension of a MS4 discharge due to an illicit discharge.**

- (a) Any person discharging to the MS4 in violation of this article may have their MS4 access terminated if such termination would abate or reduce an illicit discharge. The authorized administrators notify a violator of the proposed termination of its MS4 access. The violator may petition the authorized enforcement agency for a reconsideration and hearing.
- (b) A person commits a violation if the person reinstates MS4 access to premises terminated pursuant to this section, without the prior approval of the authorized administrators.
- (c) The Beaufort County, South Carolina administrators may, without prior notice, suspend MS4 discharge access to a person when such suspension is necessary to stop an actual or threatened discharge that presents or may present imminent and substantial danger to the environment, or to the health or welfare of persons, or to the MS4 or waters of the United States. If the violator fails to comply with a suspension order issued in an emergency, the authorized enforcement agency may take such steps as deemed necessary to prevent or minimize damage to the MS4 or waters of the United States, or to minimize danger to persons.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Secs. 99-406—99-499. Reserved.**

### ***ARTICLE VI. INSPECTION, ENFORCEMENT, AND CORRECTION***

#### **Sec. 99-500. Inspections.**

The county administrators will maintain the right to inspect any and all stormwater systems within its jurisdiction as outlined below:

- (a) An inspector designated by the administrators, bearing proper credentials and identification, may enter and inspect all properties for regular inspections, periodic investigations, monitoring, observation

measurement, enforcement, sampling and testing, to ensure compliance with the provisions of this article.

- (b) Upon refusal by any property owner to permit an inspector to enter or continue an inspection, the inspector may terminate the inspection or confine the inspection to areas concerning which no objection is raised. The inspector shall immediately report the refusal and the grounds to the administrators. The administrators will promptly seek the appropriate compulsory process.
- (c) In the event that the administrators or inspector reasonably believes that discharges from the property into the county's stormwater system or receiving waters may cause an imminent and substantial threat to human health or the environment, the inspection may take place at any time after an initial attempt to notify the owner of the property or a representative on site. The inspector shall present proper credentials upon reasonable request by the owner or representative.
- (d) The Beaufort County, South Carolina, administrators shall have the right to set up on any permitted facility such devices as are necessary in the opinion of the authorized enforcement agency to conduct monitoring and/or sampling of the facility's stormwater discharge.
- (e) The Beaufort County, South Carolina, administrators have the right to require the discharger to install monitoring equipment as necessary. The facility's sampling and monitoring equipment shall be maintained at all times in a safe and proper operating condition by the discharger at its own expense. All devices used to measure stormwater flow and quality shall be calibrated to ensure their accuracy.
- (f) Any temporary or permanent obstruction to safe and easy access to the facility to be inspected and/or sampled shall be promptly removed by the operator at the written or oral request of the authorized administrators and shall not be replaced. The costs of clearing such access shall be borne by the operator.
- (g) Unreasonable delays in allowing the Beaufort County, South Carolina, administrators access to a permitted facility is a violation of a stormwater discharge permit and of this article. A person who is the operator of a facility with a NPDES permit to discharge stormwater associated with industrial activity commits an offense if the person denies the authorized enforcement agency reasonable access to the permitted facility for the purpose of conducting any activity authorized or required by this article.
- (h) Inspection reports will be maintained in a permanent file at the offices of the administrators.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-501. Notice and warning.**

- (a) Upon the county's attention to a violation of this article, the administrators shall investigate the violation and prepare a report concerning the violation. If a violation exists, a notice of violation shall be delivered within five working days to any person occupying the property or linked to a discharge, whether the person is the owner, renter, or lessee. If the nature of the violation is not correctable, a stop work order shall be issued immediately. If no one is present or refuses to accept the notice, the administrators shall post the notice of violation on the residence or building entrance.
- (b) The notice of violation shall contain the following:
  - (1) The address and tax ID number of the property.
  - (2) The section of this chapter being violated.
  - (3) The nature and location of the violation and the date by which such violation shall be removed or abated.

- (4) A notice of the penalty for failing to remove or abate the violation, stating that if the nuisance recurs by the same apparent occupant, owner, or person in charge, a notice of violation, stop work order, or notice to appear will be issued without further notice.
  - (5) The notice shall specify the number of days in which the violation shall be removed or abated, which time shall be not less than three days nor more than ten days, except in emergency cases.
  - (c) If the violation occurs where the residence or building is unoccupied, the property may be posted as provided in this section. If the property is unimproved, the notice may be placed on a tree, a stake, or other such object as available.
  - (d) A written notice containing the same information as the notice of violation shall be sent to the owner or any other person having control of the property at the last known address of the owner, or at the address of the person having control, by U.S. mail or email.
- ( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-502. Recurring violations.**

Once a notice has been delivered pursuant to this article and the same violation recurs on the same lot or tract of land by the same person previously responsible, no further notice of violation need be given. Each day a violation continues after the expiration of the warning period to abate such a violation shall constitute a separate offence. Thereafter, the county may issue a stop work order, or such person deemed responsible may be notified to appear in court to answer to the charge against such person.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-503. Failure to act upon notice of violation.**

Upon neglect or failure to act upon the notice of violation, and/or stop work order given as provided in sections 99-501 and 99-502, the county shall issue a notice to appear and shall follow the procedures as follows:

- (a) *Service of notice to appear.* If a stop work order is given and, after the time for removal or abatement has lapsed, the property is reinspected and the administrator or designee finds and determines the violation has not been removed or abated, the administrator or designee shall fill out and sign, as the complainant, a complaint and information form or a notice to appear. The notice to appear shall include the following:

- (1) Name of the occupant, owner, or person in charge of the property.
- (2) The address or tax ID number of the property on which the violation is occurring.
- (3) This chapter section or other reference the action or condition violates.
- (4) The date on which the case will be on the court docket for hearing.
- (5) Any other information deemed pertinent by the county official.

The original copy of the notice to appear shall be forwarded to the clerk of the court for inclusion on the court's docket for the date indicated on the notice to appear.

- (b) *Notice to appear; delivery by mail.* If no one is found at the property to accept a notice to appear for failure to remove or abate a violation, the administrator or designee shall fill out and sign the notice to appear as the complainant and deliver the original plus one copy to the clerk of the court. The clerk shall verify or insert the date the case has been set for hearing before the court. The clerk shall mail the copy by certified mail to the person named in the notice to appear at that person's last known address.

- (c) *Abatement by county; costs assessed to person responsible.* If the occupant, owner, or person in charge of the property for which a warning notice has been given fails to remove or abate the violation in the time specified in the notice, whether on public or private property, the administrator or designee may, if severe conditions exist that affect health, welfare, safety or severe environmental degradation, remove the violation and thereby abate the violation. If such conditions exist, the administrator or designee may lawfully enter upon the property on which the violation remains unabated to remove or abate such violation at the cost of the person responsible for creating or maintaining the violation. The violation will be subject to civil fines reflecting the cost to the county, as prosecuted by the county attorney.
- (d) *Payment of costs; special tax bill or judgment.* All costs and expenses incurred by the county in removing or abating any violation on any private property may be assessed against the property as a lien on the property. Alternatively, the cost of removing or abating the violation may be made part of the judgment by the judge, in addition to any other penalties and costs imposed if the person charged either pleads or is found guilty of causing, creating, or maintaining a violation.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-504. Penalty for violation.**

- (a) Enforcement of this article shall fall under the jurisdiction of both the Beaufort County Public Works Department and Beaufort County Codes Enforcement. Officers and inspectors shall have the authority to exercise full discretion in deciding whether to issue a notice of violation, stop work order, or fine when investigating complaints that arise under this article.
- (b) Any person, group, firm, association, or corporation violating any section of this chapter, or the requirements of an approved Beaufort County Stormwater Permit, shall be guilty of a misdemeanor and, upon conviction thereof, shall pay such penalties as the court may decide, as prescribed by state law, not to exceed \$1000.00 or 30 days' imprisonment for each violation. Each day during which such conduct shall continue shall subject the offender to the liability prescribed in this article.
- (c) In addition to the penalties established and authorized in subsection (a) of this section, the county attorney may take other actions at law or in equity as may be required to halt, terminate, remove, or otherwise eliminate any violations of this chapter.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-505. Interpretation.**

- (a) *Meaning and intent.* All provisions, terms, phrases, and expressions contained in this article shall be construed according to the general and specific purposes set forth in section 99-202, purpose. If a different or more specific meaning is given for a term defined elsewhere in county's Code of Ordinances or in an existing development agreement, the meaning and application of the term in this article shall control for purposes of application of this article.
- (b) *Text controls in event of conflict.* In the event of a conflict or inconsistency between the text of this article and any heading, caption, figure, illustration, table, or map, the text shall control.
- (c) *Authority for interpretation.* The administrators have, after consultation with county attorney, authority to determine the interpretation of this article. Any person may request an interpretation by submitting a written request to the administrators who shall respond in writing within 30 days. The administrators shall keep on file a record of all written interpretations of this article.



- (d) *References to statutes, regulations, and documents.* Whenever reference is made to a resolution, article, statute, regulation, manual (including the most current version of the Southern Lowcountry Stormwater Design Manual), or document, it shall be construed as a reference to the most recent edition of such that has been finalized and published with due provision for notice and comment, unless otherwise specifically stated.
- (e) *Delegation of authority.* Any act authorized by this article to be carried out by the county administrator may be carried out by his or her designee.
- (f) *Usage.*
- (1) *Mandatory and discretionary terms.* The words "shall," "must," and "will" are mandatory in nature, establishing an obligation or duty to comply with the particular provision. The words "may" and "should" are permissive in nature.
  - (2) *Conjunctions.* Unless the context clearly indicates the contrary, conjunctions shall be interpreted as follows: The word "and" indicates that all connected items, conditions, provisions or events apply. The word "or" indicates that one or more of the connected items, conditions, provisions or events apply.
  - (3) *Tense, plurals, and gender words used in the present tense include the future tense.* Words used in the singular number include the plural number and the plural number includes the singular number, unless the context of the particular usage clearly indicates otherwise. Words used in the masculine gender include the feminine gender, and vice versa.
- (g) *Measurement and computation.* Lot area refers to the amount of horizontal land area contained inside the lot lines of a lot or site.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-506. Conflict of laws.**

This article is not intended to modify or repeal any other ordinance, rule, regulation or other provision of law. The requirements of this article are in addition to the requirements of any other ordinance, rule, regulation or other provision of law, and where any provision of this article imposes restrictions different from those imposed by any other ordinance, rule, regulation or other provision of law, whichever provision is more restrictive or imposes higher protective standards for human or environmental health, safety, and welfare, shall control.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-507. Severability.**

If the provisions of any section, subsection, paragraph, subdivision or clause of this article shall be adjudged invalid by a court of competent jurisdiction, such judgment shall not affect or invalidate the remainder of any section, subsection, paragraph, subdivision or clause of this article.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

## Appendix B: Infiltration Testing and Geotechnical Requirements

### Table of Contents

B.1	General Notes Pertinent to All Geotechnical Testing .....	1
B.2	Initial Feasibility Assessment .....	2
B.3	Test Pit/Boring Requirements for Infiltration Tests.....	2
B.4	Infiltration Testing Requirements .....	3
B.5	Saturated Hydraulic Conductivity Calculations.....	4
B.6	Infiltration Restrictions .....	5

### B.1 General Notes Pertinent to All Geotechnical Testing

A geotechnical report may be required for all underground stormwater best management practices (BMPs), including infiltration-based practices, filtering systems, and storage practices, as well as stormwater ponds and wetlands. The following must be taken into account when producing this report.

- Testing is to be conducted at the direction of a qualified professional. This professional shall either be a registered professional engineer, soils scientist, or geologist and must be licensed in the State.
- Soil boring or test pit information is to be obtained from at least one location on the site. Additional borings or test pits are required within the proposed BMP facility under three conditions: (1) when the soils or slopes vary appreciably from the findings in the initial boring or test pit, (2) when the groundwater level is found to be significantly higher than the initial boring or test pit indicated, and (3) when the groundwater level may adversely affect the performance of the proposed BMP facilities. However, the location, number, and depth of borings or test pits shall be determined by a qualified professional, and be sufficient to accurately characterize the site soil conditions.
- Log any indications of water saturation to include both perched and groundwater table levels; include descriptions of soils that are mottled or gleyed. Depth to the groundwater table (with 24-hour readings) must be included in the boring logs/geotechnical report.
- Laboratory testing must include grain size analysis. Additional tests such as liquid limit and plastic limit tests, consolidation tests, shear tests and permeability tests may be necessary where foundation soils or slopes are potentially unstable based on the discretion of the qualified professional.
- The geotechnical report must include soil descriptions from each boring or test pit, and the laboratory test results for grain size. Based upon the proposed development, the geotechnical report may also include evaluation of settlement, bearing capacity and slope stability of soils supporting the proposed structures.
- All soil profile descriptions should provide enough detail to identify the boundary and elevations of any problem (boundary/restrictions) conditions such as fills and seepage zones, type and depth of rock, etc.

In addition to the testing requirements described above, infiltration tests must be performed for all BMPs in which infiltration will be relied upon, including permeable pavement systems, bioretention, infiltration, and dry swales. Specific requirements for infiltration testing are discussed below.

## B.2 Initial Feasibility Assessment

The feasibility assessment is conducted to determine whether full-scale infiltration testing is necessary, screen unsuitable sites, and reduce testing costs. However, a designer or landowner may opt to skip the initial feasibility assessment at his or her discretion and begin with soil borings.

The initial feasibility assessment typically involves existing data, such as the following:

- On-site septic percolation testing, which can establish historic percolation rates, water table, and/or depth to bedrock. Percolation tests are different than tests for coefficient of permeability or infiltration rate;
- Previous geotechnical reports prepared for the site or adjacent properties; or
- Natural Resources Conservation Service (NRCS) Soil Mapping.

If the results of initial feasibility assessment show that a suitable infiltration rate (typically greater than 0.5 inches per hour) is possible or probable, then test pits must be dug or soil borings drilled to determine the saturated hydraulic conductivity ( $K_{sat}$ ).

## B.3 Test Pit/Boring Requirements for Infiltration Tests

- Excavate a test pit or drill a standard soil boring to a depth of 2 feet below the proposed BMP bottom.
- Do not construct, maintain or abandon a well in a manner that may create a point source or non-point source of pollutants to waters of the State, impair the beneficial uses of waters of the State, or pose a hazard to public health and safety or the environment.
- Determine depth to groundwater table if within 2 feet of proposed bottom.
- Determine Unified Soil Classification System (USCS) and/or United States Department of Agriculture (USDA) textures at the proposed bottom to 2 feet below the bottom of the BMP.
- Determine depth to bedrock (if within 2 feet of proposed bottom).
- Include the soil description in all soil horizons. Perform the infiltration test at the proposed bottom of the practice. If any of the soil horizons below the proposed bottom of the infiltration practice (within 2 feet) appear to be a confining layer, additional infiltration tests must be performed on this layer (or layers), following the procedure described below.
- The location of the test pits or borings shall correspond to the BMP locations; a map or plan that clearly and accurately indicates the location(s) of the test pits or soil borings must be provided with the geotechnical report.

Table 1 indicates the number of test pits or soil borings and subsequent infiltration tests that must be performed per BMP. In cases where multiple BMPs are proposed in 1 area with generally uniform conditions, a circular shape that fully encompasses all of the BMPs may be substituted for the “area of practice” that determines the number of required infiltration tests.

Table 1. Number of Infiltration Tests Required per BMP.

Area of Practice (ft <sup>2</sup> )	Minimum Number of Test Pits/Soil Borings
< 1,000	1
1,000–1,999	2
2,000–9,999	3
≥ 10,000	Add 1 test pit/soil boring for each additional 10,000 ft <sup>2</sup> of BMP.

When one test pit or boring is required, it must be located as near to the testing area as possible. When more than one test pit or boring is necessary for a single BMP or area, the pit or boring locations must be equally spaced throughout the proposed area, as directed by the qualified professional. The reported saturated hydraulic conductivity for a BMP shall be the median or geometric mean (area-weighted average) of the observed results from the soil boring/test pit locations.

## B.4 Infiltration Testing Requirements

The following tests are acceptable for use in determining soil infiltration rates. The geotechnical report shall include a detailed description of the test method and published source references:

- 1) Constant Head Bore-Hole Infiltration Tests (also referred to as bore-hole permeameter tests and constant-head well permeameter tests). These types of tests determine saturated hydraulic conductivity (coefficient of permeability) by measuring the rate of water flow to a borehole. Analytical solutions utilize principles of Darcy's Law, borehole geometry, and head (or multiple heads) of water in determining saturated hydraulic characteristics. Where the soil characteristics meet all of the above described requirements for infiltration BMPs, the hydraulic gradient element of Darcy's Law is often estimated as 1 for determining infiltration rate.

One published standard developed by the United States Bureau of Reclamation for this method is USBR 7300-89. Some of the commercially available equipment is listed below:

- Aardvark Permeameter
  - Amoozemeter
  - Guelph Permeameter
  - Johnson Permeameter
- 2) Testing Requirements for Infiltration, Bioretention, and Sand Filter Subsoils, as modified below. The data obtained from this infiltration testing procedure shall be used to calculate the saturated hydraulic conductivity (see Section B.5 Saturated Hydraulic Conductivity Calculations).
    - a. Install solid casing in the boring or test pit to the proposed BMP bottom or other required test depth (i.e. confining layer encountered within 2 feet below the BMP bottom). When installing casing, drive the casing between 3 to 5 inches below the test surface to promote a good casing-to-soil seal.
    - b. Remove any smeared, soiled surfaces, and provide a natural soil interface into which water may infiltrate. Remove all loose material from the casing. At the tester's/registered professional's discretion, a 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scouring and sediment. Fill the casing with clean, potable water 24 inches above the test surface (24 inches of head), and allow to presoak for 24 hours.

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- c. Protect the open borehole with suitable cover such as a sanitary well cap and steel plate with surrounding sandbags to prevent the introduction of surface water runoff, trash, debris, and other pollutants.
- d. Twenty-four hours later, refill the casing with approximately 24 inches of clean water (24 inches of head), and monitor the water level for 1 hour, recording the depth of water at the beginning and end of the test.
- e. Repeat step 4 (filling the casing each time) three additional times, for a total of four observations. At the registered professional's discretion, the saturated hydraulic conductivity calculations may be performed based on the values recorded during the average of the four readings or the last observation. The testing interval can be increased at the discretion of the registered professional.

All soil borings and test pits shall be properly backfilled after conclusion of the tests. A person shall not construct, maintain or abandon a well in a manner that may create a point source or non-point source of pollutants to waters of the State, impair the beneficial uses of waters of the State, or pose a hazard to public health and safety or the environment. To prevent a soil boring from becoming a conduit for stormwater or other contaminants to enter groundwater and create a low-permeability seal against vertical fluid migration, follow these steps:

- 1) Use a positive displacement technique, inject a sodium-based bentonite slurry through a tremie pipe at least 1 inch in diameter starting at the bottom of the borehole. The slurry shall be composed of 2 pounds of sodium-based bentonite powder to 1 gallon of water.
- 2) If the borehole is too narrow to accommodate a tremie pipe or the borehole is less than 10 feet deep, slowly place uncoated, medium-sized, sodium-based bentonite chips in the borehole to create a 2-foot lift of chips measured from the bottom of the borehole.
- 3) Tamp down the bentonite chips to prevent bridging.
- 4) Using a ratio of 1 gallon of water to 12.5 pounds of bentonite chips, add potable water to the borehole and allow 15 to 30 minutes to elapse to ensure proper hydration of the bentonite chips.
- 5) Adjust these instructions as necessary in accordance with the manufacturer's instructions, providing that the resulting seal will have an effective hydraulic conductivity of no more than  $1 \times 10^{-7}$  cm/s.
- 6) The process should be repeated until the boring is filled 1 to 2 feet from the ground surface.
- 7) The remainder of the borehole should be backfilled with material to match the surrounding cover and must not include the use of a coal-tar product.

Further details are provided in SCDHEC Regulations R.61-71, Well Standards.

Note: If the infiltration testing procedure reveals smells or visual indications of soil or groundwater contamination then the boring or test hole must be filled in accordance with wellhead protection best practices, unless laboratory analysis determines groundwater or soil is not contaminated.

## **B.5 Saturated Hydraulic Conductivity Calculations**

To convert the field infiltration measurements to a saturated hydraulic conductivity value ( $K_{sat}$ ), the following calculations must be performed.

$$K_{ssss} = \frac{\pi \pi \pi \pi}{11(t_2 - t_1)} \times \ln\left(\frac{H_1}{H_2}\right)$$

where:

- $K_{sat}$  = saturated hydraulic conductivity (in/hr)  
 $D$  = casing diameter (in) (minimum 4 inches)  
 $t_2$  = recorded end time of test (hr)  
 $t_1$  = recorded beginning time of test (hr)  
 $H_1$  = head in casing measured at time  $t_1$  (ft)  
 $H_2$  = head in casing measured at time  $t_2$  (ft)

This equation was adapted by the U.S. Bureau of Reclamation in 1975 from Lambe and Whitman, 1969.

## B.6 Infiltration Restrictions

If a Phase I Environmental Site Assessment identifies a Recognized Environmental Concern at a site indicating that site contamination is likely or present; or if DHEC is aware of upgradient or downgradient contaminant plumes, the presence of a brownfield or historic hotspot use, such as any of the following current or previous uses, then an impermeable liner must be used for BMPs, and infiltration is prohibited.

- Leaking underground storage tank (LUST),
- Above ground storage tanks (AST),
- Gas stations,
- Vehicle maintenance or repair facility,
- Dry cleaner,
- Transformer sub-station,
- Waste transfer or holding facility,
- Print shop,
- Chemical storage warehouse,
- Illicit hazardous wastes generator,
- Greenhouse with unlined floor,
- Septic system,
- Cement or asphalt plant, or
- Dump or landfill.

If an ASTM Phase II Environmental Site Assessment is performed based on a DHEC-approved workplan and DHEC reviews the results and determines that stormwater infiltration BMPs may impact on-site contamination by the following means, then an impermeable liner must be used for BMPs, and infiltration is prohibited.

- Spreading of contamination vertically or horizontally at the site,
- Increasing on-site groundwater contamination by leaching contaminants from the soil,

(Supp. No. 45)



- Causing or enhancing contaminant migration to go offsite,
- Interfering with contaminant remedial activities,
- Decreasing or reversing the natural degradation of contaminants, or
- Causing a pollutant discharge to a surface water body.

If DHEC concludes there is no evidence of a Recognized Environmental Concern based on ASTM Phase I and II Environmental Site, and there is no current site use that could result in the foreseeable creation of a Recognized Environmental Concern, then impermeable liners are not required, and infiltration is not restricted.

B6



## Appendix C: Soil Compost Amendment Requirements

### Table of Contents

C.1	Introduction .....	1
C.2	Physical Feasibility and Design Applications .....	1
C.3	Design Criteria.....	2
C.3.1	Performance.....	2
C.3.2	Soil Testing .....	2
C.3.3	Determining Depth of Compost Incorporation .....	2
C.3.4	Compost Specifications.....	3
C.4	Construction Sequence .....	4
C.5	Maintenance .....	4
C.5.1	First-Year Maintenance Operations.....	4
C.5.2	Ongoing Maintenance.....	4
C.5.3	Maintenance Agreement .....	5
C.6	References .....	<b>Error! Bookmark not defined.</b>

### C.1 Introduction

Soil amendment (also called soil restoration) is a technique applied after construction to deeply till compacted soils and restore their porosity by amending them with compost. These soil amendments can be used to enhance the performance of impervious cover disconnections and grass channels.

### C.2 Physical Feasibility and Design Applications

Amended soils are suitable for any pervious area where soils have been or will be compacted by the grading and construction process. They are particularly well suited when existing soils have low infiltration rates (HSG C and D) and when the pervious area will be used to filter runoff (downspout disconnections and grass channels). The area or strip of amended soils should be hydraulically connected to the stormwater conveyance system. Soil restoration is recommended for sites that will experience mass grading of more than a foot of cut and fill across the site.

Compost amendments are not recommended where any of the following exists:

- Existing soils have high infiltration rates (e.g., HSG A and B), although compost amendments may be needed at mass-graded B soils in order to maintain infiltration rates.
- The water table or bedrock is located within 1.5 feet of the soil surface.
- Slopes exceed 10% (compost can be used on slopes exceeding 10% as long as proper soil erosion and sediment control measures are included in the plan).
- Existing soils are saturated or seasonally wet.
- They would harm roots of existing trees (keep amendments outside the tree dripline).
- The downhill slope runs toward an existing or proposed building foundation.

(Supp. No. 45)

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- Areas that will be used for snow storage.

### C.3 Design Criteria

#### C.3.1 Performance

When Used in Conjunction with Other Practices. As referenced in several of the Chapter 4 Stormwater Best Management Practices (BMPs) specifications, soil compost amendments can be used to enhance the performance of allied practices by improving runoff infiltration. The specifications for each of these practices contain design criteria for how compost amendments can be incorporated into those designs:

- Impermeable Surface Disconnection – See Section 4.6 Impervious Surface Disconnection.
- Grass Channels – See Section 4.7 Open Channel Systems.

#### C.3.2 Soil Testing

Soil tests are required during two stages of the compost amendment process. The first testing is done to ascertain preconstruction soil properties at proposed amendment areas. The initial testing is used to determine soil properties to a depth 1 foot below the proposed amendment area, with respect to bulk density, pH, salts, and soil nutrients. These tests should be conducted every 5,000 square feet and are used to characterize potential drainage problems and determine what, if any, further soil amendments are needed.

The second soil test is taken at least 1 week after the compost has been incorporated into the soils. This soil analysis should be conducted by a reputable laboratory to determine whether any further nutritional requirements, pH adjustment, and organic matter adjustments are necessary for plant growth. This soil analysis must be done in conjunction with the final construction inspection to ensure tilling or subsoiling has achieved design depths.

#### C.3.3 Determining Depth of Compost Incorporation

The depth of compost amendment is based on the relationship of the surface area of the soil amendment to the contributing area of impervious cover that it receives. Table C.1 presents some general guidance derived from soil modeling by Holman-Dodds (2004) that evaluates the required depth to which compost must be incorporated. Some adjustments to the recommended incorporation depth were made to reflect alternative recommendations of Roa Espinosa (2006), Balousek (2003), Chollak and Rosenfeld (1998), and others.

Table 1 indicates the number of test pits or soil borings and subsequent infiltration tests that must be performed per BMP. In cases where multiple BMPs are proposed in 1 area with generally uniform conditions, a circular shape that fully encompasses all of the BMPs may be substituted for the “area of practice” that determines the number of required infiltration tests.

Table 1. Method to Determine Compost and Incorporation Depths.

Ratio of Area of Contributing Impervious Cover to Soil Amendment <sup>a</sup> (IC/SA)	Compost Depth <sup>b</sup> (in.)	Incorporation Depth (in.)	Incorporation Method
0.5	3 <sup>c</sup>	12 <sup>c</sup>	Tiller
0.75	4 <sup>c</sup>	18 <sup>c</sup>	Subsoiler
1.0 <sup>d</sup>	6 <sup>c</sup>	24 <sup>c</sup>	Subsoiler

<sup>a</sup>IC = contrib. impervious cover (ft<sup>2</sup>) and SA = surface area of compost amendment (ft<sup>2</sup>)

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

<sup>b</sup> Average depth of compost added

<sup>c</sup> Lower end for B soils, higher end for C/D soils

<sup>d</sup> In general, IC/SA ratios greater than 1 should be avoided

Once the area and depth of the compost amendments are known, the designer can estimate the total amount of compost needed, using an estimator developed by TCC, (1997):

$$CC = AA \times DD \times 0.0031$$

where:

- $C$  = compost needed (yd<sup>3</sup>)
- $A$  = area of soil amended (ft<sup>2</sup>)
- $D$  = depth of compost added (in)

### C.3.4 Compost Specifications

The basic material specifications for compost amendments are outlined below:

- Compost shall be derived from plant material and provided by a member of the U.S. Composting Seal of Testing Assurance (STA) program. See <https://compostingcouncil.org/> for a list of local providers.
- Alternative specifications and/or certifications, such as Clemson University or the US Department of Agriculture, may be substituted, as authorized by <local jurisdiction>. In all cases, compost material must meet standards for chemical contamination and pathogen limits pertaining to source materials, as well as reasonable limits on phosphorus and nitrogen content to avoid excessive leaching of nutrients.
- The compost shall be the result of the biological degradation and transformation of plant-derived materials under conditions that promote anaerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have a moisture content that has no visible free water or dust produced when handling the material. It shall meet the following criteria, as reported by the U.S. Composting Council STA Compost Technical Data Sheet provided by the vendor:
  - a. 100% of the material must pass through a half-inch screen
  - b. The pH of the material shall be between 6 and 8
  - c. Manufactured inlet material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight
  - d. The organic matter shall be between 35%–65%
  - e. Soluble salt content shall be less than 6.0 mmhos/cm
  - f. Maturity must be greater than 80%
  - g. Stability shall be 7 or less
  - h. Carbon/nitrogen ratio shall be less than 25:1
  - i. Trace metal test result must equal “pass”
  - j. The compost must have a dry bulk density ranging from 40–50 lb/ft<sup>3</sup>

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## C.4 Construction Sequence

The construction sequence for compost amendments differs depending whether the practice will be applied to a large area or a narrow filter strip, such as in a rooftop disconnection or grass channel. For larger areas, a typical construction sequence is as follows:

- 1) **Soil Erosion and Sediment Control.** When areas of compost amendments exceed 2,500 square feet install soil erosion and sediment control measures, such as silt fences, are required to secure the area until the surface is stabilized by vegetation.
- 2) **Deep Till.** Deep till to a depth of 12 to 18 inches after the final building lots have been graded prior to the addition of compost.
- 3) **Dry Conditions.** Wait for dry conditions at the site prior to incorporating compost.
- 4) **Compost.** Incorporate the required compost depth (as indicated in Table 1) into the tilled soil using the appropriate equipment. Level the site. Seeds or sod are required to establish a vigorous grass cover. To help the grass grow quickly, lime or irrigation is recommended.
- 5) **Vegetation.** Ensure surface area is stabilized with vegetation.
- 6) **Construction Inspection.** Construction inspection by a qualified professional involves digging a test pit to verify the depth of amended soil and scarification. A rod penetrometer should be used to establish the depth of uncompacted soil at a minimum of 1 location per 10,000 square feet.

## C.5 Maintenance

### C.5.1 First-Year Maintenance Operations

In order to ensure the success of soil compost amendments, the following tasks must be undertaken in the first year following soil restoration:

- **Initial inspections.** For the first 6 months following the incorporation of soil amendments, the site should be inspected by a qualified professional at least once after each storm event that exceeds 1/2-inch of rainfall.
- **Spot Reseeding.** Inspectors should look for bare or eroding areas in the contributing drainage area (CDA) or around the soil restoration area and make sure they are immediately stabilized with grass cover.
- **Fertilization.** Depending on the amended soils test, a one-time, spot fertilization may be needed in the fall after the first growing season to increase plant vigor.
- **Watering.** Water once every 3 days for the first month, and then weekly during the first year (April through October), depending on rainfall.

### C.5.2 Ongoing Maintenance

There are no major ongoing maintenance needs associated with soil compost amendments, although the owners may want to de-thatch the turf every few years to increase permeability. The owner should also be aware that there are maintenance tasks needed for filter strips, grass channels, and reforestation areas. The maintenance inspection checklist for an area of Soil Compost Amendments can be accessed in Appendix F Maintenance Inspection Forms.

### C.5.3 Maintenance Agreement

A Maintenance Agreement that includes all maintenance responsibilities to ensure the continued stormwater performance for the BMP is required. The Maintenance Agreement specifies the property owner's primary maintenance responsibilities and authorizes the Beaufort County Public Works staff to access the property for inspection or corrective action in the event the proper maintenance is not performed. The Maintenance Agreement is attached to the deed of the property as attached to the land. It is to be recorded in the Register of Deeds in the County office. Maintenance responsibilities on government properties must be defined through a partnership agreement or a memorandum of understanding.

C5

## Appendix D: Conceptual Design Checklist

### D.1 Design Checklist

This checklist serves as a guide for the consultant in the preparation and for the reviewer in the evaluation of a Stormwater Management Plan (SWMP). Any questions regarding items contained herein should be referred to the *Beaufort County Public Works Department*. Applicable page number or section in the Southern Lowcountry Stormwater Design Manual is included for reference.

**NOTE: PLANS SUBMITTED WITHOUT A COMPLETED CHECKLIST MAY BE RETURNED WITHOUT REVIEW**

Site/Project Name: _____	Date: _____
Consultant: _____	Applicant: _____
Phone Number: _____	Phone Number: _____
Email Address: _____	Email Address: _____

☐ Conceptual Plan or ☐ Final Plan

*Consultant: Please complete the checklist below. A box in the Conceptual or Final checklist columns indicates the item is required for a complete application submittal.*

	Conceptual	Final
<b>A. Narrative Information</b>		
1. Cover Sheet with Project Name, Engineer's Contact Information, Developer's Contact Information, Contractors Contact Information. Information required: Name, mailing address, telephone, email.	Δ	Δ
2. Site development plan and stormwater management narrative	Δ	Δ
3. Assess potential application of green infrastructure practices in the form of better site planning and design techniques. Low impact development practice should be used to the maximum extent practicable during the creation of a stormwater management concept plan. A demonstration of better site planning is required. The following site information and practices shall be considered: <ul style="list-style-type: none"> <li>a. Soil type (from Soil Study);</li> <li>b. Depth of ground water on site;</li> <li>c. Whether the type of development proposed is a hotspot as defined by the Ordinance and Design Manual and address how this influences the concept proposal;</li> <li>d. Protection of primary and secondary conservation areas;</li> <li>e. Reduced clearing and grading limits;</li> <li>f. Reduced roadway lengths and widths;</li> <li>g. Reduced parking lot and building footprints to minimize impervious surface;</li> <li>h. Soil restoration;</li> <li>i. Site reforestation/revegetation;</li> <li>j. Impervious area disconnection;</li> </ul>	Δ	

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(Supp. No. 45)

k. Green roof; and l. Permeable pavement		
4. Stormwater Pollution Prevention Plan (SWPPP) or Erosion and Sediment Control narrative (for projects disturbing over an acre)	Δ	Δ
5. Information regarding the mitigation of any off-site impacts anticipated as a result of the proposed development. Not applicable for all projects.		Δ
6. Construction specifications	Δ	Δ
<b>B. Site Plan</b>		
1. Standard drawing size (24 x 36 inches)	Δ	Δ
2. A plan showing property boundaries and the complete address of the property	Δ	Δ
3. Lot number or property identification number designation (if applicable)	Δ	Δ
4. Property lines (include longitude and latitude)	Δ	Δ
5. Location of easements (if applicable)		Δ
6. A legend identifying all symbols used on the plan	Δ	Δ
7. Location and size of existing and proposed utilities (including gas lines, sanitary lines, telephone lines or poles, electric utilities and water mains), structures, roads, and other paved areas		Δ
8. Existing and proposed topographic contours	Δ	Δ
9. Show drainage patterns, property ridge line(s) and building finish elevation on the grading plan.		Δ
10. Material and equipment staging areas	Δ	Δ
11. Clearly note on plans: <ul style="list-style-type: none"> <li>- A right-of-way permit shall be obtained prior to performing construction activity in the right-of-way</li> <li>- Chlorinated disinfected water shall not be discharged into the stormwater system</li> <li>- Call before you dig note and number</li> </ul>		Δ
12. Soil information for design purposes	Δ	Δ
13. Area(s) of soil disturbance	Δ	Δ
14. Site drainage area(s) (SDAs) within the limits of disturbance (LOD) and contributing to the LOD		Δ
15. Contributing drainage area (CDA) to each BMP		Δ
16. Location(s) of BMPs, marked with the BMP ID Numbers to agree with the BMP design summary list		Δ
17. Delineation of existing and proposed land covers including natural cover, compacted cover, and impervious surfaces.	Δ	Δ

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

D2

18. Site fingerprint map of the location of existing stream(s), wetlands, or other natural features within the project area; tree and vegetation survey; and preservation area(s)	△	△
19. All plans and profiles must be drawn at a scale of 1 in. = 10 ft, 1 in. = 20 ft, 1 in. = 30 ft, 1 in. = 40 ft, 1 in. = 50 ft, or 1 in. = 100 ft. Although, 1 in. = 10 ft, 1 in. = 20 ft, and 1 in. = 30 ft, are the most commonly used scales. Vertical scale for profiles must be 1 in. = 2 ft, 1 in. = 4 ft, 1 in. = 5 ft, or 1 in. = 10 ft	△	△
20. Drafting media that yield first- or second-generation, reproducible drawings with a minimum letter size of No. 4 (1/8 inch)	△	△
21. Applicable flood boundaries and FEMA map identification number for sites lying wholly or partially within the 100-year floodplain (if applicable)	△	△
<b>C. Design and As-Built Certification</b>		
1. Statement and seal by a registered professional engineer licensed in the State of South Carolina that the site design, land covers, and design of the BMPs conform to engineering principles applicable to the treatment and disposal of stormwater pollutants		△
2. Submission one set of the As-Built drawings sealed by a registered professional engineer licensed in the State of South Carolina within 21 days after completion of construction of the site, all BMPs, land covers, and stormwater conveyances. *Comes at close out*		△
3. For a project consisting entirely of work in the public right-of-way (PROW), the submission of a Record Drawing certified by an officer of the project contracting company is acceptable if it details the as-built construction of the BMP and related stormwater infrastructure.		△
<b>D. Maintenance of Stormwater BMPs</b>		
1. BMP maintenance access easements shall not be located on pipe easements.		△
2. A minimum 20' wide maintenance access easement is provided around stormwater detention ponds and from publicly accessible road has been provided.		△
3. A maintenance plan that identifies routine and long-term maintenance needs and a maintenance schedule		△
4. For regulated projects, a maintenance agreement stating the owner's specific maintenance responsibilities identified in the maintenance plan and maintenance schedule. These must be exhibits recorded with the property deed at the Recorder of Deeds.		△
5. For applicants using Rainwater Harvesting, submission of third-party testing of end-use water quality may be required at equipment commissioning.		△
<b>E. Stormwater Retention Volume Computations</b>		



1. Calculation(s) of the required SWRV for the entire site within the LOD and each SDA within the LOD		△
2. Calculation(s) for each proposed BMP demonstrating retention value towards SWRV in accordance with Chapters 2 and 4 Stormwater Best Management Practices (BMPs)		△
3. For Rainwater Harvesting BMP, calculations demonstrating the annual water balance as determined using the Rainwater Harvesting Retention Calculator		△
4. For proprietary and non-proprietary BMPs outside Chapter 4, complete documentation defined in Chapter 4.15		△
5. Document off-site stormwater volume where required.		△
6. Document the 8-steps of the MEP process in Chapter 3.8.		△
7. Compliance Calculator sheets identifying that proposed BMP(s) meet standards for water quality		△
<b>F. Pre/Post-Development Hydrologic Computations</b>		
1. A summary of soil conditions and field data		△
2. Pre- and post-project curve number summary table		△
3. Pre and post construction peak flow summary table for the 2, 10, 25, 50 and the 100-year 24-hour storm events for each SDA within the project's LOD		△
4. Flow control structure elevations		△
<b>G. Hydraulic Computations</b>		
1. Existing and proposed SDA must be delineated on separate plans with the flow paths used for calculation of the times of concentration		△
2. Hydraulic capacity and flow velocity for drainage conveyances, including ditches, swales, pipes, inlets.		△
3. Plan profiles for all open conveyances and pipelines, with energy (kinetic) and hydraulic gradients for the 25-year and 100-year, 24-hour storms		△
4. The proposed development layout including the following:		△
a) Location and design of BMP(s) on site, marked with the BMP ID Numbers		△
b) A list of design assumptions (e.g., design basis, 2 through 25-year return periods)		△
c) The boundary of the CDA to the BMP		△
d) Schedule of structures (a listing of the structures, details, or elevations including inverts)		△
e) Manhole to manhole listing of pipe size, pipe type, slope, computed velocity, and computed flow rate (i.e., a storm drain pipe schedule		△
5. Demonstrate downstream conveyance system capacity for the development.	Created: 2021-07-22 09:11:36 [EST]	△

(Supp. No. 45)

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D4

<b>H. Erosion and Sediment Control Plans</b>		
1. Provide erosion and sediment control drawings and detail sheets required by the CSWPPP	Δ	Δ
2. Show dewatering setup to ensure no negative off-site impacts result from the discharge	Δ	Δ
3. Provide erosion and sediment control inspection forms required by the CSWPPP		Δ
<b>I. Supporting Documentation (written report)</b>		
1. Pre- and Post-development curve number selection		Δ
2. Time of concentration calculation		Δ
3. Travel time calculation		Δ
4. Hydrologic computations supporting peak discharges assumed for each SDA within the project's LOD for the 2-, 10-, 25-, and 50-year, 24-hour storm events		Δ
5. Provide downstream and surrounding neighborhood area analysis to identify any existing capacity shortfalls or flooding based on the 10% rule.		Δ
6. SCDHEC's Construction Stormwater Pollution Prevention Plan (C-SWPPP)		Δ

The engineering features of all stormwater best management practices (BMPs), stormwater infrastructure, and land covers (collectively the "Facility") have been designed/examined by me and found to be in conformity with the standard of care applicable to the treatment and disposal of stormwater pollutants. The Facility has been designed in accordance with the specification required under Chapter 99 of the Beaufort County Ordinance.

Seal	Signed	Date	
License Number:		Expiration Date:	

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Infiltration/Filtration/Bioretention/Dry Swale Practice  
Maintenance Inspection Checklist**

Item 6.

**Party Responsible for Maintenance:** \_\_\_\_\_

**Practice ID:** \_\_\_\_\_

**Contact:** \_\_\_\_\_

**Location:** \_\_\_\_\_

**Phone Number:** \_\_\_\_\_

**GPS Coordinates:** \_\_\_\_\_

**E-mail:** \_\_\_\_\_

**Inspector(s):** \_\_\_\_\_ **Mailing Address:** \_\_\_\_\_

**Date:** \_\_\_\_\_ **Time:** \_\_\_\_\_

<b>Key Questions</b>		
<b>Item</b>	<b>X</b>	<b>Comments</b>
1. Type of practice (check all that apply)		
a. Bioretention	<input type="checkbox"/>	
b. Dry Swale	<input type="checkbox"/>	
d. Residential Rain Garden	<input type="checkbox"/>	
e. Infiltration Practice	<input type="checkbox"/>	
f. Filtration Practice	<input type="checkbox"/>	
2. For Bioretention		
a. Standard Design	<input type="checkbox"/>	
b. Enhanced Design	<input type="checkbox"/>	
3. Practice Location		
a. Open to Surface	<input type="checkbox"/>	
b. Underground	<input type="checkbox"/>	
4. Filtration Media		
a. No filtration media (e.g., stone reservoir only)	<input type="checkbox"/>	
b. Sand	<input type="checkbox"/>	
c. Bioretention Soil Mix	<input type="checkbox"/>	
d. Peat	<input type="checkbox"/>	
e. Other	<input type="checkbox"/>	
5. Hydraulic configuration		
a. On-line	<input type="checkbox"/>	
b. Off-line	<input type="checkbox"/>	
6. Type of pretreatment		
a. Separate pretreatment cell	<input type="checkbox"/>	
b. Sedimentation chamber/manhole	<input type="checkbox"/>	
c. Grass channel	<input type="checkbox"/>	
d. Grass filter strip	<input type="checkbox"/>	
e. Gravel or stone flow spreader	<input type="checkbox"/>	
f. Gravel diaphragm	<input type="checkbox"/>	
g. Other	<input type="checkbox"/>	Type of pretreatment:
7. If designed for infiltration (i.e., no underdrain OR infiltration sump below underdrain):		
a. Soil boring logs and infiltration testing report provided	<input type="checkbox"/>	
b. Field-measured infiltration rate of at least 0.5 in/hr (preferred 1-4 in/hr)	<input type="checkbox"/>	Field-measured rate:

**A. Contributing Drainage Area**

0 = Good condition. Well maintained, no action required.

(Supp. No. 45)



**Infiltration/Filtration/Bioretention/Dry Swale Practice  
Maintenance Inspection Checklist**

1 = Moderate condition. Adequately maintained, routine maintenance needed.  
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected
<input type="checkbox"/>	Not Inspected
Item	Comments
1. Excessive trash/debris	0 1 2 3 N/A
2. Bare/exposed soil	0 1 2 3 N/A
3. Evidence of erosion	0 1 2 3 N/A
4. Excessive landscape waste/yard clippings	0 1 2 3 N/A

**B. Pretreatment**

0 = Good condition. Well maintained, no action required.  
1 = Moderate condition. Adequately maintained, routine maintenance needed.  
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected
<input type="checkbox"/>	Not Inspected
Item	Comments
1. Maintenance access to pretreatment facility	0 1 2 3 N/A
2. Excessive trash/debris/sediment	0 1 2 3 N/A
3. Evidence of standing water	0 1 2 3 N/A
a. Ponding	<input type="checkbox"/>
b. Noticeable odors	<input type="checkbox"/>
c. Water stains	<input type="checkbox"/>
d. Presence of algae or floating aquatic vegetation	<input type="checkbox"/>
4. Evidence of clogging	0 1 2 3 N/A
5. Dead vegetation/exposed soil	0 1 2 3 N/A
6. Evidence of erosion	0 1 2 3 N/A

**C. Inlets**

0 = Good condition. Well maintained, no action required.  
1 = Moderate condition. Adequately maintained, routine maintenance needed.  
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected
<input type="checkbox"/>	Not Inspected
Item	Comments
1. Inlets provide stable conveyance into practice	0 1 2 3 N/A
2. Excessive trash/debris/sediment accumulation at inlet	0 1 2 3 N/A
3. Evidence of erosion at/around inlet	0 1 2 3 N/A

**D. Practice**

(Supp. No. 45)





**Infiltration/Filtration/Bioretention/Dry Swale Practice  
Maintenance Inspection Checklist**

0 = Good condition. Well maintained, no action required.  
 1 = Moderate condition. Adequately maintained, routine maintenance needed.  
 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
 3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
Item		Comments				
1.	Maintenance access	0	1	2	3	N/A
2.	Condition of structural components	0	1	2	3	N/A
3.	Condition of hydraulic control components	0	1	2	3	N/A
4.	Excessive trash/debris/sediment	0	1	2	3	N/A
5.	Evidence of erosion	0	1	2	3	N/A
6.	Evidence of oil/chemical accumulation	0	1	2	3	N/A
7.	Evidence of standing water:	0	1	2	3	N/A
	a. Ponding	<input type="checkbox"/>				
	b. Noticeable odors	<input type="checkbox"/>				
	c. Water stains	<input type="checkbox"/>				
	d. Presence of algae or floating aquatic vegetation	<input type="checkbox"/>				
8.	Underdrain system (if equipped)	0	1	2	3	N/A
	a. Broken	<input type="checkbox"/>				
	b. Clogged	<input type="checkbox"/>				
9.	Vegetation	0	1	2	3	N/A
	a. Plant composition consistent with approved plans	<input type="checkbox"/>				
	b. Presence of invasive species/weeds	<input type="checkbox"/>				
	c. Dead vegetation/exposed soil	<input type="checkbox"/>				

**E. Outlets**

0 = Good condition. Well maintained, no action required.  
 1 = Moderate condition. Adequately maintained, routine maintenance needed.  
 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
 3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
Item		Comments				
1.	Outlets provide stable conveyance out of practice	0	1	2	3	N/A
2.	Excessive trash/debris/sediment accumulation at outlet	0	1	2	3	N/A
3.	Evidence of erosion at/around outlet	0	1	2	3	N/A
<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					

**F. Miscellaneous**

(Supp. No. 45)



**Infiltration/Filtration/Bioretenention/Dry Swale Practice  
Maintenance Inspection Checklist**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

Item						Comments
1. Complaints from local residents	0	1	2	3	N/A	
2. Mosquito proliferation	0	1	2	3	N/A	
3. Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A	

**Inspector's Summary:**

**Photographs**

	Photo ID	Description
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

**Sketch of Practice**

(note problem areas)

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Infiltration/Filtration/Bioretentention/Dry Swale Practice  
Maintenance Inspection Checklist**

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*Item 6.*



**Permeable Pavement  
Maintenance Inspection Checklist**

**Party Responsible for Maintenance:** \_\_\_\_\_

**Practice ID:** \_\_\_\_\_

**Contact:** \_\_\_\_\_

**Location:** \_\_\_\_\_

**Phone Number:** \_\_\_\_\_

**GPS Coordinates:** \_\_\_\_\_

**E-mail:** \_\_\_\_\_

**Inspector(s):** \_\_\_\_\_ **Mailing Address:** \_\_\_\_\_

**Date:** \_\_\_\_\_ **Time:** \_\_\_\_\_

**Key Questions**

Item	X	Comments
1. Type of practice (check all that apply)		
a. Standard design	<input type="checkbox"/>	
b. Infiltration design	<input type="checkbox"/>	
c. Infiltration sump design	<input type="checkbox"/>	
2. Pavement Type		
a. Pervious concrete	<input type="checkbox"/>	
b. Porous asphalt	<input type="checkbox"/>	
c. Concrete grid pavers	<input type="checkbox"/>	
d. Permeable interlocking concrete pavers	<input type="checkbox"/>	
e. Other:	<input type="checkbox"/>	
3. External drainage area?		
a. Yes	<input type="checkbox"/>	Ratio: _____
b. No	<input type="checkbox"/>	
4. Pretreatment (if landscaped/turf areas in drainage area)		
a. Yes	<input type="checkbox"/>	Type: _____
b. No	<input type="checkbox"/>	
5. If designed for infiltration (e.g., no underdrain OR infiltration sump below underdrain):		
b. Soil boring logs and infiltration testing report provided	<input type="checkbox"/>	
c. Field-measured infiltration rate indicated	<input type="checkbox"/>	Field-measured rate: _____

**A. Contributing Drainage Area**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected								
<input type="checkbox"/>	Not Inspected								
	Item								Comments
1.	Excessive trash/debris	0	1	2	3	N/A			
2.	Bare/exposed soil	0	1	2	3	N/A			
3.	Evidence of erosion	0	1	2	3	N/A			
4.	Excessive landscape waste/yard clippings	0	1	2	3	N/A			

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)





**Permeable Pavement  
Maintenance Inspection Checklist**

- |   |   |   |   |   |   |     |
|---|---|---|---|---|---|-----|
| 5 | Excessive grit, sand, or other clogging agents on upgradient pavement that drains onto permeable pavement | 0 | 1 | 2 | 3 | N/A |
|---|---|---|---|---|---|-----|

**B. Pretreatment (if applicable to landscaped/turf drainage area)**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected								
<input type="checkbox"/>	Not Inspected								
Item		Comments							
1.	Maintenance access to pretreatment facility	0	1	2	3	N/A			
2.	Excessive trash/debris/sediment	0	1	2	3	N/A			
3.	Evidence of standing water								
a.	Ponding	0	1	2	3	N/A			
b.	Noticeable odors	0	1	2	3	N/A			
c.	Water stains	0	1	2	3	N/A			
d.	Presence of algae or floating aquatic vegetation	0	1	2	3	N/A			
4.	Evidence of clogging	0	1	2	3	N/A			
5.	Dead vegetation/exposed soil	0	1	2	3	N/A			
6.	Evidence of erosion	0	1	2	3	N/A			

**C. Evidence of Materials Storage or Resurfacing of Permeable Pavement**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected								
<input type="checkbox"/>	Not Inspected								
Item		Comments							
1.	Evidence of storage of sand, mulch, soil, construction staging, power washing, or other activities that can clog pavement	0	1	2	3	N/A			
2.	Evidence of resealing or resurfacing of permeable pavement surface	0	1	2	3	N/A			

**D. Practice**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected								
<input type="checkbox"/>	Not Inspected								
Item		Comments							
1.	Maintenance access to practice	0	1	2	3	N/A			
2.	Condition of structural components	0	1	2	3	N/A			

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Permeable Pavement  
Maintenance Inspection Checklist**

3. Condition of hydraulic control components	0	1	2	3	N/A
4. Excessive trash/debris/sediment on pavement surface	0	1	2	3	N/A
5. Evidence of damaged pavers and/or cracked/broken surface	0	1	2	3	N/A
6. Evidence of oil/chemical accumulation	0	1	2	3	N/A
7. Evidence of clogging:	<input type="checkbox"/>				
a. Ponding/water standing in observation wells	0	1	2	3	N/A
b. Noticeable odors	0	1	2	3	N/A
c. Water stains	0	1	2	3	N/A
8. Underdrain system (if equipped)	0	1	2	3	N/A
a. Broken	0	1	2	3	N/A
b. Clogged	0	1	2	3	N/A
9. Vegetation (e.g., grass in grid pavers) if present	0	1	2	3	N/A
a. Grass or vegetation needs mowing or maintenance	0	1	2	3	N/A
b. Excessive growth of weeds	0	1	2	3	N/A
c. Dead vegetation	0	1	2	3	N/A

**E. Miscellaneous**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
Item		Comments				
1.	Complaints from local residents	0	1	2	3	N/A
2.	Spring clean-up conducted?	0	1	2	3	N/A
3.	Vacuum sweeping without water spray (2 -- 4 time annually)	0	1	2	3	N/A
4.	Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A

**Inspector's Summary:**

Created: 2021-07-22 09:11:36 [EST]



**Permeable Pavement  
Maintenance Inspection Checklist**

Item 6.

<i>Photographs</i>	
Photo ID	Description
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

<i>Sketch of Practice</i>
(note problem areas)



**Green Roof  
Maintenance Inspection Checklist**

Party Responsible for Maintenance:

Practice ID:

Contact:

Location:

Phone Number:

GPS Coordinates:

E-mail:

Inspector(s): Mailing Address:

Date:

Time:

**Key Questions**

Item	X	Comments
1. Type of vegetated roof (check all that apply)		
a. Extensive - shallow soil	<input type="checkbox"/>	
b. Intensive - deep soil	<input type="checkbox"/>	
c. Other	<input type="checkbox"/>	Type:
2. Type of plant cover (check all that apply)		
a. Sedums	<input type="checkbox"/>	
b. Shrubs	<input type="checkbox"/>	
c. Trees	<input type="checkbox"/>	
d. Other	<input type="checkbox"/>	Type:

**A. Practice**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected
<input type="checkbox"/>	Not Inspected
Item	Comments
1. Maintenance access to practice	0 1 2 3 N/A
2. Condition of structural components	0 1 2 3 N/A
3. Condition of hydraulic control components	0 1 2 3 N/A
4. Excessive trash/debris/sediment	0 1 2 3 N/A
5. Evidence of leaking in waterproof	0 1 2 3 N/A
6. Evidence of perforated root barrier	0 1 2 3 N/A
7. Evidence of standing water:	0 1 2 3 N/A
a. Ponding	<input type="checkbox"/>
b. Noticeable odors	<input type="checkbox"/>
c. Water stains	<input type="checkbox"/>
d. Presence of algae	<input type="checkbox"/>
8. Roof drain system	0 1 2 3 N/A
a. Broken	<input type="checkbox"/>
b. Clogged	<input type="checkbox"/>
9. Vegetation	0 1 2 3 N/A
a. Plant composition consistent with approved plans	<input type="checkbox"/>
b. Presence of invasive species/weeds	<input type="checkbox"/>
c. Plants appear nutrient deficient	<input type="checkbox"/>
d. Evidence of birds/pests removing plants	<input type="checkbox"/>
e. Dead/sparse vegetation soil	<input type="checkbox"/>

22 09:11:36 [EST]

(Supp. No. 45)





**Green Roof  
Maintenance Inspection Checklist**

**B. Outlets**

0 = Good condition. Well maintained, no action required.  
 1 = Moderate condition. Adequately maintained, routine maintenance needed.  
 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
 3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
	Item					Comments
1.	Roof drain conveyance is clogged	0	1	2	3	N/A
2.	Excessive trash/debris/sediment accumulation at roof drain outlets	0	1	2	3	N/A
3.	Evidence of erosion at/around outlet	0	1	2	3	N/A

**C. Miscellaneous**

0 = Good condition. Well maintained, no action required.  
 1 = Moderate condition. Adequately maintained, routine maintenance needed.  
 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
 3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
	Item					Comments
1.	Complaints from local residents	0	1	2	3	N/A
2.	Mosquito proliferation	0	1	2	3	N/A

**Inspector's Summary:****Photographs**

	Photo ID	Description
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

**Sketch of Practice**  
 (Supp. No. 45)

6-1-1-2024-07-22 09:11:36 [EST]



**Green Roof  
Maintenance Inspection Checklist**

(note problem areas)

(Supp. No. 45)

Created: 2021-07-22 09:11:36 [EST]



## Rainwater Harvesting Maintenance Inspection Checklist

Party Responsible for Maintenance: \_\_\_\_\_

Practice ID: \_\_\_\_\_

Contact: \_\_\_\_\_

Location: \_\_\_\_\_

Phone Number: \_\_\_\_\_

GPS Coordinates: \_\_\_\_\_

E-mail: \_\_\_\_\_

Inspector(s): \_\_\_\_\_ Mailing Address: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

### A. Contributing Drainage Area (Roof Area)

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
Item		Comments				
1.	Excessive leaves and debris in gutters/downspouts	0	1	2	3	N/A
2.	Other materials/debris on roof surface (e.g., excessive bird droppings)	0	1	2	3	N/A
3.	Clear overhanging trees/vegetation over roof surface	0	1	2	3	N/A

### B. Pretreatment

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
Item						Comments
1.	Maintenance access to pretreatment facility	0	1	2	3	N/A
2.	Check first flush diverters/filters for proper functioning (e.g., not bypassing too much water). Clean debris from filter screens.	0	1	2	3	N/A Sediment marker reading:

### C. Inlets

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected					
<input type="checkbox"/>	Not Inspected					
Item						Comments
1.	Check all conveyances into tank; remove debris; check for clogging	0	1	2	3	N/A

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



## Rainwater Harvesting Maintenance Inspection Checklist

2. Patch any holes or gaps.	0	1	2	3	N/A
<b>D. Tank or Cistern</b>					
0 = Good condition. Well maintained, no action required.					
1 = Moderate condition. Adequately maintained, routine maintenance needed.					
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.					
3 = Serious condition. Immediate need for repair or replacement.					
<input type="checkbox"/> Inspected					
<input type="checkbox"/> Not Inspected					
Item	Comments				
1. Maintenance access to practice	0	1	2	3	N/A
2. Check storage tank lids	0	1	2	3	N/A
a. Vents and screens on inflow/outflow spigots	0	1	2	3	N/A
b. Lids in place, properly secured	0	1	2	3	N/A
3. Overflow pipes & downstream flow path	0	1	2	3	N/A Cause:
a. Debris/clogging in overflow pipes	0	1	2	3	N/A Cause:
b. Erosion, excessive debris, clogging of flow path	0	1	2	3	N/A Cause:
c. Condition of downstream secondary runoff reduction practice (see applicable checklist)	0	1	2	3	N/A Cause:
4. Sediment build-up in tank	0	1	2	3	N/A
5. Backflow preventer	0	1	2	3	N/A
6. Structural integrity	0	1	2	3	N/A
a. Tank and foundation	0	1	2	3	N/A
b. Pump and pump housing	0	1	2	3	N/A
c. Pipes	0	1	2	3	N/A
d. Electrical system and housing	0	1	2	3	N/A
7. Water Quality Devices	0	1	2	3	N/A
8. Mosquitos	0	1	2	3	N/A
a. Mosquito screens; check gaps and holes	0	1	2	3	N/A
b. Evidence of mosquito larvae in tank or manholes	0	1	2	3	N/A

<b>E. Miscellaneous</b>					
0 = Good condition. Well maintained, no action required.					
1 = Moderate condition. Adequately maintained, routine maintenance needed.					
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.					
3 = Serious condition. Immediate need for repair or replacement.					
<input type="checkbox"/> Inspected					
<input type="checkbox"/> Not Inspected					
Item	Comments				
1. Complaints from local residents	0	1	2	3	N/A
2. Mosquito proliferation	0	1	2	3	N/A
3. Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A
4. Adequate safety signage	0	1	2	3	N/A

**Inspector's Summary:**

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)





Photographs	
Photo ID	Description
1.	
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**Sketch of Practice**  
(note problem areas)



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**Rainwater Harvesting**  
**Maintenance Inspection Checklist**

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*Item 6.*



## Impervious Surface Disconnection Maintenance Inspection Checklist

Party Responsible for Maintenance: \_\_\_\_\_

Practice ID: \_\_\_\_\_

Contact: \_\_\_\_\_

Location: \_\_\_\_\_

Phone Number: \_\_\_\_\_

GPS Coordinates: \_\_\_\_\_

E-mail: \_\_\_\_\_

Inspector(s): \_\_\_\_\_ Mailing Address: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

### Key Questions

Item	X	Comments
1. Type of impervious area disconnected		
a. Rooftop	<input type="checkbox"/>	
b. Parking	<input type="checkbox"/>	
c. Other	<input type="checkbox"/>	
2. Type of disconnection surface		
a. Managed turf areas	<input type="checkbox"/>	
b. Forest cover or preserved open space	<input type="checkbox"/>	
c. Soil compost amended filter path	<input type="checkbox"/>	
3. Type of forest cover or open space (if applicable)		
a. Forest	<input type="checkbox"/>	
b. Meadow/Brush	<input type="checkbox"/>	
c. Other	<input type="checkbox"/>	
4. Vegetative Cover Condition		
a. Good	<input type="checkbox"/>	
b. Average	<input type="checkbox"/>	
c. Poor	<input type="checkbox"/>	
5. Meets width/length requirement	<input type="checkbox"/>	

### A. Contributing Drainage Area

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/> Inspected									
<input type="checkbox"/> Not Inspected									
Item									Comments
1. Excessive trash/debris	0	1	2	3	N/A				
2. Excessive landscape waste/yard clippings	0	1	2	3	N/A				

### B. Inflow Points

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/> Inspected									
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(Supp. No. 45)

Created: 2021-07-22 09:11:36 [EST]



## Impervious Surface Disconnection Maintenance Inspection Checklist

<input type="checkbox"/>	Not Inspected								
Item		Comments							
1.	Inflow points (e.g. downspouts, curb cuts, edge of pavement, level spreader) provide stable conveyance into practice	0	1	2	3	N/A			
2.	Runoff enters pervious area as sheet flow	0	1	2	3	N/A			
3.	Excessive trash/debris/sediment	0	1	2	3	N/A			
4.	Evidence of erosion at/around inflow points	0	1	2	3	N/A			
5.	Level spreader functional, if applicable	0	1	2	3	N/A			

### C. Practice (Pervious Area Receiving Runoff)

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected								
<input type="checkbox"/>	Not Inspected								
Item		Comments							
1.	Maintenance access to area	0	1	2	3	N/A			
2.	Downspouts or surface impervious area drains to the receiving pervious area (doesn't bypass)	0	1	2	3	N/A			
3.	Receiving pervious areas retain dimensions as shown on plans and are in good	0	1	2	3	N/A			
4.	Excessive trash/debris/sediment	0	1	2	3	N/A			
5.	Evidence of standing water:	0	1	2	3	N/A			
	a. Ponding								
	b. Noticeable odors								
	c. Water stains								
	d. Presence of algae or floating aquatic vegetation								
6.	Evidence of erosion	0	1	2	3	N/A			
7.	Evidence of oil/chemical accumulation	0	1	2	3	N/A			
8.	Vegetation	0	1	2	3	N/A			
	a. Plant composition consistent with approved plans	0	1	2	3	N/A			
	b. Presence of invasive species/weeds	0	1	2	3	N/A			
	c. Dead vegetation/exposed soil	0	1	2	3	N/A			
	d. Disturbance to natural vegetation or excessive maintenance (e.g. mowing, tree cutting)	0	1	2	3	N/A			
	e. Restoration planting survival, if	0	1	2	3	N/A			
9.	Conservation area signs (if applicable)	0	1	2	3	N/A			
10.	Level spreader (if applicable)	0	1	2	3	N/A			

### D. Miscellaneous

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

(Supp. No. 45)





## Impervious Surface Disconnection Maintenance Inspection Checklist

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected						
<input type="checkbox"/>	Not Inspected						
Item							Comments
1.	Complaints from local residents	0	1	2	3	N/A	
2.	Mosquito proliferation	0	1	2	3	N/A	
3.	Encroachment on pervious area or easement by buildings or other structures	0	1	2	3	N/A	

### Inspector's Summary:

### Photographs

	Photo ID	Description
1.		
2.		
3.		
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### Sketch of Practice (note problem areas)

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



20 of 33

## Dry Detention Practices Maintenance Inspection Checklist

<b>Party Responsible for Maintenance:</b> _____ <b>Contact:</b> _____ <b>Phone Number:</b> _____ <b>E-mail:</b> _____	<b>Practice ID:</b> _____ <b>Location:</b> _____ <b>GPS Coordinates:</b> _____ <b>Inspector(s):</b> _____ <b>Mailing Address:</b> _____ _____ <b>Date:</b> _____ <b>Time:</b> _____
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Key Questions		
Item	X	Comments
1. Type of detention practice		
a. Dry Pond	<input type="checkbox"/>	
b. Underground Detention Vault and/or Tank	<input type="checkbox"/>	
c. Other	<input type="checkbox"/>	Type: _____

<b>A. Contributing Drainage Area</b> 0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.							
<input type="checkbox"/>	Inspected						
<input type="checkbox"/>	Not Inspected						
	Item	0	1	2	3	N/A	Comments
1.	Excessive trash/debris					N/A	
2.	Bare/exposed soil					N/A	
3.	Evidence of erosion					N/A	
4.	Excessive landscape waste/yard clippings					N/A	
5.	Oils, greases, paints and other harmful substances disposed of in drainage area.					N/A	

<b>B. Forebay/Pretreatment</b> 0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.							
<input type="checkbox"/>	Inspected						
<input type="checkbox"/>	Not Inspected						
	Item	0	1	2	3	N/A	Comments
1.	Maintenance access to pretreatment facility					N/A	
2.	Excessive trash/debris accumulation					N/A	
3.	Excessive sediment accumulation					N/A	Sediment marker reading: _____
4.	Evidence of clogging					N/A	
5.	Dead vegetation/exposed soil					N/A	
6.	Evidence of erosion					N/A	

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Dry Detention Practices**  
**Maintenance Inspection Checklist**

**C. Inlets**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected									
<input type="checkbox"/>	Not Inspected									
		Item					Comments			
1.	Inlets provide stable conveyance into	0	1	2	3	N/A				
2.	Excessive trash/debris/sediment accumulation at inlet	0	1	2	3	N/A				
3.	Evidence of erosion at/around inlet	0	1	2	3	N/A				
4.	Damaged pipes or components	0	1	2	3	N/A				
5.	Inflow hindered by soil height, build up of sediment and/or grass	0	1	2	3	N/A				

**D. Practice**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected									
<input type="checkbox"/>	Not Inspected									
		Item					Comments			
1.	Maintenance access to practice	0	1	2	3	N/A				
2.	Sediment accumulation	0	1	2	3	N/A				
3.	Abnormally high or low water levels	0	1	2	3	N/A Cause:				
4.	Evidence of pollution/hotspot runoff	0	1	2	3	N/A Cause:				
5.	Berm(s)/embankment(s)	0	1	2	3	N/A				
a.	Cracking, bulging, or sloughing	0	1	2	3	N/A				
b.	Soft spots or sinkholes	0	1	2	3	N/A				
c.	Evidence of erosion/bare spots	0	1	2	3	N/A				
d.	Evidence of animal burrows	0	1	2	3	N/A				
e.	Presence of woody vegetation	0	1	2	3	N/A				
6.	Riser/outlet	0	1	2	3	N/A Type of riser:				
a.	Maintenance access to riser	0	1	2	3	N/A				
b.	Structural condition of riser	0	1	2	3	N/A				
c.	Condition of joints	0	1	2	3	N/A				
d.	Trash/debris accumulation	0	1	2	3	N/A				
e.	Woody growth within 5 ft. of outlet	0	1	2	3	N/A				
f.	Emergency spillway eroding or failing	0	1	2	3	N/A				
7.	Low flow orifice	0	1	2	3	N/A				
a.	Trash/debris accumulation	0	1	2	3	N/A				
b.	Adjustable control valve accessible and operational	0	1	2	3	N/A				
9.	Vegetation	0	1	2	3	N/A				
a.	Plant composition consistent with approved plans	0	1	2	3	N/A				
b.	Presence of invasive species/weeds	0	1	2	3	N/A				
c.	Dead vegetation/exposed soil	0	1	2	3	N/A				

[EST]

(Supp. No. 45)



**Dry Detention Practices**  
**Maintenance Inspection Checklist**

d. Reinforcement planting recommended ☐

**E. Outlets**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected

☐ Not Inspected

	Item						Comments
1.	Outlets provide stable conveyance out of practice	0	1	2	3	N/A	
2.	Excessive trash/debris/sediment accumulation at outlet	0	1	2	3	N/A	
3.	Evidence of erosion at/around outlet/outfall	0	1	2	3	N/A	
4.	Evidence of leaking/clogging of trash racks or reversed slope pipes	0	1	2	3	N/A	

**F. Miscellaneous**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected

☐ Not Inspected

	Item						Comments
1.	Complaints from local residents	0	1	2	3	N/A	
2.	Mosquito proliferation	0	1	2	3	N/A	
3.	Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A	
4.	Adequate safety signage	0	1	2	3	N/A	

**Inspector's Summary:****Photographs**

[EST]

(Supp. No. 45)





Dry Detention Practices  
Maintenance Inspection Checklist

Photo ID	Description
1.	
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Sketch of practice (note problem areas)

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Stormwater Wet Pond/Wetland  
Maintenance Inspection Checklist**

Item 6.

**Party Responsible for Maintenance:** \_\_\_\_\_

**Practice ID:** \_\_\_\_\_

**Contact:** \_\_\_\_\_

**Location:** \_\_\_\_\_

**Phone Number:** \_\_\_\_\_

**GPS Coordinates:** \_\_\_\_\_

**E-mail:** \_\_\_\_\_

**Inspector(s):** \_\_\_\_\_ **Mailing Address:** \_\_\_\_\_

**Date:** \_\_\_\_\_ **Time:** \_\_\_\_\_

**Key Questions**

Item	X	Comments
1. Type of stormwater practice (check all that apply)		
a. Stormwater wetland basin	<input type="checkbox"/>	
b. Stormwater multi-cell wetland or pond/wetland combination	<input type="checkbox"/>	
c. Subsurface gravel wetland	<input type="checkbox"/>	
d. Wet pond	<input type="checkbox"/>	
d. Other	<input type="checkbox"/>	Type: _____
2. Type of pretreatment facility (check all that apply)		Pretreatment must be provided
a. Sediment forebay	<input type="checkbox"/>	
b. Other	<input type="checkbox"/>	Type: _____

**A. Contributing Drainage Area**

0 = Good condition. Well maintained, no action required.  
 1 = Moderate condition. Adequately maintained, routine maintenance needed.  
 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
 3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected								
<input type="checkbox"/>	Not Inspected								
Item	0	1	2	3	N/A	Comments			
1. Excessive trash/debris	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
2. Bare/exposed soil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
3. Evidence of erosion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
4. Excessive landscape waste/yard clippings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
5. Oils, greases, paints and other harmful substances disposed of in drainage area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				

**B. Pretreatment**

0 = Good condition. Well maintained, no action required.  
 1 = Moderate condition. Adequately maintained, routine maintenance needed.  
 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.  
 3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected								
<input type="checkbox"/>	Not Inspected								
Item	0	1	2	3	N/A	Comments			

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Stormwater Wet Pond/Wetland  
Maintenance Inspection Checklist**

1. Maintenance access to pretreatment facility	0	1	2	3	N/A	
2. Excessive trash/debris accumulation	0	1	2	3	N/A	
3. Excessive sediment accumulation	0	1	2	3	N/A	Sediment marker reading:
4. Evidence of clogging	0	1	2	3	N/A	
5. Dead vegetation/exposed soil	0	1	2	3	N/A	
6. Evidence of erosion	0	1	2	3	N/A	

**C. Inlets**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected									
<input type="checkbox"/>	Not Inspected									
		Item					Comments			
1.	Inlets provide stable conveyance into	0	1	2	3	N/A				
2.	Excessive trash/debris/sediment accumulation at inlet	0	1	2	3	N/A				
3.	Evidence of erosion at/around inlet	0	1	2	3	N/A				
4.	Damaged pipes or components	0	1	2	3	N/A				
5.	Inflow hindered by soil height, build up of sediment and/or grass	0	1	2	3	N/A				
6.	Asphalt/concrete crumbling at inlets	0	1	2	3	N/A				

**D. Practice**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected									
<input type="checkbox"/>	Not Inspected									
		Item					Comments			
1.	Maintenance access to practice	0	1	2	3	N/A				
2.	Sediment accumulation	0	1	2	3	N/A				
	Bathymetric study recommended									
3.	Abnormally high or low water levels	0	1	2	3	N/A	Cause:			
4.	Evidence of pollution/hotspot runoff	0	1	2	3	N/A	Cause:			
5.	Berm(s)/embankment(s)	0	1	2	3	N/A				
	a. Cracking, bulging, or sloughing	0	1	2	3	N/A				
	b. Soft spots or sinkholes	0	1	2	3	N/A				
	c. Evidence of erosion/bare spots	0	1	2	3	N/A				
	d. Evidence of animal burrows	0	1	2	3	N/A				
	e. Presence of woody vegetation	0	1	2	3	N/A				

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Stormwater Wet Pond/Wetland  
Maintenance Inspection Checklist**

6. Riser/outlet	0	1	2	3	N/A	Type of riser:
a. Maintenance access to riser	0	1	2	3	N/A	
b. Structural condition of riser	0	1	2	3	N/A	
c. Condition of joints	0	1	2	3	N/A	
d. Trash/debris accumulation	0	1	2	3	N/A	
e. Woody growth within 5 ft. of outlet	0	1	2	3	N/A	
f. Emergency spillway eroding, or failing	0	1	2	3	N/A	
7. Low flow orifice	0	1	2	3	N/A	
a. Trash/debris accumulation	0	1	2	3	N/A	
b. Adjustable control valve accessible and operational	0	1	2	3	N/A	
8. Pond drain (underdrain) system (if applicable)	0	1	2	3	N/A	
a. Broken	0	1	2	3	N/A	
b. Clogged	0	1	2	3	N/A	
c. Adjustable control valve accessible and operational	0	1	2	3	N/A	
9. Vegetation	0	1	2	3	N/A	
a. Plant composition consistent with approved plans	0	1	2	3	N/A	
b. Presence of invasive species/weeds	0	1	2	3	N/A	
c. Dead vegetation/exposed soil	0	1	2	3	N/A	
d. Reinforcement planting recommended	<input type="checkbox"/>					

**E. Outlets**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected☐ Not Inspected

Item	Comments
1. Outlets provide stable conveyance out of practice	0 1 2 3 N/A
2. Excessive trash/debris/sediment accumulation at outlet	0 1 2 3 N/A
3. Evidence of erosion at/around outlet/outfall	0 1 2 3 N/A
4. Evidence of polluted water being released – discoloration, odor, staining, etc.	0 1 2 3 N/A

**F. Miscellaneous**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

Created: 2021-07-22 09:11:50 [EST]

(Supp. No. 45)





**Stormwater Wet Pond/Wetland  
Maintenance Inspection Checklist**

Item 6.

<input type="checkbox"/>	Inspected						
<input type="checkbox"/>	Not Inspected						
Item							Comments
1.	Complaints from local residents	0	1	2	3	N/A	
2.	Mosquito proliferation	0	1	2	3	N/A	
3.	Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A	
4.	Adequate safety signage	0	1	2	3	N/A	

**Inspector's Summary:**

Photographs	
Photo ID	Description
1.	
2.	
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9.	
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**Sketch of practice**  
(note problem areas)

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)



**Stormwater Wet Pond/Wetland  
Maintenance Inspection Checklist**

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*Item 6.*



**Grass Swale**  
**Maintenance Inspection Checklist**

**Party Responsible for Maintenance:** \_\_\_\_\_

**Practice ID:** \_\_\_\_\_

**Contact:** \_\_\_\_\_

**Location:** \_\_\_\_\_

**Phone Number:** \_\_\_\_\_

**GPS Coordinates:** \_\_\_\_\_

**E-mail:** \_\_\_\_\_

**Inspector(s):** \_\_\_\_\_ **Mailing Address:** \_\_\_\_\_

**Date:** \_\_\_\_\_ **Time:** \_\_\_\_\_

**A. Contributing Drainage Area**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected

☐ Not Inspected

Item						Comments
1. Excessive trash/debris	0	1	2	3	N/A	
2. Bare/exposed soil	0	1	2	3	N/A	
3. Evidence of erosion	0	1	2	3	N/A	
4. Excessive landscape waste/yard clippings	0	1	2	3	N/A	
5. Impervious area added	0	1	2	3	N/A	

**B. Inflow Points**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected

☐ Not Inspected

Item						Comments
1. Inflow points (e.g. curb cuts, edge of pavement, pipes) provide stable conveyance into the channel	0	1	2	3	N/A	
2. Excessive trash/debris/sediment accumulation at inflow points	0	1	2	3	N/A	
3. Evidence of erosion at/around inflow points	0	1	2	3	N/A	

**C. Practice (Grass Swale)**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected

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(Supp. No. 45)



**Grass Swale**  
**Maintenance Inspection Checklist**

<input type="checkbox"/>	Not Inspected						
	Item	0	1	2	3	N/A	Comments
1.	Swale remains vegetated; no concrete, rip-rap, or other lining has been added	0	1	2	3	N/A	
2.	Grade ensures positive flow	0	1	2	3	N/A	
3.	Evidence of erosion	0	1	2	3	N/A	
4.	Sediment accumulation	0	1	2	3	N/A	
5.	Excessive trash/debris accumulation	0	1	2	3	N/A	
6.	Evidence of oil/chemical accumulation	0	1	2	3	N/A	
7.	Vegetation condition	0	1	2	3	N/A	
	a. Mowing as needed to maintain 4"-6" grass height.	0	1	2	3	N/A	
	b. 90% turf cover in practice.	0	1	2	3	N/A	
8.	Check dams in place	0	1	2	3	N/A	
9.	Signs of erosion around or under check dams	0	1	2	3	N/A	

**D. Miscellaneous**

0 = Good condition. Well maintained, no action required.

1 = Moderate condition. Adequately maintained, routine maintenance needed.

2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.

3 = Serious condition. Immediate need for repair or replacement.

<input type="checkbox"/>	Inspected						
<input type="checkbox"/>	Not Inspected						
	Item	0	1	2	3	N/A	Comments
1.	Complaints from local residents	0	1	2	3	N/A	
2.	Mosquito breeding	0	1	2	3	N/A	
3.	Encroachments (e.g. filling, fences, obstructions, etc.)	0	1	2	3	N/A	

**Inspector's Summary:**

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Photographs	
Photo ID	Description
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

(note problem areas)



**Grass Swale**  
**Maintenance Inspection Checklist**

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## Appendix G: Compliance Calculator Spreadsheet Instructions

### Table of Contents

G.1 Introduction.....	1
G.2 Compliance Calculator Spreadsheet Guidance .....	1

### **G.1 Introduction**

The compliance calculator spreadsheet (Appendix H) was created to allow a designer to quickly analyze multiple LID options and check them against the watershed area's water quality design requirements. As is clear from the specifications, each LID BMP has different design requirements, equations, and standards that determine its effectiveness. Depending upon the site, it can become difficult to determine which BMP(s) best meets the requirements. With the compliance calculator, it is easier to examine different combinations of BMPs in order to find the best option or set of options. The compliance calculator is also to be used by the plan reviewer to quickly verify the compliance status of a plan.

It is important to note that the compliance calculator is not a model, and while it can be used as a design tool, it does not replace the needed efforts of a competent designer. The numbers in the spreadsheet don't guarantee that a BMP meets the specifications, is appropriate for its location, or is generally well-designed.

### **G.2 Compliance Calculator Spreadsheet Guidance**

The following guidance explains how to use each of the worksheets in the compliance calculator spreadsheet (Appendix H).

Note: All cells highlighted in blue are user input cells. Cells highlighted in gray are calculation cells, and cells highlighted in yellow are constant values that generally should not be changed.

#### **Site Data Sheet**

1. Enter the name of the proposed project on **line 9**.
2. Enter the pre-development land cover areas (in acres) of forest/open space cover, turf cover, impervious cover and BMP cover for the site for Natural Resource Conservation Service (NRCS) soil types A, B, C, and D in cells C24-C27, E24-E27, G24-G27, and I24-I27, respectively.
3. Verify/enter the NRCS runoff curve numbers for each land use/soil type combination in cells D24-D27, F24-F27, H24-H27, and J24-J27. Default values have already been included in these cells, but they can be changed if necessary.
4. Enter the post-development land cover areas (in acres) of forest cover/open space, turf cover, impervious cover and BMP cover on the site for Natural Resource Conservation Service (NRCS) soil types A, B, C, and D in cells C34-C37, E34-E37, G34-G37, and I34-I37, respectively.
5. Verify/enter the NRCS runoff curve numbers for each land use/soil type combination in cells D34-D37, F34-F37, H34-H37, and J34-J37. As with the pre-development entries, default values have already been included in these cells, but they can be changed if necessary.

## BMP Sheet

1. Apply BMPs to the drainage area to address the required water quality volume by indicating the area in square feet (sf) of forest cover, turf cover, and impervious cover to be treated by a given BMP in **Columns B, C, and D**. This will likely be an iterative process. The available BMPs include the following:
  - Bioretention – No Underdrain
  - Bioretention - IWS
  - Bioretention - Standard
  - Permeable Pavement - Enhanced
  - Permeable Pavement - Standard
  - Infiltration
  - Green Roof
  - Green Roof – Irrigated
  - Rainwater Harvesting
  - Impervious Surface Disconnection
  - Grass Channel
  - Grass Channel – Amended Soils
  - Dry Swale
  - Wet Swale
  - Regenerative Stormwater Conveyance (RSC)
  - Filtering Systems
  - Storage Practices
  - Stormwater Ponds
  - Stormwater Wetlands
  - Proprietary Practice
  - Planted Tree
  - Preserved Tree
2. Enter the BMP's surface area (sf) in Column E and storage volume (cf) in Column F.
3. If a Stormwater Pond is used for irrigation the contributing drainage area and storage volume (determined from the Rainwater Harvesting Calculator) are entered in the Rainwater Harvesting cells B24, C24, D24, E24 and F24, respectively. The Stormwater Pond row remains empty unless there are other ponds used that are not used for irrigation.
4. If other Rainwater Harvesting BMPs are used, the Rainwater Harvesting Calculator is used to determine the contributing drainage area and storage volume inputs to the BMP worksheet.
5. The volume from direct drainage to the BMP is calculated and reported in **Column E**. Note that the total disturbed area is reflected as the sum of impervious cover (**Column D**), turf cover (**Column C**) and forest/open space cover (**Column B**) draining to the practice.
6. If more than one BMP will be employed in series, any overflow from upstream BMPs will be accounted for in **Column M**.

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

G2

7. The total volume captured by the practice ( $V_{CAP}$ ) is reported in **Column N** and is equal to the following:

$$W_{CCCC} = \text{MMNNNNNNNNMM} (SSSS, W_{UUUU} + W_{DDDD})$$

Where:

$WQv_{CAP}$	=	Water Quality Volume captured by the practice (cf) ( <b>Column N</b> )
$S_v$	=	Storage Volume (cf) ( <b>Column F</b> )
$V_{US}$	=	Volume of runoff from upstream practice (cf) ( <b>Column M</b> )
$V_{DD}$	=	Volume of runoff from direct discharge (cf) ( <b>Column L</b> )

8. The Runoff Reduction or Pollutant Removal Efficiency (%) for each BMP (from Table 2.3) is reported in **Columns H-K**.
9. The Water Quality Volume Credited is calculated in **Column O**, and is equal to the following:

$$WWWWSS_{CCCC} = \text{MMNNNNNNNNMM } 0000 (SSSS \times CCCC, V_{CCCC})$$

Where:

$WQv_{CR}$	=	Water Quality Volume Credited (cf)
$S_v$	=	Storage Volume (cf) ( <b>Column F</b> )
$CR$	=	Credit (fraction)
$V_{CAP}$	=	Volume Captured by the Practice (cf) ( <b>Column N</b> )

10. The Remaining Water Quality Volume (**Column P**) is calculated as:

$$WWWWSS_{CC} = V_{UUUU} + V_{DDDD} - W_{CCCC}$$

Where:

$WQv_R$	=	Water Quality Volume Remaining (cf) ( <b>Column O</b> )
$V_{US}$	=	Volume from Upstream Practices (cf) ( <b>Column M</b> )
$V_{DD}$	=	Volume from Direct Drainage (cf) ( <b>Column L</b> )

11. Any runoff volume remaining can be directed to a downstream BMP by selecting a practice from the pull-down menu in **Column G**. Selecting a BMP from the menu will automatically direct the runoff volume remaining to **Column M (volume from upstream practices)** for the appropriate BMP.
12. Planted Trees. Input the number of planted and preserved trees of each size class in cells F38-F42 (retention values correspond to Table 4.62 and 4.63 in design manual).
13. The Target Retention Volume ( $WQv_T$ ) is reported in **Cell B49**, from corresponding **Cell C42** on the **Site Data Tab**.
14. The Water Quality Volume Provided ( $WQv_P$ ), is calculated in **Cell C49** as a combination of the retention values for all BMPs and trees (Cells O17-O42)
15. The fraction of target achieved (either by practice or by the entire site as appropriate) is calculated in **Cells F31-F35**. The % of target achieved is calculated as follows:

$$TT = \text{MMMMMMMMMMMM } 0000 \frac{WWWWSS_{CC}}{WWWWSS_{TT}}, 1$$

Where:

$T$	=	Treatment (fraction)
-----	---	----------------------

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$WQv_P$  = Water Quality Volume Provided (cf)  
 $WQv_T$  = Water Quality Volume Target (cf)

16. Cells **D49, 52, 54, 58, and 61** determine if the site target has been reached as follows:

- Overall Retention Goal
  - Target Retention Volume
- General Stormwater Management Watershed Area Minimum Requirements
  - Target Retention Volume (1.16 in storm)
  - Target TSS Removal
  - Target Nitrogen Removal
  - Target Bacteria Removal
- Savannah River Special Watershed Protection Area Minimum Requirements
  - Target Retention Volume (1.16 in storm)
  - Target TSS Removal
  - Target Nitrogen Removal
  - Target Bacteria Removal

### Channel and Flood Protection

This sheet assists with calculation of Adjusted Curve Numbers that can be used to calculate peak flows associated with the 2- to 100-year storm events.

17. Enter the appropriate depths for the 2-year, 10-year, 25-year and 100-year 24-hour storms (as provided in Table 2.4) on **Line 5**.

18. The Total Site Area (from the **Site Data** Tab), is reported in **Cell C7**.

19. Detention Storage Volume (cf) is calculated in **Cell C8**, and refers to the total storage provided in all LID practices using the following equation:

$$V_{DDUV} = \frac{SSSS_{BBBBCC} \cdot ICCII_{BBBBCC}}{LLLLDD_{BBBBCCBB}}$$

Where:

$V_{DS}$  = Volume in Site Detention Storage (cf)  
 $SV_{BMP}$  = Storage Volume Provided in Each BMP (cf)  
 (from **Column F** of the **BMPs** Tab)  
 $IRD_{BMP}$  = Infiltration, Retention or Detention Credit for Each BMP  
 (from **Column J** of the **BMPs** Tab)

Note that, while other practices such as ponds provide detention, it is assumed that design engineers will explicitly account for this detention in a Pond Routing program.

20. As indicated in the Site Data sheet, each cover type is associated with a NRCS curve number. **Cells D15–G22** show the pre-development land cover areas and curve numbers that were indicated on the Site Data Sheet. Using these curve numbers, a weighted curve number is calculated in **cell G24**.
21. **Cells D29–G36** show the post-development land cover areas and curve numbers that were indicated on the Site Data Sheet. Using these curve numbers, a weighted curve number is calculated in **cell G38**.
22. Using NRCS methodology, **Line 42** calculates the pre-development runoff volume (inches) for the various storm events.

*Potential Abstraction*

$$SS = \frac{1000}{(CCCC - 10)}$$

Where:

$S$  = potential abstraction (in.)  
 $CN$  = weighted curve number

*Runoff Volume*

$$WW = \frac{(PP - 0.2 \cdot SS)^2}{(PP + 0.8 \cdot SS)}$$

Where:

$Q$  = runoff volume (in.)  
 $P$  = precipitation depth for a given 24-hour storm (in.)  
 $S$  = potential abstraction (in.)

23. **Line 43** calculates the post-development runoff volume based solely on land cover (without regard to the BMPs selected on the BMP sheet). **Line 44** then subtracts the runoff reduction volume provided by BMPs, from **Cell C8**.
24. Based upon the reduced runoff volumes calculated in line 44, the spreadsheet then calculates corresponding reduced curve numbers for each storm event. This Adjusted Curve Number is reported on **Line 45**.
25. **Line 46** compares the pre-development runoff volume in line 42 with the post-development (with BMPs) runoff volume in line 44. If the post-development volume (with BMPs) is less than or equal to the pre-development volume for a given storm event, then it is assumed that detention will not be required. If the post-development volume (with BMPs) is greater than the pre-development volume for a given storm event, then detention will be necessary, and the Adjusted Curve Numbers from line 45 should be used to calculate the post-development peak runoff rates.



[illegible]

Southern Low Country Stormwater Compliance Calculator - Updated 8/20/20																
Site Drainage Area 1																
Indicate Post-Development Land Cover and Runoff Curve Numbers in the Site's Disturbed Area																
Area (square feet)																
Cover Type	Soil Type A	Soil Type B	Soil Type C	Soil Type D	Total	% Cover	Rv									
Forest Cover/Open Space					0	0%	0									
Turf Cover					0	0%	0									
Impervious Cover					0	0%	0.95									
BMP					0	0%	0.95									
Total	0	0	0	0	0	0%	0									
BMPs																
Contributing Drainage Area																
	Forest Cover Draining to BMP	Turf Cover Draining to BMP	Impervious Cover Draining to BMP	BMP Surface Area	Storage Volume Provided by BMP (cubic feet)	Downstream BMP	Water Quality Credits				Retention (cf)					
	Area (square feet)	Area (square feet)	Area (square feet)	Area (square feet)			Runoff Reduction	TSS % Removal	Total N % Removal	Bacteria % Removal	Volume from Direct Drainage	Volume from Upstream Practices	Total Volume Captured by BMP	Volume Credited		
Bioretention - No Underdrain							100%	100%	100%	100%	#N/A	0	#N/A	#N/A		
Bioretention - IWS							75%	85%	85%	80%	#N/A	0	#N/A	#N/A		
Bioretention - Standard							60%	85%	75%	80%	#N/A	0	#N/A	#N/A		
Permeable Pavement - Enhanced							100%	100%	100%	100%	#N/A	0	#N/A	#N/A		
Permeable Pavement - Standard							30%	80%	45%	30%	#N/A	0	#N/A	#N/A		
Infiltration							100%	100%	100%	100%	#N/A	0	#N/A	#N/A		
Green Roof							100%	100%	100%	100%	#N/A	0	#N/A	#N/A		
Rainwater Harvesting							100%	100%	100%	100%	#N/A	0	#N/A	#N/A		
Impervious Surface Disconnection							40%	80%	40%	40%	#N/A	0	#N/A	#N/A		
Grass Channel							10%	50%	25%	30%	#N/A	0	#N/A	#N/A		
Grass Channel - Amended Soils							20%	50%	35%	30%	#N/A	0	#N/A	#N/A		
Dry Swale							60%	85%	70%	80%	#N/A	0	#N/A	#N/A		
Wet Swale							0%	80%	25%	60%	#N/A	0	#N/A	#N/A		
RSC							0%	80%	40%	80%	#N/A	0	#N/A	#N/A		
Filtering Systems							0%	80%	30%	80%	#N/A	0	#N/A	#N/A		
Storage Practices							0%	60%	10%	60%	#N/A	0	#N/A	#N/A		
Stormwater Ponds							0%	80%	30%	60%	#N/A	0	#N/A	#N/A		
Stormwater Wetlands							0%	80%	25%	60%	#N/A	0	#N/A	#N/A		
Proprietary Practice											#N/A	0	#N/A	#N/A		
Input Number of Trees																
Planted Tree - Small							5 cf/tree	N/A	N/A	N/A	N/A	N/A	N/A	0		
Planted Tree - Large							10 cf/tree	N/A	N/A	N/A	N/A	N/A	N/A	0		
Preserved Tree - Small							10 cf/tree	N/A	N/A	N/A	N/A	N/A	N/A	0		
Preserved Tree - Large							20 cf/tree	N/A	N/A	N/A	N/A	N/A	N/A	0		
Preserved Tree - Special							30 cf/tree	N/A	N/A	N/A	N/A	N/A	N/A	0		
Totals	0.00	0.00	0.00		0.00											

[illegible]



Watershed Protection Area	Design Storm
General Stormwater Management Watershed Area	1.16
Savannah River Special Watershed Protection Area	1.16
Bacteria and Shellfish Special Watershed Protection Area	1.95

0%  
100%

0%  
80%



## Appendix I: General Design Criteria and Guidelines

### Table of Contents

I.1	Hydrology and Runoff Determination.....	1
I.1.1	Acceptable Hydrologic Methods and Models.....	1
I.1.1.1	Urban Hydrology for Small Watersheds TR-55 .....	2
I.1.1.2	Storage-Indication Routing .....	4
I.1.1.3	HEC-1, WinTR-55, TR-20, ICPR and SWMM Computer Models .....	4
I.1.2	Stormwater Volume Peak Discharge .....	4
I.2	Storm Sewer Collection System .....	6
I.2.1	Introduction .....	6
I.2.2	Clearance with Other Utilities .....	6
I.2.3	Pipe Systems .....	6
I.2.4	Hydraulic Grade Line .....	7
I.3	Open Channels .....	7
I.4	References .....	<b>Error! Bookmark not defined.</b>

### **I.1 Hydrology and Runoff Determination**

#### **I.1.1 Acceptable Hydrologic Methods and Models**

The following are the acceptable methodologies and computer models for estimating runoff hydrographs before and after development. These methods are used to predict the runoff response from given rainfall information and site surface characteristic conditions. The design storm frequencies used in all of the hydrologic engineering calculations will be based on design storms required in this guidebook unless circumstances make consideration of another storm intensity criterion appropriate:

- ☐ Rational Method (limited to sites under 10 acres)
- ☐ Urban Hydrology for Small Watersheds TR-55 (TR-55)
- ☐ Storage-Indication Routing
- ☐ HEC-1, WinTR-55, TR-20, and SWMM Computer Models

These methods are given as valid in principle and are applicable to most stormwater management design situations in the Southern Lowcountry. Other methods may be used when the Southern Lowcountry reviewing authority approves their application.

Note: Of the above methods, TR-55 and SWMM allow for the easiest correlation of the benefits of retention BMPs used to meet the stormwater retention volume (SWRV) with peak flow detention requirements and are therefore strongly recommended.

The following conditions shall be assumed when developing predevelopment, pre-project, and post-development hydrology, as applicable:

(Supp. No. 45)

Created: 2021-07-22 09:11:36 [EST]

- For new development sites the runoff conditions shall be computed independent of existing developed land uses and conditions and shall be based on “Meadow in good condition” or better, assuming good hydrologic conditions and land with grass cover (NEH, 2004).
- For infill and redevelopment sites the predeveloped condition is the condition at the time of project submittal.
- Post-development conditions shall be computed for future land use assuming good hydrologic and appropriate land use conditions. If an NRCS CN Method-based approach, such as TR-55, is used, this curve number (CN) may be reduced based upon the application of retention BMPs, as indicated in the General Retention Compliance Calculator (Appendix H). This CN reduction will reduce the required detention volume for a site, but it should not be used to reduce the size of conveyance infrastructure.
- The rainfall intensity - duration - frequency curve should be determined from the most recent version of the Hydrometeorological Design Studies Center’s Precipitation Frequency Data Server (NOAA Atlas 14, Volume 2).
- Predevelopment Time of Concentration ( $T_c$ ) shall be based on the sum total of computed or estimated overland flow time and travel in natural swales, streams, creeks and rivers, but never less than 6 minutes.
- Post-development Time of Concentration shall be based on the sum total of the inlet time and travel time in improved channels or storm drains but shall not be less than 6 minutes.
- Site drainage areas exceeding 10 acres that are heterogeneous with respect to land use, soils, RCN or Time of Concentration ( $T_c$ ) shall require a separate hydrologic analysis for each sub-area.
- Hydrologic soil groups (HSGs) approved for use in the <local jurisdiction> are contained in the US Department of Agriculture Web Soil Survey. Where the HSG is not available through the Soil Survey due to the listed soil type being “Urban Soils” or similar, an HSG of C shall be used.

#### I.1.1.1 Urban Hydrology for Small Watersheds TR-55

Chapter 6 of Urban Hydrology for Small Watersheds TR-55, Storage Volume for Detention Basins, or TR-55 shortcut procedure, is based on average storage and routing effects for many structures and can be used for multistage outflow devices. Refer to TR-55 for more detailed discussions and limitations.

##### Information Needed

To calculate the required storage volume using TR-55, the predevelopment hydrology, along with the post-development hydrology for the 2, 10 and 25-year, 24-hour storm events are needed. The predevelopment hydrology is based on natural conditions (meadow) and will determine the site’s predevelopment peak rate of discharge, or allowable release rate,  $q_0$ .

The post-development hydrology may be determined using the reduced CNs calculated in the General Retention Compliance Calculator or more detailed routing calculations. This will determine the site’s post-development peak rate of discharge, or inflow for the 2, 10 and 25-year, 24-hour storm events, and the site’s post-developed runoff in inches. Note that this method does not require a hydrograph. Once the above parameters are known, the TR-55 Manual can be used to approximate the storage volume required for each design storm.

##### Procedure

- 1) Determine the peak development inflows,  $q_i$ , and the allowable release rates,  $q_0$ , from the hydrology for the appropriate design storm.

Using the ratio of the allowable release rate ( $q_o$ ) to the peak developed inflow ( $q_i$ )—or  $q_o/q_i$ —for the design storms, use Figure 1 to obtain the ratio of storage volume ( $V_s$ ) to runoff volume ( $V_R$ )—for Type III storms.

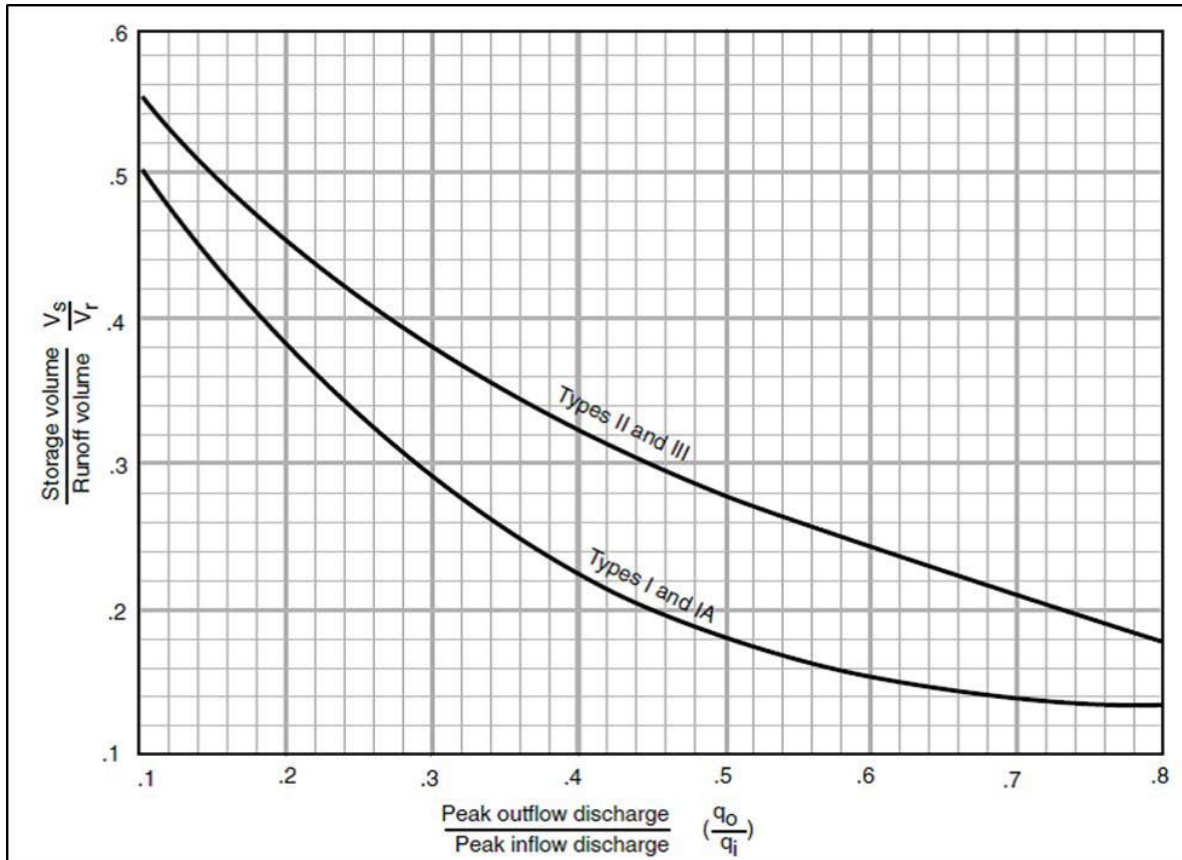


Figure 1. Approximate detention basin routing for rainfall Types I, IA, II, and III.

- 2) Determine the runoff volume  $V_R$ .

$$W_R = \frac{Q}{12} \times SDA$$

where:

- $V_R$  = post-development runoff for the design storm ( $\text{ft}^3$ )
- $Q$  = post-development runoff for the design storm (in)
- 12 = conversion factor (inches to feet)
- $SDA$  = site drainage area ( $\text{ft}^2$ )

- 3) Multiply the  $V_s/V_R$  ratios from Step 1 by the runoff volume ( $V_R$ ) from Step 2 to determine the required storage volumes ( $V_s$ ) in acre-feet.



The design procedure presented above may be used with Urban Hydrology for Small Watersheds TR-55 Worksheet 6a. The worksheet includes an area to plot the stage-storage curve, from which actual elevations corresponding to the required storage volumes can be derived. The characteristics of the stage-storage curve are dependent upon the topography of the proposed storage practice and the outlet structure, and it may be best developed using a spreadsheet or appropriate hydraulics software.

### Limitations

This routing method is less accurate as the  $q_o/q_i$  ratio approaches the limits shown in Figure 1. The curves in Figure 1 depend on the relationship between available storage, outflow device, inflow volume, and shape of the inflow hydrograph. When storage volume ( $V_s$ ) required is small, the shape of the outflow hydrograph is sensitive to the rate of the inflow hydrograph. Conversely, when  $V_s$  is large, the inflow hydrograph shape has little effect on the outflow hydrograph. In such instances, the outflow hydrograph is controlled by the hydraulics of the outflow device and the procedure therefore yields consistent results. When the peak outflow discharge ( $q_o$ ) approaches the peak inflow discharge ( $q_i$ ) parameters that affect the rate of rise of a hydrograph, such as rainfall volume, CN, and Time of Concentration, become especially significant.

The procedure should not be used to perform final design if an error in storage of 25% cannot be tolerated. Figure 1 is biased to prevent under-sizing of outflow devices, but it may significantly overestimate the required storage capacity. More detailed hydrograph development and storage indication routing will often pay for itself through reduced construction costs.

### I.1.1.2 Storage-Indication Routing

Storage-Indication Routing may be used to analyze storage detention practices. This approach requires that the inflow hydrograph be developed through one of the methods listed in this appendix (TR-55, WinTR-55, SWMM, etc.), as well as the required maximum outflow,  $q_o$ . Using the stage-discharge relationship for a given combination outlet devices, the detention volume necessary to achieve the maximum outflows can be determined.

### I.1.1.3 HEC-1, WinTR-55, TR-20, ICPR and SWMM Computer Models

If the application of the above computer models is needed, the complete input data file and print-out will be submitted with the Stormwater Management Plans (SWMPs). Submission of SWMPs shall include the following computer model documentation:

- For all computer models, supporting computations prepared for the data input file shall be submitted with the SWMPs.
- Inflow-outflow hydrographs shall be computed for each design storm presented graphically and submitted for all plans.
- Schematic (node) diagrams must be provided for all routings.

### I.1.2 Stormwater Volume Peak Discharge

The peak rate of discharge for individual design storms may be required for several different components of water quality BMP design. While the primary design and sizing factor for most stormwater retention BMPs is the design Stormwater Retention Volume (SWRV), several design elements will require a peak rate of discharge for specified design storms. The design and sizing of pretreatment cells, level spreaders, by-pass diversion structures, overflow riser structures, grass swales (Supp. No. 45)

Created: 2021-07-22 09:11:36 [EST]

and water quality swale geometry, etc. all require a peak rate of discharge in order to ensure non-erosive conditions and flow capacity.

The peak rate of discharge from an SDA can be calculated from any one of several calculation methods discussed in this appendix. The two most commonly used methods of computing peak discharges for peak runoff calculations and drainage system design are NRCS TR-55 CN methods (NRCS TR-55, 1986) and the Rational Formula. The Rational Formula is limited to 10 acre drainage areas. It is highly sensitive to the Time of Concentration and rainfall intensity, and therefore should only be used with reliable Intensity-Duration-Frequency (IDF) curves or tables for the rainfall depth and region of interest (Claytor & Schueler, 1996).

The NRCS CN methods are very useful for characterizing complex sub-watersheds and SDAs and estimating the peak discharge from large storms (greater than 2 inches), but it can significantly underestimate the discharge from small storm events (Claytor and Schueler, 1996). Since the SWRV is based on smaller storm events, this underestimation of peak discharge can lead to undersized diversion and overflow structures, potentially bypassing a significant volume of the design SWRV around the retention practice. Undersized overflow structures and outlet channels can cause erosion of the BMP conveyance features that can lead to costly and frequent maintenance.

In order to maintain consistency and accuracy, the following Modified CN Method is recommended to calculate the peak discharge for the SWRV rain event. The method utilizes the Small Storm Hydrology Method (Pitt, 1994) and NRCS Graphical Peak Discharge Method (USDA, 1986) to provide an adjusted CN that is more reflective of the runoff volume from impervious areas within the SDA. The design rainfall is a NRCS Type III distribution, so the method incorporates the peak rainfall intensities common in the eastern United States, and the time of concentration is computed using the method outlined in TR-55.

The following steps describe how to calculate the SWRV peak rate of discharge ( $q_{pSWRV}$ ) for the 85<sup>th</sup> percentile rain (1.16-inch) event.

**1) Calculate the adjusted CN for the site or contributing drainage area (CDA).**

The following equation is derived from the NRCS CN Method and is described in detail in the National Engineering Handbook Part 630 Chapter 10: Estimation of Direct Runoff from Storm Rainfall and NRCS TR-55 Chapter 2: Estimating Runoff:

$$CN_{adj} = \frac{1,000}{10 + 5P + 10Q_a - 10(Q_a^2 + 1.25PQ_a)^{0.5}}$$

where:

$CN$  = adjusted curve number

$P$  = rainfall (in, 1.16 or 1.95 in)

$Q_a$  = runoff volume (watershed inches), equal to SWRV/SDA

Note: When using hydraulic/hydrologic model for sizing a retention BMP or calculating the SWRV peak discharge, designers must use this modified CN for the CDA to generate runoff equal to the SWRV for the design rainfall event.

**2) Compute the site drainage area's time of concentration ( $T_c$ ).**

(Supp. No. 45)

TR-55 Chapter 3: Time of Concentration and Travel Time provides a detailed procedure for computing the  $T_c$ .

Created: 2021-07-22 09:11:36 [EST]



**3) Calculate the stormwater retention volume peak discharge ( $q_{pSWRv}$ ).**

The  $q_{pSWRv}$  is computed using the following equation and the procedures outlined in TR-55, Chapter 4: Graphical Peak Discharge Method. Designers can also use WinTR-55 or an equivalent TR-55 spreadsheet to compute  $q_{pSWRv}$ :

- Read initial abstraction ( $I_a$ ) from TR-55 Table 4.1 or calculate using  $I_a = 200/CN - 2$
- Compute  $I_a/P$  ( $P = 1.16$ )
- Read the Unit Peak Discharge ( $q_u$ ) from Exhibit 4-II using  $T_c$  and  $I_a/P$
- Compute the  $q_{pSWRv}$  peak discharge:

$$q_{pSWRv} = q_u \times SS \times Q_a$$

where:

$q_{pSWRv}$  = stormwater retention volume peak discharge (ft<sup>3</sup>/sec)

$q_u$  = unit peak discharge (ft<sup>3</sup>/sec/mi<sup>2</sup>/in)

$A$  = site drainage area (mi<sup>2</sup>)

$Q_a$  = runoff volume (watershed inches), equal to SWRv/SDA

This procedure is for computing the peak flow rate for the 85<sup>th</sup> and 95<sup>th</sup> percentile rainfall events. Calculations of peak discharge from larger storm events for the design of drainage systems, culverts, etc., should use published CNs and computational procedures.

## **I.2 Storm Sewer Collection System**

### **I.2.1 Introduction**

The focus of the *Southern Lowcountry Stormwater Design Manual* is to define standards and specifications for design, construction and maintenance of BMPs required to meet post construction stormwater performance objectives. Design of the conveyance of stormwater runoff within the public right-of-way (PROW) must follow the current requirements in SCDOT's Requirements for Hydraulic Studies, Part 2 Requirements for Roadway Drainage (SCDOT, 2009). These are incorporated by reference with the following notes pertinent to the <local jurisdiction>.

### **I.2.2 Clearance with Other Utilities**

- All proposed and existing utilities crossing or parallel to designed storm sewer systems must be shown on the plan and profile.
- Storm drain and utility crossings must not have less than a 45-degree angle between them.
- Minimum vertical and horizontal clearances, wall to wall, must be provided between storm drainage lines and other utilities as defined by the Beaufort-Jasper Water & Sewer Authority.

### **I.2.3 Pipe Systems**

- The pipe sizes used for any part of the storm drainage system within the PROW must be designed in accordance with the current requirements in SCDOT's Requirements for Hydraulic Studies, Part 2 Requirements for Roadway Drainage. (SCDOT, 2009)

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(Supp. No. 45)





- The material and installation of the storm drain for any part of public storm sewer must be designed in accordance with the current requirements in SCDOT's Requirements for Hydraulic Studies, Part 2 Requirements for Roadway Drainage (SCDOT, 2009). An exception to the SCDOT list is spiral ribbed aluminum pipe (SRAP), which is not an acceptable pipe material for brackish waters. Materials shall be RCP, CAAP, HDPE or HP Storm per AASHTO standards for H20/H25 loading and installation per ASTM/AASHTO standards. Durability must be 100 years or greater per SCDOT standards.
- An alternative overflow path for the 100-year storm is to be shown on the plan view if the path is not directly over the pipe. Where applicable, proposed grading must ensure that overflow will be into attenuation facilities designed to control the 100-year storm.
- A pipe schedule tabulating pipe length by diameter and class is to be included on the drawings. Public and private systems must be shown separately.
- Profiles of the proposed storm drains must be shown on the drawings and indicate size, type, and class of pipe, percent grade, existing ground and proposed ground over the proposed system, and invert elevations at both ends of each pipe run. Pipe elevations and grades must be set to avoid hydrostatic surcharge during design conditions. Where hydrostatic surcharge greater than 1-foot of head cannot be avoided, a rubber gasket pipe is to be specified.

#### **I.2.4 Hydraulic Grade Line**

The existing grade line and proposed 25- and 100-year hydraulic grade lines (HGL) must be clearly indicated on the system profiles and identified with the initials HGL on the line and identified in the legend key. This grade line must take into consideration pipe and channel friction losses, computing structures losses, tailwater conditions and entrance losses. All pipe systems must be designed so that they will operate without building up a surcharged hydrostatic head under design flow conditions. It is recommended that the HGL be no more than 1 foot above the pipe crown. If pipes have a HGL more than 1 foot above the pipe crown, rubber gaskets are required. The 100-year HGL must not overtop the 6" curb of ingress/egress routes that would isolate interior parcels in the extreme flood event.

If the structural stormwater BMP discharges into a storm sewer, a detailed HGL analysis of the system including the receiving system must be submitted with the final Stormwater Management Plans (SWMPs) for 100-year storm event. Provide documentation supporting safe passage of the 100-yr post-development flow downstream and an analysis of the surrounding neighborhood area to identify any existing capacity shortfalls or drainage blockages based on the 10% rule in Section 3.8.

#### **I.3 Open Channels**

- Calculations must be provided for all channels, streams, ditches, swales, etc., including a typical section of each reach and a plan view with reach locations. In the case of existing natural streams/swales, a field survey of the stream (swale) cross sections may be required prior to the final approval.
- The final designed channel must safely pass the 100-yr storm event.
- If the base flow exists for a long period of time or velocities are more than 5 feet per second in earth and sodded channel linings, gabion or riprap protection must be provided at the intersection of the inverts and side slopes of the channels unless it can be demonstrated that the final bank and vegetation are sufficiently erosion-resistant to withstand the designed flows, and the channel will stay within the floodplain easement throughout the project life.

(Supp. No. 45)

Created: 2021-07-22 09:11:36 [EST]

- Channel inverts and tops of bank are to be shown in plan and profile views.
- For a designed channel, a cross section view of each configuration must be shown.
- For proposed channels, a final grading plan must be provided.
- The limits of a recorded 100-year floodplain easement or surface water easement sufficient to convey the 100-year flow must be shown.
- The minimum 25-foot horizontal clearance between a residential structure and 100-year floodplain must be indicated in the plan.
- For designed channels, transition at the entrance and outfall is to be clearly shown on the site

## Appendix J: Rainwater Harvesting Treatment and Management Requirements

This Appendix is provided as an example of requirements necessary for approval of use of reclaimed rainwater in non-potable water systems. It is not intended to regulate water retained by another BMP for use in irrigation and to meet stormwater retention volume requirements.

### Table of Contents

J.1	Rainwater Harvesting Treatment and Management Requirements .....	1
J.1.1	Introduction .....	1
J.1.2	Pathogen Reduction Targets .....	2
J.1.3	Filtration .....	3
J.1.4	Disinfection .....	3
J.1.5	Treatment Trains .....	5
J.1.6	Volatile Organic Compounds .....	5
J.1.7	Storage and Distribution Management Practices .....	7
J.1.8	Commissioning .....	8
J.1.9	Operational Monitoring and Reporting .....	8
J.1.10	Field Verification .....	9
J.1.11	Design Report .....	9
J.1.12	Treatment Design Examples .....	10
J.2	Rainwater Harvesting Storage Volume Calculator Instructions .....	12

### J.1 Rainwater Harvesting Treatment and Management Requirements

#### J.1.1 Introduction

The majority of the information and requirements provided herein are excerpted from the 2017 Water Environment and Reuse Foundation Report: Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems (DNWS Report), and much of the text is directly quoted. In some cases, text from this report has been modified to conform to the Stormwater Design Manual and <local jurisdiction> review and inspection procedures.

The purpose of this appendix is to provide information and guidance through a risk-based framework to help designers and <local jurisdiction> ensure that all rainwater harvesting systems are adequately protective of public health. This appendix identifies pathogen reduction targets that must be met and various treatment systems that can be used to meet the targets, as well as volatile organic compound (VOC) limits that must be achieved storage and distribution management considerations, operation and maintenance as well as long-term monitoring and reporting requirements are also discussed.

### J.1.2 Pathogen Reduction Targets

Risk-based pathogen reduction targets have been developed based on analysis of potential human health risks associated with exposure to microbial hazards, and are based on a “ $10^{-4}$  Per Person per Year Benchmark.” This means that the agreed-upon “tolerable” risk level is a probability of infection of 1 in 10,000 people per year. Pathogen reduction targets are expressed in terms of the 95th percentile Log<sub>10</sub> Reduction Target (LRT). LRTs were developed for each source water and end use addressed in this appendix based on attaining the “tolerable” infection risk. If a system can maintain this level of treatment performance at all times, then the predicted probability of infection across the population will be less than the 1 in 10,000 benchmark for each pathogen 95% of the time.

The LRT for each non-potable use scenario is presented in Table 1 for healthy adults (values are based on the DNWS Report, although additional uses have been added). A rainwater harvesting system must maintain this level of treatment performance at all times for all three pathogen types: viruses, protozoa, and bacteria. When both general runoff and roof runoff (as defined below in Table 1) are combined, the reduction targets for general runoff shall apply. Similarly, when multiple uses are proposed, the highest reduction targets shall apply.

Table 1. Ninety-fifth percentile log<sub>10</sub> pathogen reduction targets (LRT) to meet infection ppy benchmarks for healthy adults.

Water Source and Use	Log <sub>10</sub> Reduction Targets for $10^{-4}$ Per Person Per Year Benchmarks		
	Enteric Viruses	Parasitic Protozoa	Enteric Bacteria
General Runoff <sup>a</sup>			
Cooling Towers <sup>b</sup>	–	–	–
Irrigation	5.0	4.5	4.0
Indoor Use	5.5	5.5	5.0
Roof Runoff <sup>c</sup>			
Cooling Towers <sup>b</sup>	–	–	–
Irrigation	N/A	Limited data available	3.5
Indoor Use	N/A	Limited data available	3.5
a. For the purposes of this appendix, general runoff means precipitation runoff from rain or snowmelt events that flows over land and/or impervious surfaces (e.g., streets, sidewalks, and parking lots). It also includes runoff from roofs or parking garages with frequent public access.			
b. The pathogen risks associated with cooling towers and other uses in which there is no public exposure can be controlled by post-treatment management practices rather than initial treatment. The reason is that greater microbial risks from this use is likely to result from not controlling the growth of water-based pathogens (e.g., Legionella pneumophila, Pseudomonas aeruginosa, and non-tuberculous mycobacteria) that may proliferate in stagnant piped water. Management practices are discussed in Section J.1.7 Storage and Distribution Management Practices.			
c. Roof runoff means precipitation from a rain event that is collected directly from a roof surface not subject to frequent public access.			

The non-potable uses and LRTs included in Table 1 assume that human contact with the harvested water will be infrequent, and ingestion unintentional. Uses where frequent human contact with the harvested water is intended, like fountains or splash pads, will be considered similar to swimming pools, and must meet the standards defined by the *<local jurisdiction>*. The remaining sections in this appendix only cover non-potable uses with infrequent human contact. Treatment and monitoring procedures for frequent contact uses will be reviewed on a case-by-case basis.

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## Treatment Process

A well-established and accepted concept in modern drinking water and water reuse practices is to attribute the log<sub>10</sub> reduction of pathogen groups to specific technologies that are operated within defined limits, coupled with appropriate control points to demonstrate the proper performance of the technology. This is referred to as the log<sub>10</sub> reduction value (LRV) and can be compared directly to the LRTs described in Section J.1.2 above. Various treatment processes and treatment trains can be used to obtain the LRT for each pathogen for a given combination of source water and end use. Sections J.1.5 and J.1.6 discuss a range of treatment processes and provide LRVs for each process.

### J.1.3 Filtration

The removal of particulate matter, including pathogens, by size exclusion is of interest because filters can serve as a barrier to pathogens in water. Filtration is especially important because pathogens can be shielded by or embedded in particulate matter, reducing the effectiveness of subsequent disinfection processes. Typical values for pathogen group log<sub>10</sub> reduction by filtration processes are summarized in Table 2.

Table 2. Typical values for pathogen reduction using filtration processes.

Barrier	Typical Log <sub>10</sub> Reduction Values		
	Virus	Protozoa	Bacteria
Slow sand filter	2	4	2
Dual media filter with coagulant	1	2	1
Cartridge/bag filter (5-10 microns)	0	0	0
Cartridge/bag filter (3 microns or less)	0	3	0
Cartridge/bag filter (1 micron)	0	4	0
Diatomaceous earth	1	4	2
Microfilter	1	6	6
Ultrafilter or Nanofilter	6	6	6
Reverse osmosis	6	6	6

### J.1.4 Disinfection

Processes for pathogen inactivation include disinfection by chlorine, peracetic acid, ozone, ultraviolet (UV) radiation, advanced oxidation, and pasteurization. Particles in water can inhibit effective disinfection through shading (in the case of UV) and shielding embedded pathogens. Larger particles may require more time for a disinfecting agent to penetrate the particle and reach an embedded pathogen; therefore, for any disinfectant to be effective, particles larger than 10 microns must be removed.

Typical values for the inactivation of pathogens for disinfection processes in filtered water are given in Table 3, Table 4, and

Table 5. These values serve as a guide to the relative effectiveness of different disinfection technologies and are not for a specific microorganism.

Table 3. Typical values for various levels of the inactivation of enteric virus in filtered secondary effluent with selected disinfection processes.

Disinfectant	Unit <sup>b</sup>	Dose for Corresponding Log <sub>10</sub> Reduction Value			
		1 Log <sub>10</sub>	2 Log <sub>10</sub>	3 Log <sub>10</sub>	4 Log <sub>10</sub>
Free chlorine	mg•min/L	–	1.5–1.8	2.2–2.6	3.0–3.5
Chloramine <sup>a</sup>	mg•min/L	–	370–400	550–600	750–800
Peracetic acid	mg•min/L	NA	NA	NA	NA
Ozone	mg•min/L	–	0.25–0.30	0.35–0.45	0.50–0.60
Ultraviolet radiation	mJ/cm <sup>2</sup>	50–60	90–110	140–150	180–200
Advanced oxidation	mJ/cm <sup>2</sup>	10–20	50–60	70–80	110–130
Pasteurization (60°C)	Second	140	280	420	560
a. Due to interferences with chloro-organic compounds, when chloramine is used as a disinfectant, log <sub>10</sub> reductions can only be used if the actual dosage of monochloramine is known, not just the amount of combined chlorine.					
b. mg•min/L = Milligram-minutes per liter					
c. mJ/cm <sup>2</sup> = Millijoules per square centimeter.					

Table 4. Typical values for various levels of the inactivation of parasitic protozoa in filtered secondary effluent with selected disinfection processes.

Disinfectant	Unit <sup>b</sup>	Dose for Corresponding Log <sub>10</sub> Reduction Value			
		1 Log <sub>10</sub>	2 Log <sub>10</sub>	3 Log <sub>10</sub>	4 Log <sub>10</sub>
Free chlorine	mg•min/L	2,000–2,600	NA	NA	NA
Chloramine <sup>a</sup>	mg•min/L	NA	NA	NA	NA
Peracetic acid	mg•min/L	NA	NA	NA	NA
Ozone	mg•min/L	4.0–4.5	8.0–8.5	12–13	NA
Ultraviolet radiation	mJ/cm <sup>2</sup>	2–3	5–6	11–12	20–25
Advanced oxidation	mJ/cm <sup>2</sup>	2–3	5–6	10–12	20–25
Pasteurization (60°C)	Second	30	60	90	120
a. Due to interferences with chloro-organic compounds, when chloramine is used as a disinfectant, log <sub>10</sub> reductions can only be used if the actual dosage of monochloramine is known, not just the amount of combined chlorine.					
b. mg•min/L = Milligram-minutes per liter.					
c. mJ/cm <sup>2</sup> = Millijoules per square centimeter.					

Table 5. Typical values for various levels of the inactivation of enteric bacteria in filtered secondary effluent with selected disinfection processes.

Disinfectant	Unit <sup>b</sup>	Dose for Corresponding Log <sub>10</sub> Reduction Value			
		1 Log <sub>10</sub>	2 Log <sub>10</sub>	3 Log <sub>10</sub>	4 Log <sub>10</sub>
Free chlorine	mg•min/L	0.4–0.6	0.8–1.2	1.2–1.8	1.6–2.4
Chloramine <sup>a</sup>	mg•min/L	50–70	95–150	140–220	200–300
Peracetic acid	mg•min/L	10–25	40–60	75–125	150–200
Ozone	mg•min/L	0.005–0.01	0.01–0.02	0.02–0.03	0.03–0.04
Ultraviolet radiation	mJ/cm <sup>2</sup>	10–15	20–30	30–45	40–60
Advanced oxidation	mJ/cm <sup>2</sup>	4–6	6–8	8–10	10–12
Pasteurization (60°C)	Second	50	100	150	200
a. Due to interferences with chloro-organic compounds, when chloramine is used as a disinfectant, log <sub>10</sub> reductions can only be used if the actual dosage of monochloramine is known, not just the amount of combined chlorine.					
b. mg•min/L = Milligram-minutes per liter.					
c. mJ/cm <sup>2</sup> = Millijoules per square centimeter.					

### J.1.5 Treatment Trains

Most non-potable water systems use a number of unit processes in series to accomplish treatment, known commonly as the “multiple barrier” approach. Multiple barriers are used to improve the reliability of a treatment approach through process redundancy, robustness, and resiliency. When multiple treatment barriers are used to achieve the pathogen LRT, the contribution from each barrier is cumulative; therefore, a reduction in performance by one process is mitigated by other processes in the treatment train.

In addition to these treatment barriers, operational and management barriers are used to ensure that systems are in place to respond to non-routine operation. Treatment barriers can be monitored using sensors and instrumentation for continuous process monitoring. An important ability is to take the treatment train offline automatically in the event of process malfunction.

If each barrier in a treatment train is independent, the LRVs for each process in the treatment train can be added together to obtain the overall treatment train LRV.

### J.1.6 Volatile Organic Compounds

For rainwater harvesting systems that use general runoff from vehicular access areas as a source and will have some level of public exposure risk, the treated water must be tested for the presence of volatile organic compounds (VOCs); however, this does not apply when the water will be used for cooling towers or other “no public exposure” uses. The test must be performed by the system operator prior to commissioning of the system (see Commissioning) and prior to subsequent <local jurisdiction> maintenance inspections (see Operational Monitoring and Reporting). VOC levels must be below the maximums indicated in Table 6. If any VOC levels exceed these limits, the rainwater harvesting system must not be utilized until the problem is satisfactorily addressed, and a successful test has been performed. VOC limit exceedances may be addressed through source controls or through provision of additional treatment devices.

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(Supp. No. 45)



Table 6. Volatile organic compound maximum concentrations.

VOC	Maximum Concentration (mg/L) <sup>a</sup>
Benzene	0.1
Carbon Tetrachloride	0.5
1,2-Dichlorobenzene	5.4
1,4-Dichlorobenzene	5.4
1,1 Dichloroethane	14.4
1,2 Dichloroethane	0.1
1,1-Dichloroethylene	0.1
cis-1,2-Dichloroethylene	28.4
trans-1,2-Dichloroethylene	28.4
Dichloromethane	3.1
1,2-Dichloropropane	12.6
1,3-Dichloropropene	0.2
Ethylbenzene	15.6
Methyl-tert-butyl ether	5.2
Monochlorobenzene	1.7
Styrene	7.7
1,1,2,2-Tetrachloroethane	0.3
Tetrachloroethylene	6.1
Toluene	6.8
1,2,4-Trichlorobenzene	1.4
1,1,1-Trichloroethane	68.2
1,1,2-Trichloroethane	1.6
Trichloroethylene	4.8
Trichlorofluoromethane	201.1
1,1,2-Trichloro-1,2,2-Trifluoroethane	272.9
Vinyl Chloride	0.1
Xylenes	15.6
a. Values determined by the San Francisco Department of Public Health based on U.S. Occupational Safety and Health Administration Permissible Exposure Limits for 8-hour inhalation exposures to selected VOCs.	

### J.1.7 Storage and Distribution Management Practices

To achieve the desired objectives of public health protection, treated water must be properly stored and distributed to prevent compromising the quality of water after treatment. For example, opportunistic pathogens like *Legionella* could grow in the distribution system, sewage could contaminate treated water, or lead and copper (which cause toxicity) could leach from piping. Producing adequate quality non-potable water that meets all the pathogen control criteria set forth in this appendix is the first step in ensuring proper public health protection. The final step in quality control is to manage properly 1) storage and distribution systems and 2) the uses of non-potable water.

In rainwater harvesting systems, neither significant/routine ingestion nor direct contact with the treated water product is typically anticipated due to limited exposures to non-potable water. Nevertheless, the occurrence of aerosol inhalation and indirect contact requires the careful management of DNW system storage and distribution systems to control exposures to non-tuberculous mycobacterial and *Legionella* pathogens. For example, even clean drinking water may allow biofilm growth of *Legionella* (aerosol pathogen risk) if the water temperature is between 25°C and 45°C and stagnates, resulting in the presence of minimal residual chlorine.

A number of approaches are available to control microbial regrowth in distribution systems, each with varying benefits and drawbacks that depend on the characteristics and use of the system. Below are some recommended approaches for controlling microbial growth in distribution systems:

- **Producing non-potable water low in carbonaceous material and nutrient content**  
The primary energy source for pathogen regrowth is organic carbon measured as assimilable organic carbon, biodegradable dissolved organic carbon, total organic carbon, and other essential nutrients, including nitrogen (N), phosphorous (P), and iron (Fe); therefore, the primary means to reduce the regrowth potential of pathogens is to provide highly treated water. Reducing the potential for regrowth is more important in large-scale buildings or neighborhood/district-scale projects where there will be more residence time (creating more opportunities for regrowth) in distribution systems that supply non-potable water.
- **Producing highly disinfected non-potable water**  
Low concentrations of microbes resulting from filtration and advanced means of disinfection have a reduced potential for regrowth if organic carbon levels are low. Otherwise, there may be a need for a residual disinfectant to manage growth in larger community systems that produce aerosols. Post-treatment disinfection with UV radiation is a recommended means of disinfection that does not increase levels of assimilable organic carbon or biodegradable dissolved organic carbon.
- **Using non-reactive, biologically stable materials of construction**  
Avoid the use of corrosive materials or organic materials that tend to protect microorganisms from disinfection and enhance the regrowth environment by the adsorption of organic compounds.
- **Maintaining a residual disinfectant**  
Different disinfectants offer advantages and disadvantages to overall water quality and system management. In general, a higher disinfectant residual provides lower regrowth. Many design and operation considerations are available for each specific system. It is recommended that a free chlorine residual of 0.2 milligrams per liter (mg/L) or monochloramine residual of 2 to 3 mg/L be maintained at or near the point of use to control microbial growth. Chloramine provides a better residual duration as compared to chlorine. Various combinations of UV

chlorine, chloramine, ozone, and hydrogen peroxide are beneficial for specific disinfection goals. Periodic shock treatments with disinfectants and continuous disinfection looping of reservoirs help reduce the potential for regrowth and manage issues with biofilms. Stagnation resulting from dead zones or prolonged periods of zero-flow or low flow that create long residence times and allow disinfectants to dissipate and sediments to deposit result in improved conditions for regrowth and should be avoided.

- **Cleaning storage tanks**

The required frequency of storage tank cleaning varies depending upon the quality of water stored, detention time in storage, temperature of the water, and nature of the tank. Tanks that are open to the atmosphere require more frequent cleaning.

- **Flushing the distribution system**

The required frequency of distribution system flushing varies depending upon the quality of water transmitted, detention time in the distribution system, temperature of the water, and nature of the distribution system components. Periodic flushing is a good means of both removing sediments and scouring pipe walls. System design must include means for easily flushing pipes as part of routine maintenance.

- **Controlling temperature**

Avoid the storage and distribution of non-potable water within 20°C to 45°C to reduce the potential for pathogen regrowth. Otherwise, consider a disinfection residual or point-of-use system, particularly if aerosols are generated.

The rainwater harvesting system designer and Person Responsible for Maintenance each should review published guidelines for the management of Legionella in distribution systems and implement as appropriate for each specific system. In particular, ANSI/ASHRAE Standard 188-2015 Legionellosis: Risk Management for Building Water Systems (2015) provides guidance on stormwater best management practices (BMPs) for both potable and non-potable water systems. It addresses management program responsibilities, system design, risk analysis, control mechanisms, monitoring, confirmation, and documentation. Although the ASHRAE Standard targets legionellosis, its rationales and approaches are applicable to all pathogens and health risks identified in this appendix.

#### J.1.8 Commissioning

In the process of initializing a rainwater harvesting system, the system must be evaluated for leaks in the storage unit and the performance of the components of the treatment and distribution system. A commissioning report of the evaluation is required at the initial startup of the system and anytime the system is brought back online after cleaning, flushing, and/or a hiatus of use (e.g., winter shutdown).

#### J.1.9 Operational Monitoring and Reporting

The Person Responsible for Maintenance, as identified in the Stormwater Management Plan (SWMP), must maintain the rainwater harvesting system in good working condition and assure adequate treatment of the harvested rainwater. All systems, with the exception of those installed in single-family homes, shall include continuous monitoring systems that are capable of determining if the rainwater harvesting system is operating within the design specification, and if all system components of the rainwater harvesting system are functional.

Data logs from continuous monitoring systems must be kept on file and produced upon request from <local jurisdiction>. In addition, annual reports must be generated that identify the following:

- Significant maintenance activities;
- Treatment modifications;
- Outages and malfunctions (including reasons and durations); and
- Steps taken to mitigate or eliminate recurrence of outages and malfunctions.

If there is a change of personnel—Person Responsible for Maintenance—it is the responsibility, within 15 business days, of the owner of the rainwater harvesting system or her/his agent to update the <local jurisdiction> with the name and contact information of the new personnel.

An operation and maintenance manual that includes a schematic drawing of the system, standard operating procedures for the system, and maintenance schedule(s), as well as commissioning reports, field verification reports, and annual reports must be on site and produced upon request from <local jurisdiction>.

#### J.1.10 Field Verification

Field verification is a performance confirmation of a rainwater harvesting system. It can be accomplished by physically observing the collection, storage, and distribution system, and the treatment process components. It can also be conducted using challenge testing, including surrogate microorganisms and/or other non-biological surrogates and typically involves manual collection of water samples for microbial analysis to check system performance in achieving LRTs. While not specifically required, <local jurisdiction> construction or maintenance inspections may include field verification testing to ensure that the rainwater harvesting system is achieving its LRTs, and that operational monitoring and control systems are functional.

#### J.1.11 Design Report

A design report must be submitted with each rainwater harvesting system that includes, at a minimum, the following:

- Pathogen log<sub>10</sub> reduction target
- Proposed treatment process and associated log<sub>10</sub> reduction value
- Proposed storage and distribution management practices
- Identification of the Person Responsible for Maintenance
  - Operation and Maintenance Manual
- Reliability analysis that identifies the following:
  - How the equipment used to monitor treatment, operations, and water quality enables determination of whether the system is working as planned.
  - How the monitoring and controls of the system will enable the operator or automatic controls to intervene in the event of the production of off-specification water.
  - Remedies and provisions for operation disruption (e.g., power failures, vandalism, and excessive source contamination)
  - Unauthorized access limitations for the rainwater harvesting and distribution system.

J.1.12 Treatment Design Examples**Example 1: Rooftop Runoff for Landscape Irrigation****1) Identify the log<sub>10</sub> reduction targets for the reference pathogen groups.**

Since the roof will not allow frequent public access, the water source qualifies as roof runoff rather than general runoff. No LRT is provided for enteric bacteria or parasitic protozoa, but an LRT of 3.5 is defined for enteric bacteria.

**2) Select a treatment process to achieve the log<sub>10</sub> reduction target.**

An ozone system with a CT value (the product of concentration and contact time) of 0.04 mg • min/L can achieve 4-log<sub>10</sub> reduction of enteric bacteria. However, as all disinfection processes require removal of particles 10 microns or larger, a 10-micron cartridge filter or similar device will also be necessary (see Figure 1).

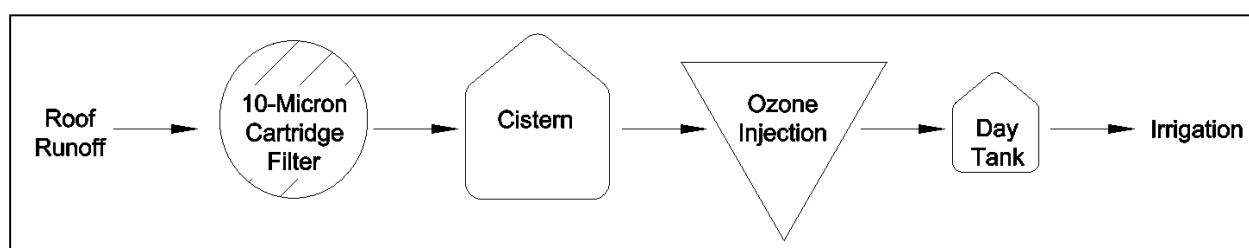


Figure 1. Example 1 treatment schematic.

Alternative treatment trains that also could meet the required LRT include the following:

- Microfiltration (i.e., 6-log<sub>10</sub> reduction of bacteria).
- Sand filter with an equivalent effluent particle size distribution of 10 microns, followed by UV radiation with a dose of 40 to 60 mJ/cm<sup>2</sup> (i.e., 4-log<sub>10</sub> inactivation of bacteria).
- Cartridge filtration (10 microns), followed by chlorination with free chlorine with a CT value of 1.6 to 2.4 mg•min/L (i.e., 4-log<sub>10</sub> inactivation of bacteria).

**3) Determine storage and distribution management practices.**

For non-potable water systems, consider the chemical characteristics of roof runoff and storage conditions, as follows:

- Due to its high purity, roof runoff may result in the corrosion of components and fixtures of the metallic distribution system. If any metallic pipe, fittings, solder, or fixtures are used that may be subject to corrosion from contact with aggressive water, then modify the water system or add a corrosion inhibitor to the non-potable water supply.
- If the temperature of water in the non-potable water distribution system exceeds 25°C (which is a condition that could promote the growth of opportunistic pathogens like Legionella), then maintain a free chlorine residual of 0.2 milligrams per liter (mg/L) or chloramine residual of 0.5 mg/L at or near the point of use.

**4) Identify maintenance and monitoring requirements and schedule of activities.**

These will vary based on the specific equipment and devices included in each design.

**5) Submit design report and SWMP.**

**Example 2: General Runoff for Indoor Use****1) Identify the  $\log_{10}$  reduction targets for the reference pathogen groups.**

The proposed rainwater harvesting system will capture runoff from two different areas on a rooftop. The first area will have no public access, but the second area includes a patio area that is designed for public access. The combined water from the two areas is therefore considered “general runoff,” and will need to be treated accordingly. The LRT for both enteric viruses and protozoa is 5.5, and the LRT for enteric bacteria is 5.0.

**2) Select a treatment process to achieve the  $\log_{10}$  reduction target.**

An ultrafiltration system can achieve 6- $\log_{10}$  reduction of viruses, protozoa, and bacteria (see Figure 2).

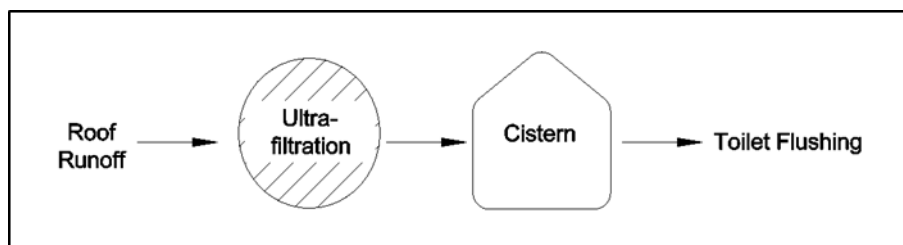


Figure 2. Example 2 treatment schematic.

The only alternative processes that can also meet the required LRTs are nanofiltration and reverse osmosis.

**3) Determine storage and distribution management practices.**

For non-potable water systems, consider the chemical characteristics of roof runoff and storage conditions, as follows:

- Due to its high purity, roof runoff may result in the corrosion of components and fixtures of the metallic distribution system. If any metallic pipe, fittings, solder, or fixtures are used that may be subject to corrosion from contact with aggressive water, then modify the water system or add a corrosion inhibitor to the non-potable water supply.
- If the temperature of water in the non-potable water distribution system exceeds 25°C (which is a condition that could promote the growth of opportunistic pathogens like Legionella), then maintain a free chlorine residual of 0.2 milligrams per liter (mg/L) or chloramine residual of 0.5 mg/L at or near the point of use.

**4) Identify maintenance and monitoring requirements and schedule of activities.**

These will vary based on the specific equipment and devices included in each design.

**5) Submit design report and SWMP.**

**Example 3: Roof Runoff for Cooling Towers****1) Identify the log<sub>10</sub> reduction targets for the reference pathogen groups.**

As there is not public exposure to the harvested rainwater, there are not initial treatment requirements. Chlorination may still be required to control the growth of opportunistic pathogens however (see Step 2).

**2) Determine storage and distribution management practices.**

For non-potable water systems, consider the chemical characteristics of roof runoff and storage conditions, as follows:

- Due to its high purity, roof runoff may result in the corrosion of components and fixtures of the metallic distribution system. If any metallic pipe, fittings, solder, or fixtures are used that may be subject to corrosion from contact with aggressive water, then modify the water system or add a corrosion inhibitor to the non-potable water supply.
- If the temperature of water in the non-potable water distribution system exceeds 25°C (which is a condition that could promote the growth of opportunistic pathogens like Legionella), then maintain a free chlorine residual of 0.2 milligrams per liter (mg/L) or chloramine residual of 0.5 mg/L at or near the point of use.

**3) Identify maintenance and monitoring requirements and schedule of activities.**

These will vary based on the specific equipment and devices included in each design.

**4) Submit design report and SWMP.****J.2 Rainwater Harvesting Storage Volume Calculator Instructions****Input Sheet**

The cells of the spreadsheet are color coded as follows:

**Color Code**

	Title/New Category
	Required Entry value
	Alternate Category Entry (if selected, do not enter value into "Required Entry value")
	Final Category Value

**Design Storm (inches)**

Cell L4 Choose either 1.16 inches or 1.95 inches depending on the Watershed Protection Area in which the project is located.

**CONTRIBUTING DRAINAGE AREA (CDA)**

Cell L7, L9, L11 Indicate the impervious CDA, the turf cover CDA, and the runoff coefficient (Rv) for the turf cover. The turf cover Rv should range between 0.15 and 0.25. The CDA is assumed to convey 95 percent of the rainfall that lands on its impervious surface and 15 - 25 percent of the rainfall that lands on its turf cover area.

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(Supp. No. 45)

**CONTRIBUTING BMPS**

Cell L17 Enter the retention volume as well as the overflow from the Design Storm for any BMPs that drain to the cistern. Both of these values can be found in the SoLoCo Compliance Calculator. The retention volume is in the "Volume Credited" column, and the overflow volume is in the "Remaining Volume" column.

**The following instructions identify how the collected rainwater will be used. Only fill in the sections that are applicable to the site.**

**IRRIGATION**

Cells L23, L25 Indicate the area to be irrigated in square feet and if the irrigation system as smart controls.

Row A31-L31 The spreadsheet allows for irrigation to be used in certain months. Indicate, for each month, the average weekly irrigation application rate in either inches per week or gallons per month.

The EPA WaterSense Water Budget Tool can be used to calculate Monthly Landscape Water Requirement (based on the site's peak watering month). The output for this calculation is found on the Part 2-LWA sheet, which can be found at the following link: <https://www.epa.gov/watersense/water-budget-tool>

**INDOOR DEMAND - FLUSHING TOILETS/URINALS**

Cell L35 Indicate the number of people using the building.

Cells L35, L37 The values in **lines 35 and 37** can be altered depending on how much water is used when flushing urinals or toilets. The default values are 0.80 gallons/flush and 1.60 gallons/flush for urinals and toilets, respectively.

Cell L39 If the user knows the daily toilet and urinal demand, that value can be input into **line 39** and the information in the rows above will not be used.

Cells L44, L46, L48 Indicate the first and last day of the week that the building will be in use and the number of hours each day the building will be occupied.

**INDOOR DEMAND - LAUNDRY**

Cell L54 Indicate the number of loads of laundry done each day.

Cell L54 The value in **line 54** can be altered depending on how much water is used for each load of laundry. The default value is 42 gallons per load.

Cell L56 If the user knows the daily laundry demand, the value can be input into **line 56** and the information in the rows above will not be used.

Cells L60, L62 Indicate the first and last day of the week when the water will be used.

**ADDITIONAL DAILY USE**

Row A71-L71 If there is any other additional daily use not covered in the spreadsheet, **line 69** can accommodate additional demand. Indicate, for each month, the average daily demand in gallons per day.

Cells L73, L75 Indicate the first and last day of the week when the water will be used.

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**COOLING TOWERS**

Row A79-L79 If the rainwater collected is to be used for cooling towers, indicate in **line 79** the average daily demand in gallons per day for each month the cooling towers use the collected rainwater.

The following section allows for additional contribution to the cistern from sources other than rainwater.

**CONTRIBUTION FROM OTHER SOURCES**

Row A88-L88 If there are other sources of water that contribute to the cistern, indicate the average daily contribution in gallons per day for each month

Cells L90,  
L92 Indicate the first and last day of the week when the water will be input.

**FIRST FLUSH FILTER DIVERSION AND EFFICIENCY**

This section accounts for the filter efficiency of the cistern. It is assumed that, after the first flush diversion and loss of water due to filter inefficiencies, the remainder of the SWRv storm will be successfully captured. These minimum values can be altered if appropriate.

Cell L98 **Line 98** indicates that for the 1.16-inch storm, a minimum of 95 percent of the runoff should be conveyed into the cistern.

Cell L100 **Line 100** indicates that for the 4.19-inch storm, a minimum of 90 percent of the runoff should be conveyed.

**Storage Volume Results Sheets**

These sheets give a range of possible cistern sizes and the corresponding storage volume available. Once a cistern size is chosen, the corresponding storage volume may be used in the Stormwater Database.

The table on this sheet has the following information.

- **Cistern Volume** (gallons) – This row gives a range of cistern sizes in gallons based on the CDA size.
- **Daily Average Available Storage Volume** (gallons or cubic feet) – This row shows the average available storage capacity of a given cistern (Sv). Use the Sv that corresponds to the cistern size selected for the site for the General Retention Calculator.
- **Overflow Volume (Sv)** (gallons or cubic feet) – This row shows the average overflow created by a 1.7" storm for various cistern sizes, based on average available storage volumes.

The graph shows a trade-off curve, which allows for a comparison of the retention achieved versus cistern size. While larger cisterns yield more retention, they are more costly. The curve helps the user to choose the appropriate cistern size, based on the design objectives and site needs. The overflow volume is also plotted to illustrate the effects of cistern size on overflow volume.

Southern Low Country -- RAINWATER HARVESTING STORAGE VOLUME CALCULATOR v1.1, August 26, 2020	
<p><b>Input Sheet</b></p> <p>The cells of the spreadsheet are color coded as follows:</p> <p><b>Color Code</b></p> <p>Tile/New Category</p> <p>Required Entry value</p> <p>Alternate Category Entry (if selected, do not enter value into "Required Entry value")</p> <p>Final Category Value</p>	<p><b>Storage Volume Results Sheets</b></p> <p>These sheets give a range of possible cistern sizes and the corresponding storage volume available. Once a cistern size is chosen, the corresponding storage volume may be used in the Stormwater Database.</p> <p>The table on this sheet has the following information:</p> <ul style="list-style-type: none"> <li><b>Cistern Volume (gallons)</b> – This row gives a range of cistern sizes in gallons based on the CDA size.</li> <li><b>Daily Average Available Storage Volume (gallons or cubic feet)</b> – This row shows the average available storage capacity of a given cistern (Sv). Use the Sv that corresponds to the cistern size selected for the site for the General Retention Calculator.</li> <li><b>Overflow Volume (Sv) (gallons or cubic feet)</b> – This row shows the average overflow created by a 1.7" storm for various cistern sizes, based on average available storage volumes.</li> </ul> <p>The graph shows a trade-off curve, which allows for a comparison of the retention achieved versus cistern size. While larger cisterns yield more retention, they are more costly. The curve helps the user to choose the appropriate cistern size, based on the design objectives and site needs. The overflow volume is also plotted to illustrate the effects of cistern size on overflow volume.</p>
<p><b>Design Storm (inches)</b></p> <p>Choose either 1.16 inches or 1.95 inches depending on the Watershed Protection Area in which the project is located.</p>	
<p><b>CONTRIBUTING DRAINAGE AREA (CDA)</b></p> <p>Indicate the impervious CDA, the turf cover CDA, and the runoff coefficient (Rv) for the turf cover. The turf cover Rv should range between 0.15 and 0.25. The CDA is assumed to convey 95 percent of the rainfall that lands on its impervious surface and 15 - 25 percent of the rainfall that lands on its turf cover area.</p>	
<p><b>CONTRIBUTING BMPs</b></p> <p>Enter the retention volume as well as the overflow from the Design Storm for any BMPs that drain to the cistern. Both of these values can be found in the Soil-CO Compliance Calculator. The retention volume is in the "Volume Credited" column, and the overflow volume is in the "Remaining Volume" column.</p>	
<p>The following instructions identify how the collected rainwater will be used. Only fill in the sections that are applicable to the site.</p>	
<p><b>IRRIGATION</b></p> <p>Indicate the area to be irrigated in square feet and if the irrigation system is smart controls. The spreadsheet allows for irrigation to be used in certain months. Indicate, for each month, the average weekly irrigation application rate in either inches per week or gallons per month. The EPA Watersense Water Budget Tool can be used to calculate Monthly Landscape Water Requirement (based on the site's peak watering month). The output for this calculation is found on the Part 2.4.LWA sheet, which can be found at the following link: <a href="https://www.epa.gov/watersense/water-budget-tool/">https://www.epa.gov/watersense/water-budget-tool/</a></p>	
<p><b>INDOOR DEMAND - FLUSHING TOILETS/URINALS</b></p> <p>Indicate the number of people using the building. The values in lines 35 and 37 can be altered depending on how much water is used when flushing urinals or toilets. The default values are 0.80 gallons/flush and 1.60 gallons/flush for urinals and toilets, respectively. If the user knows the daily toilet and urinal demand, that value can be input into line 39 and the information in the rows above will not be used. Indicate the first and last day of the week that the building will be in use and the number of hours each day the building will be occupied.</p>	
<p><b>INDOOR DEMAND - LAUNDRY</b></p> <p>Indicate the number of loads of laundry done each day. The value in line 54 can be altered depending on how much water is used for each load of laundry. The default value is 42 gallons per load. If the user knows the daily laundry demand, the value can be input into line 56 and the information in the rows above will not be used. Indicate the first and last day of the week when the water will be used.</p>	
<p><b>ADDITIONAL DAILY USE</b></p> <p>If there is any other additional daily use not covered in the spreadsheet, line 69 can accommodate additional demand. Indicate, for each month, the average daily demand in gallons per day. Indicate the first and last day of the week when the water will be used.</p>	
<p><b>COOLING TOWERS</b></p> <p>If the rainwater collected is to be used for cooling towers, indicate in line 79 the average daily demand in gallons per day for each month the cooling towers use the collected rainwater.</p>	
<p>The following section allows for additional contribution to the cistern from sources other than rainwater.</p>	
<p><b>CONTRIBUTION FROM OTHER SOURCES</b></p> <p>If there are other sources of water that contribute to the cistern, indicate the average daily contribution in gallons per day for each month. Indicate the first and last day of the week when the water will be input.</p>	
<p><b>FIRST FLUSH FILTER DIVERSION AND EFFICIENCY</b></p> <p>This section accounts for the filter efficiency of the cistern. It is assumed that, after the first flush diversion and loss of water due to filter inefficiencies, the remainder of the SWR's storm will be successfully captured. These minimum values can be altered if appropriate.</p> <p>Line 96 indicates that for the 1.16-inch storm, a minimum of 95 percent of the runoff should be conveyed into the cistern.</p> <p>Line 98 indicates that for the 4.19-inch storm, a minimum of 90 percent of the runoff should be conveyed.</p>	

[illegible]

Storage Volume Summary

Average Daily Available Storage Volume by Month and Cistern Volume																			
Month\ Cistern Volume (gallons)	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500	8,000	8,500	9,000	9,500
January	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
February	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
March	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
April	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
May	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
June	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
July	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
August	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
September	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
October	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
November	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
December	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Daily Average Available Storage Volume, SV (cubic feet)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Note: Cistern Volume does not include detention for larger storm events. Detention volume that will be drawn down after each storm event should be modeled separately.																			
Overflow Volume from a 1.16-Inch Rain Event by Cistern Volume																			
Cistern Volume (Gallons)	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500	8,000	8,500	9,000	9,500
Overflow Volume (cubic feet)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

# Daily Averages of Available Storage (Sv) and Overflow Volu

1

1

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me (cubic feet)

## Appendix L: Glossary

A	
Advanced Design (AD)	<p>Detailed design for an area of a project described explicitly in the following:</p> <ul style="list-style-type: none"> <li>• Stage II planned unit development (PUD) application to the District of Columbia Zoning Commission;</li> <li>• Application for design review under the Capitol Gateway Overlay District to the District Zoning Commission; and</li> <li>• Final design submission to the National Capital Planning Commission (NCPC)</li> </ul>
Affordable housing	A single-family or two-family house that is built to be offered for rent or for sale for residential occupancy below market value and is made available to, and affordable to, a household whose income is equal to, or less than, eighty percent (80%) of the Area Median Income calculation provided by the United States Department of Housing and Urban Development
Animal confinement area	An area, including a structure, used to stable, kennel, enclose, or otherwise confine animals, not including confinement of a domestic animal on a residential property
Applicant	A person or their agent who applies for approval pursuant to this chapter
As-built plan	A set of architectural, engineering, or site drawings, sometimes including specifications that certify, describe, delineate, or present details of a completed construction project
Athletic playing fields	Compacted land cover and synthetic surfaces that are constructed primarily for use for athletic activities at public parks and schools. Compacted land cover and synthetic surfaces for which athletic activities are not the primary use are not considered athletic playing fields, unless these areas are necessary to support use of an adjacent area that is primarily used for athletic activities. Synthetic surfaces must have a minimum surface permeability of at least 10 inches per hour, in accordance with ASTM F2898 Standard Test Method for Permeability of Synthetic Turf Sports Field Base Stone and Surface System by Non-confined Area Flood Test Method
B	
Best management practice (BMP)	Structural or nonstructural practice that minimizes the impact of stormwater runoff on receiving waterbodies and other environmental resources, especially by reducing runoff volume and the pollutant loads carried in that runoff
Buffer	An area along a stream, river, or other natural feature that provides protection for that feature
Building permit	Authorization for construction activity issued by the <i>&lt;local jurisdiction&gt;</i>
C	

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(Supp. No. 45)

Clearing	The removal of trees and brush from the land excluding the ordinary mowing of grass, pruning of trees or other forms of long-term landscape maintenance
Combined sewer overflow (CSO)	The discharge of untreated effluent into a water body as a result of the combined volume of stormwater and sanitary water exceeding the capacity of the combined sewer system and wastewater treatment plant
Combined sewer system (CSS)	Sewer system in which stormwater runoff is conveyed together with sanitary wastewater through sewer lines to a wastewater treatment plant
Common plan of development	Multiple, separate, and distinct land-disturbing, substantial improvement, or other construction activities taking place under, or to further, a single, larger plan, although they may be taking place at different times on different schedules
Compacted cover	An area of land that is functionally permeable, but where permeability is impeded by increased soil bulk density as compared to natural cover, such as through grading, construction, or other activity and will require regular human inputs such as periodic planting, irrigation, mowing, or fertilization. Examples include landscaped planting beds, lawns, or managed turf
Conservation area	An area with a natural cover designation set aside to receive stormwater runoff as part of an impervious surface disconnection practice
Construction	Activity conducted for the following: <ul style="list-style-type: none"> <li>• Building, renovating, modifying, or razing a structure; or</li> <li>• Moving or shaping of earth, sediment, or a natural or built feature</li> </ul>
Contributing drainage area (CDA)	Area contributing runoff to a BMP
Control measure	Technique, method, device, or material used to prevent, reduce, or limit discharge
Critical area stabilization	Stabilization of areas highly susceptible to erosion, including down-slopes and side-slopes, through the use of brick bats, straw, erosion control blanket mats, gabions, vegetation, and other control measures
Cut	An act by which soil or rock is dug into, quarried, uncovered, removed, displaced, or relocated and the conditions resulting from those actions
<b>D</b>	
Demolition	The removal of part or all of a building, structure, or built land cover
Detention	Controlling the peak discharge rate of stormwater from a site
Dewatering	Removing water from an area or the environment using an approved technology or method, such as pumping
Director	The local administrator of the stormwater construction permits.
<b>E</b>	

Created: 2021-07-22 09:11:36 [EST]



Easement	A right acquired by a person to use another person's land for a special purpose
Electronic media	Means of communication via electronic equipment, including the internet
Energy Grade Line	The energy grade line represents the total energy at any point along the culvert (pipe) barrel.
Erosion	The process by which the ground surface, including soil and deposited material, is worn away by the action of wind, water, ice, or gravity
Excavation	An act by which soil or rock is cut into, dug, quarried, uncovered, removed, displaced or relocated and the conditions resulting from those actions
Exposed area	Land that has been disturbed or land over which unstabilized soil or other erodible material is placed
<b>F</b>	
<b>G</b>	
Grading	Causing disturbance of the earth, including excavating, filling, stockpiling of earth materials, grubbing, root mat or topsoil disturbance, or any combination of them
<b>H</b>	
Hydraulic Grade Line	The hydraulic grade line is the depth to which water would rise in vertical tubes connected to the side of the culvert (pipe) barrel.
<b>I</b>	
Impervious cover	A surface area that has been compacted or covered with a layer of material that impedes or prevents the infiltration of water into the ground, examples include conventional streets, parking lots, rooftops, sidewalks, pathways with compacted sub-base, and any concrete, asphalt, or compacted gravel surface and other similar surface
Infiltration	The passage or movement of surface water through the soil profile
<b>J</b>	
<b>K</b>	
<b>L</b>	
Land cover	Surface of land that is impervious, compacted, or natural
Land cover change	Conversion of land cover from one type to another, typically in order to comply with a requirement of this chapter.
Land-disturbing activity	Movement of earth, land, or sediment that disturbs the land surface and the related use of pervious land to support that movement. Land-disturbing activity includes stripping, grading, grubbing, trenching, excavating, transporting, and filling of land, as well as the use of pervious adjacent land for movement and storage of construction vehicles and materials. Land-disturbing activity does not include repaving or re-milling that does not expose the underlying soil

Created: 2021-07-22 09:11:36 [EST]

Low impact development (LID)	A land-planning and engineering-design approach to manage stormwater runoff within a development footprint. It emphasizes conservation, the use of on-site natural features, and structural stormwater BMPs to store, infiltrate, evapotranspire, retain, and detain rainfall as close to its source as possible with the goal of mimicking the runoff characteristics of natural cover
<b>M</b>	
Maintenance agreement	See Section 5.5.2 Maintenance Agreement
Maintenance contract	See “maintenance agreement”
Maintenance responsibility	See Section 5.5.1 Maintenance Responsibility
Maintenance plan	Planned scheduled maintenance for the life of the BMP
Maintenance schedule	See “maintenance plan”
Maintenance standards	Detailed maintenance plan laid out in Exhibit C within declaration of covenants
Major land-disturbing activity	<p>A distinct project or a part of a larger common plan of development that involves the creation, addition or replacement of 5000 square feet of impervious surface, or that involves one acre or greater of land disturbing activities. New development regardless of size, that is part of a larger common plan of development, even though multiple, separate and distinct land disturbing activities, may take place at different times and on different schedules.</p> <p>Multiple distinct areas that each disturb one acre of land, that are in separate, non-adjacent sites, and that are not part of a larger common plan of development do not constitute a major land-disturbing activity.</p>
Major Substantial Improvement	a renovation or addition to a structure or existing property that meets both of the following cost and size thresholds: a) construction costs for the building renovation/addition are greater than or equal to 50% of the pre-project assessed value of the structure as developed using current Building Valuation Data of the International Code Council, and b) combined footprint of structure(s) exceeding the cost threshold and any land disturbance are greater than or equal to 5,000 square feet.
<b>N</b>	
Natural cover	Land area that is dominated by vegetation and does not require regular human inputs such as irrigation, mowing, or fertilization to persist in a healthy condition. Examples include forest, meadow, or pasture
Non-structural BMP	A land use, development, or management strategy to minimize the impact of stormwater runoff, including conservation of natural cover or disconnection of impervious surface
<b>O</b>	
Off-site retention	Use of property not within the limits of disturbance of the project to comply with the stormwater retention volumes required by this Manual

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

Off-site retention volume (Off <sub>v</sub> )	A portion of a required stormwater retention volume or required water quality treatment volume that is not retained on site
On-site retention	Retention of a site's stormwater on that site or via conveyance to a shared stormwater BMP on another site
On-site stormwater management	Retention, detention, or treatment of stormwater on site or via conveyance to a shared stormwater BMP
Owner	The person who owns real estate or other property, or that person's agent
<b>P</b>	
Peak discharge	The maximum rate of flow of water at a given point and time resulting from a storm event
Permeable athletic track	A surface, including a surface made of synthetic material, located at a school or public park that is used for athletic purposes including biking, running, and walking, and that allows the infiltration of water into the ground. The track must have a minimum surface permeability of at least 10 inches per hour, in accordance with the ASTM F2898 Standard Test Method for Permeability of Synthetic Turf Sports Field Base Stone and Surface System by Non-confined Area Flood Test Method
Permeable playground surface	A surface, including a surface made of synthetic material, located under a playground area at a school or public park, that allows the infiltration of water into the ground. The playground surface must have a minimum surface permeability of at least 10 inches per hour, in accordance with ASTM F2898 Standard Test Method for Permeability of Synthetic Turf Sports Field Base Stone and Surface System by Non-confined Area Flood Test Method
Person	A legal entity, including an individual, partnership, firm, association, joint venture, public or private corporation, trust, estate, commission, board, public or private institution, cooperative, the <local authority> and its agencies, the State of South Carolina and its agencies, and the federal government and its agencies
Pervious area	Area with a compacted cover designation set aside to receive stormwater runoff as part of an impervious surface disconnection practice
Post-development	Describing conditions that may be reasonably expected to exist after completion of land development activity on a site
Practice	A system, device, material, technique, process, or procedure that is used to control, reduce, or eliminate an impact from stormwater; except where the context indicates its more typical use as a term describing a custom, application, or usual way of doing something
Preconstruction meeting	The mandatory meeting occurring prior to any construction, including the owner, the designer, the installer, and the DHEC inspector. This meeting must contain an on-site component to evaluate the SWMP against existing site conditions. This should include, at a minimum, a visual examination of land cover types, the tree preservation plan, boundaries of the CDA(s), the existing inlet elevation(s) to ensure they conform to original design

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

Predevelopment	Describing conditions of meadow land and its relationship to stormwater before human disturbance of the land
Pre-project	Describing conditions, including land covers, on a site that exist before the construction described in a Stormwater Management Plan has begun
Publicly-owned or publicly-financed project	A project: <ul style="list-style-type: none"> <li>a. That is municipally-owned or municipality-instrumentality-owned;</li> <li>b. Where at least 15% of the project's total cost is municipally-financed or municipality-instrumentality-financed; or</li> <li>c. That includes a gift, lease, or sale from municipally-owned or municipality-instrumentality-owned property to a private entity</li> </ul>
Public right-of-way (PROW)	The surface, the air space above the surface (including air space immediately adjacent to a private structure located on public space or in a public right-of-way), and the area below the surface of any public street, bridge, tunnel, highway, railway track, lane, path, alley, sidewalk, or boulevard
Public space	All the publicly owned property between the property lines on a street, park, or other public property as such property lines are shown on the records of the State. This includes any roadway, tree space, sidewalk, or parking between such property lines, but it excludes adjacent parks and other public property that is not associated with the public right-of-way
<b>Q</b>	
<b>R</b>	
Raze	The complete removal of a building or other structure down to the ground or to its foundation
Responsible person	Construction personnel knowledgeable in the principles and practices of erosion and sediment control and certified by a Department-approved soil erosion and sedimentation control training program to assess conditions at the construction site that would impact the effectiveness of a soil-erosion or sediment-control measure on the site
Retention	Keeping a volume of stormwater runoff on site through infiltration, evapotranspiration, storage for non-potable use, or some combination of these
Retention capacity	The volume of stormwater that can be retained by a stormwater BMP or land cover
Retrofit	A stormwater BMP or land cover installed in a previously developed area to improve stormwater quality or reduce stormwater quantity relative to current conditions
Runoff	The portion of precipitation (including snow-melt) that travels over the land surface, and also from rooftops, either as sheetflow or as channel flow, in small trickles and streams, into the main water courses

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

S	
Savannah River Watershed Protection Area	
Sediment	Soil, including soil transported or deposited by human activity or the action of wind, water, ice, or gravity
Sedimentation	The deposition or transportation of soil or other surface materials from one place to another as a result of an erosion process
Shared BMP (S-BMP)	A stormwater BMP, or combination of BMPs, providing stormwater management for stormwater conveyed from another site or sites
Single- or two-family house	An individual house, townhouse, or rowhouse designed and used for occupancy by one or two families. An individual house, townhouse, or rowhouse that has been physically altered for use by more than one or two families is not considered a single- or two-family house
Site	A tract, lot or parcel of land, or a combination of tracts, lots, or parcels of land for which development is undertaken as part of a unit, sub-division, or project. The mere divestiture of ownership or control does not remove a property from inclusion in a site
Site drainage area (SDA)	The area that drains stormwater from the site to a single discharge point or sheet flows from a single area off the site
Soil	All earth material of whatever origin that overlies bedrock and may include the decomposed zone of bedrock that can be readily excavated by mechanical equipment
Soil erosion and sediment control plan	A set of drawings, calculations, specifications, details, and supporting documents related to minimizing or eliminating erosion and off-site sedimentation caused by stormwater on a construction site. It includes information on construction, installation, operation, and maintenance
Soils report	A geotechnical report addressing all soil erosion and sediment control-related soil attributes, including but not limited to site soil drainage and stability
Special watershed protection areas	Areas identified by US Geological Survey 12-digit Hydrologic Unit Code (HUC 12) in the Southern Low Country Stormwater Design Manual that require area-specific stormwater standards
Storm sewer	A system of pipes or other conduits that carries or stores intercepted surface runoff, street water, and other wash waters, or drainage, but excludes domestic sewage and industrial wastes
Stormwater	Flow of water that results from runoff, snow melt runoff, and surface runoff and drainage
Stormwater management	A system to control stormwater runoff with structural and non-structural stormwater BMPs, including the following: (a) quantitative control of volume and rate of surface runoff and (b) qualitative control to reduce or eliminate pollutants in runoff
Stormwater Management Plan (SWMP)	A set of drawings, calculations, specifications, details, and supporting documents related to the management of stormwater for a site. A SWMP includes information on construction, installation, operation, and maintenance

Created: 2021-07-22 09:11:36 [EST]

(Supp. No. 45)

Stormwater Pollution Prevention Plan (SWPPP)	A document that identifies potential sources of stormwater pollution at a construction site, describes practices to reduce pollutants in stormwater discharge from the site, and may identify procedures to achieve compliance
Stormwater retention volume (SWRV)	Volume of stormwater from a site for which the site is required to achieve retention
Stripping	An activity that removes or significantly disturbs the vegetative surface cover including clearing, grubbing of stumps and rock mat, and top soil removal
Substantial improvement	A repair, alteration, addition, or improvement of a building or structure, the cost of which equals or exceeds 50% of the market value of the structure before the improvement or repair is started
Structural stormwater BMP	A practice engineered to minimize the impact of stormwater runoff, including a bioretention, green roof, permeable pavement, system to capture stormwater for non-potable uses, etc.
Supplemental review	A review that <i>&lt;local jurisdiction&gt;</i> conducts after the review it conducts for a first resubmission of a plan
Swale	A narrow low-lying stretch of land that gathers or carries surface water runoff
<b>T</b>	
Total suspended solids (TSS)	The entire amount of organic and inorganic particles dispersed in water. TSS is measured by several methods, which entail measuring the dry weight of sediment from a known volume of a subsample of the original
<b>U</b>	
<b>V</b>	
<b>W</b>	
Waste material	Construction debris, dredged spoils, solid waste, sewage, garbage, sludge, chemical wastes, biological materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial or municipal waste
<b>X</b>	
<b>Y</b>	
<b>Z</b>	

## Appendix M: References and Resources

### M.1 References

The following documents provide more detailed information on many aspects of BMP design than is found in this Manual. These resources may be useful for those looking to develop greater understanding of individual BMPs or stormwater design in general. Recommendations in these resources may be used to inform BMP designs; however, where conflicts occur between these resources and the Manual, the requirements of the Manual prevail.

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## M.2 Resources for Natural Resources Survey

Resource Group	Resource Type	Sources for Information
General Resources	<ul style="list-style-type: none"> <li>•Topography</li> <li>•Natural Drainage Divides</li> <li>•Natural Drainage Patterns</li> <li>•Natural Drainage Features (e.g., Swales, Basins, Depressional Areas)</li> <li>•Soils</li> <li>•Erodible Soils Comes with soil survey</li> <li>•Steep Slopes (e.g., Areas with Slopes Greater Than 15%) Can determine from DEM or query soil types with steep slopes. Recommend the former for accuracy.</li> <li>•Trees and Other Existing Vegetation – Can use NLCD data to get forest land cover</li> <li>•Impervious surfaces</li> <li>•Protected Lands</li> </ul>	<p>LiDAR:  <a href="https://coast.noaa.gov/dataviewer/index.html#/lidar/search/">https://coast.noaa.gov/dataviewer/index.html#/lidar/search/</a></p> <p>Major basin boundaries:  <a href="https://apps.dhec.sc.gov/GIS/ClearingHouse/">https://apps.dhec.sc.gov/GIS/ClearingHouse/</a></p> <p>Soils:  <a href="https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx">https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx</a></p> <p>Land Cover (NLCD): <a href="https://www.mrlc.gov/data">https://www.mrlc.gov/data</a></p> <p>Land Cover (NOAA C-CAP):  <a href="https://coast.noaa.gov/digitalcoast/data/ccapregional.html">https://coast.noaa.gov/digitalcoast/data/ccapregional.html</a></p> <p>County Level LIDAR  <a href="http://www.dnr.sc.gov/GIS/lidarstatus.html">http://www.dnr.sc.gov/GIS/lidarstatus.html</a></p> <p>NLCD impervious surface -  <a href="https://www.mrlc.gov/data/type/urban-imperviousness">https://www.mrlc.gov/data/type/urban-imperviousness</a></p> <p>Protected Lands (PAD-US) - LINK  <a href="#">TNC</a></p>
Freshwater Resources	<ul style="list-style-type: none"> <li>•Rivers – NHD or state level data</li> </ul>	<p>NHD: <a href="https://www.usgs.gov/core-science-systems/ngp/national-hydrography">https://www.usgs.gov/core-science-systems/ngp/national-hydrography</a></p>

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(Supp. No. 45)

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	<p>should be available</p> <ul style="list-style-type: none"> <li>•Perennial and Intermittent Streams – This distinction might not be available.</li> <li>•Freshwater Wetlands – National Wetland Inventory</li> </ul>	<p>Water classifications (view only):  <a href="https://gis.dhec.sc.gov/watersheds/">https://gis.dhec.sc.gov/watersheds/</a></p> <p>NWI: <a href="https://www.fws.gov/wetlands/index.html">https://www.fws.gov/wetlands/index.html</a></p>
Estuarine Resources	<ul style="list-style-type: none"> <li>•Tidal Rivers and Streams I think we can get all of this from NWI. Tidal influence might not be denoted.</li> <li>•Tidal Creeks</li> <li>•Coastal Marshlands</li> <li>•Tidal Flats</li> <li>•Scrub-Shrub Wetlands</li> </ul>	<p>NOAA C-CAP classification scheme includes palustrine forested wetland, palustrine scrub/shrub wetland, palustrine emergent wetland, estuarine forested wetland, estuarine scrub/shrub wetland, estuarine emergent wetland, palustrine aquatic bed, and estuarine aquatic bed</p> <p><u>County Level LIDAR Breaklines (with terrain dataset)</u>  <a href="http://www.dnr.sc.gov/GIS/lidarstatus.html">http://www.dnr.sc.gov/GIS/lidarstatus.html</a></p>
Marine Resources	<ul style="list-style-type: none"> <li>•Near Coastal Waters</li> <li>•Beaches</li> <li>•Shoreline</li> </ul>	<p>NOAA C-CAP classification scheme includes unconsolidated shore</p> <p>DHEC OCRM - <a href="https://apps.dhec.sc.gov/GIS/ClearingHouse/">https://apps.dhec.sc.gov/GIS/ClearingHouse/</a>  ←look under OCRM from drop down “List GIS Layers by DHEC...”</p>
Groundwater Resources	<ul style="list-style-type: none"> <li>•Groundwater Recharge Areas</li> <li>•Wellhead Protection Areas</li> </ul>	<p><a href="https://scdhec.gov/environment/bureau-water/groundwater-use-reporting/groundwater-management-planning/groundwater-2">https://scdhec.gov/environment/bureau-water/groundwater-use-reporting/groundwater-management-planning/groundwater-2</a></p> <p><a href="http://hydrology.dnr.sc.gov/well-database.html">http://hydrology.dnr.sc.gov/well-database.html</a></p> <p>DHEC Watershed atlas - <a href="https://gis.dhec.sc.gov/watersheds/">https://gis.dhec.sc.gov/watersheds/</a>  Check under Public Water supply tab in layer contents for protection areas</p>

Resource Group	Resource Type	Sources for Information
Terrestrial Resources	<ul style="list-style-type: none"> <li>•Dunes</li> <li>•Maritime Forests</li> <li>•Marsh Hammocks</li> <li>•Evergreen Hammocks</li> <li>•Canebrakes</li> </ul>	<ul style="list-style-type: none"> <li>• Forest inventory analysis (FIA). The SC Forestry Commission would have that data</li> <li>•Natural Communities of SC  <a href="https://dc.statelibrary.sc.gov/handle/10827/30179">https://dc.statelibrary.sc.gov/handle/10827/30179</a></li> </ul>

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(Supp. No. 45)

	<ul style="list-style-type: none"> <li>•Bottomland Hardwood Forests</li> <li>•Beech-Magnolia Forests</li> <li>•Pine Flatwoods</li> <li>•Longleaf Pine-Wiregrass Savannas</li> <li>•Longleaf Pine-Scrub Oak Woodlands</li> </ul>	
Other Resources	<ul style="list-style-type: none"> <li>• Shellfish Harvesting Areas</li> <li>•Floodplains – FEMA data available nationally</li> <li>•Aquatic Buffers</li> <li>•Other High Priority Habitat Areas as described by South Carolina Department of Natural Resources</li> </ul>	<ul style="list-style-type: none"> <li>•FEMA: <a href="https://msc.fema.gov/portal/home">https://msc.fema.gov/portal/home</a></li> <li>•SCDHEC: <a href="https://apps.dhec.sc.gov/GIS/ClearingHouse/">https://apps.dhec.sc.gov/GIS/ClearingHouse/</a></li> <li>•GAP/species richness/habitat/etc. data <a href="http://www.dnr.sc.gov/GIS/gap/mapping.html">http://www.dnr.sc.gov/GIS/gap/mapping.html</a></li> <li>•Intertidal Oyster Reefs - <a href="http://www.dnr.sc.gov/GIS/descoysterbed.html">http://www.dnr.sc.gov/GIS/descoysterbed.html</a></li> <li>•Shellfish harvesting areas - <a href="#">Link</a></li> </ul>

## Appendix N: Summary of Federal and State Stormwater Regulations

### Table of Contents

N.1 Summary of Federal Regulations.....	1
N.1.1 MS4 Program.....	2
N.1.2 Industrial Activity Program.....	3
N.2 Summary of State Regulations .....	4

### N.1 Summary of Federal Regulations

In general, Federal regulations and legislation have been applied at the State level to regulate stormwater runoff quality, whereas for many years local stormwater ordinances and regulations focused on regulating drainage, streets, peak stormwater runoff flow and flooding concerns.

Federal regulations that directly affect stormwater runoff control include the Coastal Zone Management Act and the National Pollutant Discharge Elimination System (NPDES) stormwater regulations of the Clean Water Act, administered by the U.S. Environmental Protection Agency (EPA). The Coastal Zone Management Act was designed to encourage and assist coastal states to develop and implement management programs. The State of South Carolina developed its own Coastal Zone Management Act in 1977, to protect coastal resources and promote responsible development in Beaufort County and seven other coastal counties. This will be discussed further in the following section on State regulations. The EPA NPDES requirements are presented below.

The 1987 amendments to the Federal Clean Water Act define specific stormwater discharges as point source discharges subject to NPDES regulations. These amendments required EPA to promulgate regulations pertaining to stormwater discharges via a phased approach.

The initial phase, promulgated by EPA on November 16, 1990, became known as the Phase I Stormwater NPDES regulations. These final regulations created two broad classes of stormwater discharges under the NPDES program:

- 1) Municipal Separate Storm Sewer System (MS4) discharges; and
- 2) Stormwater Discharges Associated with Industrial Activity.

The MS4 Program was divided into three categories (large, medium, and small populations) based on U.S. Census Bureau population estimates, with Phase I regulations including only large and medium MS4 stormwater discharges.

The Stormwater Discharges Associated with Industrial Activity program was divided into 11 categories of industrial activity. These included industrial manufacturing facilities, landfills, transportation facilities, construction (land clearing on 5 or more acres), etc., without consideration given to the type of facility owner or operator such that a publicly owned or operated facility could be included in one of the 11 categories.

On December 8, 1999, EPA adopted the Phase II stormwater regulations, which included small MS4 discharges located in an “Urbanized Area” per U.S. Census Bureau definitions and delineations. In addition, the land disturbance activity regulation with the threshold of 5 or more acres (as per the construction activity regulation) was reduced to 1 or more acres, with a provision that construction sites that disturb less than 1 acre could also be regulated if water quality concerns or problems related to the activity warrant permit coverage under the NPDES Program.

The State of South Carolina has been an EPA NPDES Program delegated authority for a number of years. The State agency that administers the Federal NPDES Program in South Carolina is the Department of Health and Environmental Control (DHEC). As such, DHEC oversees all NPDES Program related permitting, monitoring, and enforcement issues in the State of South Carolina. However, EPA does have authority over DHEC on NPDES Program issues and may, at its discretion, conduct independent audits of a DHEC-issued NPDES permit.

### **N.1.1 MS4 Program**

Phase I of the NPDES Stormwater Program required large MS4s (with populations of 250,000 people or greater) and medium MS4s (with populations of 100,000 people or greater but less than 250,000) to apply for permit coverage in two parts. All permits issued under this phase were individual permits and required the development and implementation of a stormwater management program. At a minimum, this program had to address the following key elements:

- 1) Structural control maintenance
- 2) Areas of significant development and redevelopment
- 3) Roadway runoff management
- 4) Flood control related to water quality issues
- 5) Municipally owned operations, including landfills, wastewater treatment facilities, etc.
- 6) Hazardous waste treatment, storage or disposal sites, etc.
- 7) Application of pesticides, herbicides, and fertilizers
- 8) Illicit discharge detection and elimination
- 9) Regulation of sites classified as associated with industrial activity
- 10) Construction site and post-construction site runoff control
- 11) Public education and outreach

As of July 2007, the State of South Carolina has one large MS4 (South Carolina Department of Transportation) and four medium MS4s – the City of Columbia, Greenville County, Lexington County, and Richland County.

As of July 2007, there is a list of 70 regulated small MS4s, which did not specifically include Beaufort County. In 2014 this list was increased, and additional communities were added, including Beaufort County. These small MS4s are required to begin running programs to address stormwater runoff from construction sites and post-construction activities. These activities are two of the six components of a stormwater management program as defined by the NPDES Phase II Final Rule, as listed below:

- 1) Public education and outreach.

(Supp. No. 45)

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- 2) Public participation/involvement.
- 3) Illicit discharge detection and elimination.
- 4) Construction site runoff control.
- 5) Post-construction runoff control.
- 6) Pollution prevention/good housekeeping.

Several of these items are addressed by this document and will fulfill part of the NPDES Phase II requirements.

### **N.1.2 Industrial Activity Program**

The NPDES Phase I stormwater regulations created 11 categories of Stormwater Discharges Associated with Industrial Activity. Categories “i” through “ix” and category “xi” became part of the Industrial Program, while category “x” became part of the Construction Program. Thus, the NPDES stormwater program is made up of three distinct program components: the MS4 Program, the Industrial Program, and the Construction Program. Although the Phase I included a provision for a no-exposure permit exemption to category “xi” (light industry) only, the Phase II regulations extended this no-exposure exemption to categories “i” through “ix.”

The no-exposure exemption applied to facilities that had no stormwater runoff exposed to raw materials, byproducts, waste products, intermediate products, final products, etc. Activities within the Industrial Program and the Construction Program can have NPDES stormwater permits issued as either individual permits or general permits; however, due to the nature and number of facilities that must be issued NPDES stormwater permits, general permits are typically utilized. On rare occasions, when water quality concerns become a permit issue, DHEC may require an individual permit in lieu of granting general permit coverage. The general permit under the Industrial Program requires the preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP) for each covered facility and requires monitoring and/or inspections. Although only certain facilities require both, inspections are required of all facilities.

Under the Construction Program, the construction activity category is divided into two phases, Phase I (for large construction sites) and Phase II (for small construction sites). On a case-by-case basis, a permit may also be required when a construction activity involves the disturbance of less than 1 acre of land. Stormwater discharges from construction activities that disturb less than 5 acres of land are called “small construction activities.” A Construction Activity permit can either be issued in the form of a general permit or an individual permit. Typically, the general permit is utilized unless specific water quality issues warrant the use of an individual permit. The general permit requires that a SWPPP be prepared and implemented for each construction site, but sampling of stormwater runoff from the site is not required.

Inspections must be conducted at all construction sites covered under the general permit. In addition, a provision in the MS4 program regulations requires that all regulated MS4s implement a program for controlling construction site runoff. This provision essentially requires that the construction site must receive a permit from the regulated MS4 in addition to having to be covered under an NPDES Stormwater Construction Activity permit.



It is important to note that with the March 10, 2003 initiation of the NPDES Phase II Stormwater Program implementation, considerable overlap exists between the Federal NPDES Stormwater Program and the State of South Carolina's Sediment, Erosion, and Stormwater Management Program as discussed below.

## **N.2 Summary of State Regulations**

In addition to being an EPA NPDES Program delegated authority, the State of South Carolina also has its own relevant regulations. The South Carolina's Sediment, Erosion, and Stormwater Management Program was initiated in 1983, and required construction activities on State-owned and State-managed lands to control sediment and erosion. In 1991, via the South Carolina Stormwater Management and Sediment Reduction Act, the program was expanded to include all construction activities that disturbed more than 2 acres of land. Regulation 72-300, entitled "Standards for Stormwater Management and Sediment Reduction," describes the requirements for preparing a stormwater management and sediment and erosion control plan from land disturbance activities. Exemptions, Waivers, and Variances from the Law are explained in Section 72-302. The Bureau of Water of the Office of Environmental Quality Control (EQC) of DHEC is responsible for administering the Sediment, Erosion, and Stormwater Management Program, and by regulation the Office of Ocean and Coastal Resource management (OCRM) implements the program in the eight coastal county areas. A local government may become a State-delegated authority after submitting a request and receiving approval by the State. However, Federal, State, local government, and public school projects must be submitted to DHEC even if they are located within the jurisdiction of a State-delegated entity.

As indicated previously, the Federal NPDES Stormwater Construction Activity Program requires permit coverage for construction sites that disturb more than 1 acre of land and, on a case-by-case basis, even less than 1 acre of land. Consequently, an overlap exists currently between the State's Sediment, Erosion, and Stormwater Management Program and the NPDES Stormwater Construction Activity Program (that is, when more than 2 acres of land are disturbed due to a construction activity, permits must be secured under both programs). The State coordinates the various aspects of the two programs (i.e., permitting, compliance, monitoring, and enforcement) to minimize the overlapping responsibilities. The two programs are integrated into a comprehensive Stormwater Regulatory Program for the State of South Carolina.

The *South Carolina Stormwater Management and Sediment Control Handbook for Land Disturbance Activities* (DHEC, 2003) includes all existing South Carolina stormwater management regulations required for individuals to submit a stormwater management and sediment reduction permit application to DHEC. Elements of the Federal NPDES Stormwater Program, Coastal Zone Management Program, and the State's Stormwater Management and Sediment Reduction regulations are included in the handbook.

Table 1 summarizes the State regulatory requirements that are applicable to Southern Lowcountry, including jurisdictions in the State of South Carolina's Coastal Zone Management Program. For land disturbance of 0.5 acre or less that is within 0.5 mile of a receiving waterbody in the coastal zone, Section R.72- 307H of the State Stormwater Management and Sediment Reduction Act of 1991 is applicable. Section R.72-307H is also applicable for land disturbance of less than 1 acre, at locations that are not within 0.5 mile of a coastal zone receiving water. If the land disturbance is at least 1 acre, but less than 2 acres, the NPDES General Permit and Section R.72-307H apply. Development is highly impervious or is located directly adjacent to a critical area, the more stringent R.72-307I regulations are applicable; otherwise, the less stringent R.72-307H regulations are appropriate.

Table 1. South Carolina Requirements for Land Development in Southern Lowcountry.

Extent of Land Disturbance (acres)	Applicable Regulatory Requirements
Less than 0.5 acre and within 0.5 acre of receiving waters	R.72-307H
Less than 1 acre and not within 0.5 acre of receiving waters	R.72-307H
At least 1 but less than 2 acres	R.72-307H, SCR100000
More than 2 and less than 5 acres	R.72-307I, SCR100000
5 acres or more	R.72-305, R.72-307, SCR100000

Section R.72-307I regulations are also applicable for developments of more than 2 and less than 5 acres. For developments of 5 acres or more, the applicable regulations include Sections R.72-305 and R.72-307 of the Stormwater Management and Sediment Reduction Act of 1991, plus the NPDES General Permit.

Features of the regulations highlighted in Table 1 are presented in

Table 2. The regulations under Section R.72-307H provide for a simplified stormwater management and sediment control plan that does not require approval by DHEC and does not require preparation or certification by a registered engineer, landscape architect or Tier B land surveyor (SCDHEC, 1997). However, DHEC staff does have the authority to conduct site inspections to ensure compliance with the submitted plan. Under Section R.72-307I, the stormwater management and sediment control plan must be approved by DHEC, and requires preparation and certification by a registered engineer, landscape architect or Tier B land surveyor. The plan must also include BMPs to control erosion and sediment, and measures to control peak discharge rates and peak velocities of stormwater runoff from the site.

N6

Table 2. South Carolina Sediment, Erosion, and Stormwater Management Program Land Development Regulatory Requirement Details Applicable to Non-Coastal Counties.

Plan Feature	Applicable Regulation(s)		
	R.72-307H	R.72-307I	R.72-305, R.72-307, SCR100000
Plan Approval by Implementing Agency	Not required	Required	Required
Plan Preparation / Certification by Registered Professional Engineers / Landscape Architects / Land Surveyors	Not required	Required	Required
BMPs to Control Erosion and Sediment	Not required	Required	Required
Measures to Control Stormwater Quantity	Not required	Required <sup>1</sup>	Required <sup>1</sup>
Measures to Control Stormwater Quality	Not required	Not required	Required <sup>2</sup>
<p>1. Stormwater quantity control requirements include:</p> <ul style="list-style-type: none"> <li>a. Post-development peak discharge rates shall not exceed pre-development discharge rates for the 2- and 10- year frequency, 24-hour duration storm events. Implementing agencies may utilize a less frequent storm event (e.g., 25-year, 24-hour storm) to address existing or future stormwater quantity or quality problems.</li> <li>b. Discharge velocities shall be reduced to provide a non-erosive velocity flow from a structure, channel, or other control measure or the velocity of the 10-year, 24-hour storm runoff in the receiving waterway prior to the land disturbance activity, whichever is greater.</li> <li>c. Watersheds other than “designated watersheds” that have well documented water quantity problems may have more stringent, or modified, design criteria determined by the local government that is responsive to the needs of that watershed.</li> </ul> <p>2. See Table A-3 for a summary of stormwater quality requirements.</p>			

The State regulation requires that post-development peak flows shall not exceed the pre- development peak flow rate for the 2-year/24-hour and 10-year/24-hour design storms. Developments of 5 acres or more must meet all of the requirements listed above and must provide measures for stormwater quality control.

The current NPDES general permit SCR100000 (effective September 1, 2006) includes requirements for inspections on construction sites. Once construction begins, these inspections must be conducted at least once every 7 calendar days, or at least once every 14 calendar days and within 24 hours of the end of a storm event of 0.5 inches or greater. The inspections must be conducted by qualified personnel (as defined in the permit) and an inspection report must be completed for each inspection. The report must be retained for at least 3 years from the date that permit coverage expires or is terminated. For construction activities disturbing 10 acres or more, a monthly report must also be submitted to DHEC. Monthly reports may also be required on a case-by- case basis.

Stormwater runoff quality control measures required for developments of 5 acres or more are presented in Table 3. In general, the water quality storage requirements depend upon the type of BMP and, in some cases, the location of the development site.

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(Supp. No. 45)

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Table 3. South Carolina Coastal Zone Management Program Stormwater Quality Bmp Requirements Beaufort County.

BMP Facility Type	Water Quality Volume Requirements		
	General	Within 0.5 Miles of a Receiving Waterbody in the Coastal Zone	Within 1,000 Ft of Shellfish Beds
Water quality facility with permanent pool of water (e.g., wet detention pond)	Permanent pool volume of 0.5 inches of runoff per acre of drainage; storage above permanent pool of 0.5 inches of runoff per acre of drainage, required to bleed down over a 24-hour period	Permanent pool volume of 0.5 inches of runoff per acre of drainage <u>or</u> 1.0 inches of runoff per impervious acre of drainage, whichever is greater; same general storage requirement above permanent pool	Permanent pool volume of 0.5 inches of runoff per acre of drainage <u>or</u> 1.5 inches of runoff per impervious acre of drainage, whichever is greater; same general storage requirement above permanent pool
Water quality facility without permanent pool of water (e.g., extended dry detention pond)	Storage of 1.0 inches of runoff from the entire drainage area, required to bleed down over a 24-hour period	General requirements apply	Not applicable
Infiltration practices	Storage of 1.0 inches of runoff per impervious acre of drainage, required to drain completely in 72 hours	General requirements apply	Storage of 1.5 inches of runoff per impervious acre of drainage, required to drain completely in 72 hours

The basic water quality volume requirements vary based on the type of BMP. A water quality facility with a permanent pool of water (e.g., a wet detention pond) has a required permanent pool volume equivalent to 0.5 inch of runoff per acre of drainage, as well as another 0.5 inch of storage above the permanent pool. The storage above the permanent pool is required to bleed down over a 24-hour period. In contrast, a water quality facility without a permanent pool of water (e.g., an extended dry detention pond) has a required water quality storage volume equivalent to 1.0 inch of runoff per acre of drainage, and this volume is required to bleed down over a 24-hour period. Infiltration facilities, which capture runoff and then release the captured runoff through evapotranspiration and infiltration into the underlying soil, are required to provide water quality storage equivalent to 1.0 inches of runoff per impervious acre of drainage.

Under existing State regulations, water quality control facilities with a permanent pool of water may have more stringent requirements if the development is within 0.5 mile of a receiving waterbody in the coastal zone. In this case, the required permanent pool volume is the greater of: (a) 0.5 inch of runoff from the entire drainage area, or (b) 1.0 inch of runoff per impervious acre of drainage. The latter condition will apply for commercial, industrial and high-density residential land uses with an imperviousness of more than 50 percent. There are no special requirements for infiltration facilities and facilities without a permanent pool of water.

Special considerations also apply when the development is within 1,000 ft of shellfish beds (determined from State mapping or by site inspection). In this case, the regulations require that 1.5 inches of runoff (Supp. No. 45)

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per impervious acre of drainage must be retained. Of the three BMP types discussed above, only infiltration facilities are designed to retain runoff (i.e., captured runoff is depleted by storage through evapotranspiration and infiltration into the underlying soil, rather than released to a drainage channel or waterbody). In contrast, facilities such as ponds are designed to detain runoff (i.e., captured runoff is detained for treatment and is then released to a drainage channel or waterbody).

Table 3 shows how the shellfish bed regulation has been interpreted for this report. The requirement for infiltration facilities is 1.5 inches per impervious acre of drainage, which is 50 percent greater than the general requirements. For facilities with a permanent pool, it was presumed that the requirement would be met by providing a permanent pool volume equivalent to 1.5 inches of runoff per impervious acre. For storms producing runoff of 1.5 inches or less, the runoff will be stored in the permanent pool and an equal volume of water will be displaced from the pool and discharged to a drainage channel or waterbody. The table provides no interpretation of the shellfish bed requirements for other facilities without a permanent pool. Such a facility would actually be operating as an infiltration facility.

As mentioned previously, DHEC administers the Federal NPDES Program on behalf of EPA; therefore, along with having jurisdiction over the NPDES Construction Program, DHEC also has jurisdiction over the NPDES Industrial Program. Under the latter program, the general permit (SCR000000) covers all categories of stormwater discharges associated with industrial activity, except the construction activity, which is covered under the Construction Program. SCR000000 requires the development of a SWPPP, which identifies potential sources of stormwater pollution and describes practices to be implemented for reducing stormwater pollutant discharges. These practices may include structural BMPs (e.g., wet detention ponds), good housekeeping practices, spill prevention procedures, and employee training. Annual or semi-annual monitoring of stormwater discharge from the site is required for certain industrial facilities. The monitoring would include measurement of specific pollutants such as nutrients and metals, and acute whole effluent toxicity tests.

Information on the South Carolina Sediment, Erosion, and Stormwater Management Program can be found at: <http://www.scdhec.net/water/html/erfmain.html>

Information on NPDES Stormwater Program Implementation in South Carolina can be found at: <http://www.scdhec.net/eqc/water/html/swnhistory.html>

## Appendix O: Maintenance Agreement Template

### O.1 Maintenance Agreement Template

#### E.3 Sample Maintenance Agreement

State of South Carolina )  
 )  
 County of Beaufort ) Permanent Stormwater Facility Maintenance  
 and Responsibility Agreement  
 Tax Map No. \_\_\_\_\_

This Agreement is entered into this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_, by and between \_\_\_\_\_, (hereinafter referred to as "Landowner") and the County of Beaufort, political subdivision of the State of South Carolina (hereinafter referred to as "County").

It is agreed as follows:

##### **Landowner Responsible for Stormwater Facility:**

The South Carolina Stormwater Management and Sediment Reduction Act of 1991 (§48-14-10, et. seq.) and Regulation 72-308 provide that a Landowner shall adequately establish and maintain stormwater management/Best Management Practices (BMP) facilities upon making certain improvements to the Landowner's property. This law applies to any individual, partnership, corporation or other entity, constructing a stormwater facility. It also applies to all subsequent owners of the property. The obligation applies to the maintenance of all pipes, equipment, and channels built to convey stormwater to a retention facility, as well as all structures, improvements, and vegetation provided to control the quantity and quality of the stormwater on the property. (All fixtures and graded or excavated improvements for controlling stormwater are herein the "Facility"). Adequate maintenance is herein defined as keeping the Facility in good working condition so that the Facility is performing all of its design functions in accordance with the purposes for which it is designed.

##### **Maintenance Required:**

The Landowner, its successors and assigns, will perform the maintenance, repair, and replacement necessary to keep the Facility in good working order. In the event a maintenance schedule for the Facility (including sediment removal) is outlined on the approved plans, the schedule must be followed.

##### **Inspection Required:**

The Landowner, its successors and assigns, shall regularly and periodically inspect the Facility in its entirety. Records shall be kept to identify the dates and maintenance performed and shall be made available to the County at the County's request. The purpose of the inspection is to assure safe and proper functioning of the Facility. The inspection shall cover all parts of the Facility including, but not limited to, berms, outlet structures, pond areas, and access roads. The Landowner's failure to inspect shall be treated as a breach of this Agreement just as much as a failure to repair if repair is needed after inspection.

##### **Access Permitted:**

The Landowner grants permission to the County, its authorized employees and agents, to enter upon the Property and to inspect the Facility whenever the County deems necessary. The purpose of inspection is to follow-up on reported or observed deficiencies, to respond to citizen complaints, or to make an inspection if a significant time has passed after the last inspection. The County shall provide the Landowner a copy of the inspection findings and a directive to commence with the repairs if necessary. In the case of multiple Landowners of a single property, notice to one shall suffice as notice to all.

Page 1 of 3

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(Supp. No. 45)

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**No Duty on the County:**

This Agreement creates no affirmative duty on the County to inspect, and it imposes no liability of any kind whatsoever on the County for omissions in inspecting. The Landowner agrees to hold the County harmless from any liability in the event the Facility fails to operate properly due to the Landowner's failure to abide by the terms of this Agreement.

**Landowner Covenants:**

The Landowner accepts responsibility for ownership and proper maintenance of the stormwater system, the Facility (pond, swales, etc.) on parcel # (R \_\_\_\_\_) located at \_\_\_\_\_, (see attached Site Map) Beaufort, South Carolina, per the approved maintenance plan. The specific BMPs on the property are listed below:

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_
- 4) \_\_\_\_\_
- 5) \_\_\_\_\_

Landowner will complete any necessary repairs and/or preventive maintenance procedures in a timely manner to ensure proper functioning as a stormwater management device(s).

Landowner understands that the maintenance plan may be amended or revised at any time by the County in order to address changed conditions or to address conditions not being effectively met by the Facility. Following the County's sending notice; Landowner will abide by any prescribed changes.

This covenant to maintain the Facility shall run with the land. Landowner will continue to own and maintain the Facility until the County is notified in writing of a transfer in ownership and maintenance responsibility. The notification will include a date for the transfer of responsibility which will become effective upon the County's receipt of a letter of acceptance from the new owner. Notwithstanding the provision for a letter of acceptance, any new Landowner shall be responsible for all duties and obligations created by this Permanent Stormwater Facility and Maintenance Responsibility Agreement upon it being executed and filed in the Register of Deeds Office for Beaufort County.

Landowner understands that failure to adhere to the signed Maintenance Agreement may result in fines of up to \$1,000.00 per day, per violation and /or the institution of a court action, or such other and additional penalties, fines, or assessments as shall be enacted and provided for by the general law of the state or by local regulation lawfully enacted.

(Signatures contained on the next page)



IN WITNESS our hand and seal this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_.

\_\_\_\_\_  
WITNESS 1

Land Owner Name: \_\_\_\_\_  
(Print)

\_\_\_\_\_  
WITNESS 2

Land Owner Signature: \_\_\_\_\_

Mailing Address: \_\_\_\_\_

Phone Number: \_\_\_\_\_

County of Beaufort

\_\_\_\_\_  
WITNESS 1

BY: \_\_\_\_\_

\_\_\_\_\_  
WITNESS 2

ITS: County Administrator

STATE OF SOUTH CAROLINA )  
 )  
COUNTY OF BEAUFORT )

#### ACKNOWLEDGEMENT

The foregoing instrument was acknowledged before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_  
by \_\_\_\_\_, (Landowner's name).

\_\_\_\_\_  
Notary Public for South Carolina  
My Commission Expires: \_\_\_\_\_

STATE OF SOUTH CAROLINA )  
 )  
COUNTY OF BEAUFORT )

#### ACKNOWLEDGEMENT

The foregoing instrument was acknowledged before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_  
by \_\_\_\_\_, County Administrator for Beaufort County.

\_\_\_\_\_  
Notary Public for South Carolina  
My Commission Expires: \_\_\_\_\_

## Appendix R: Land Cover Designation and Maintenance

### Table of Contents

R.1	General Notes .....	1
R.1.1	Existing Natural Cover Requirements .....	1
R.1.2	Planting Requirements for the Creation of Natural Cover.....	2
R.2	Stormwater Management Plans and Natural Cover .....	3
R.3	Construction Requirements for Natural Cover Designation.....	3
R.4	Maintenance Requirements for Natural Cover Designation .....	4
R.5	Compacted Cover Designation.....	4

### R.1 General Notes

The retention standard approach taken in this guidance manual for on-site stormwater management and the run-off reduction methodology recognizes the ability of pervious land covers to manage some, or most, of the rainwater that falls on it. This is termed "land abstraction" in this appendix and is assumed to be based on SCS Hydrologic Soil Group (HSG) or soil type and whether the land cover is best represented as Forest/Open Space (RvN), Managed Turf (RvC) or Impervious Cover (RvI). As noted in Section 3.7, Equation 3.2 Stormwater Retention Volume, the designation of Forest/Open Space with these lands will generate between 2-5% stormwater runoff for a design rain event. The designation of compacted cover assumes these lands will generate 15-25% stormwater runoff for a design rain event. Impervious cover will generate 95% stormwater runoff for the design rain event. The minimum area threshold for the natural cover designation is 1,500 square feet, with a minimum length of 30 feet. Areas not meeting the natural cover threshold will be considered compacted cover RvC. To ensure no loss of land abstraction, all land cover designations must be recorded in the maintenance agreement.

#### R.1.1 Existing Natural Cover Requirements

A site claiming natural cover based on the preservation of existing conditions must ensure conditions remain undisturbed to preserve hydrologic properties equal to or better than meadow in good condition. No credit will be given for areas that are cut and then replaced with planting. The intention of preserving areas is to allow for natural succession with saplings reaching maturity after a period of time.

Preservation areas for natural cover may include the following:

- Portions of residential yards in forest cover that will not be disturbed during construction;
- Community open space areas that will not be mowed routinely, but left in a natural vegetated state, as defined below (can include areas that will be rotary mowed no more than two times per year);
- Utility rights-of-way that will be left in a natural vegetated state (can include areas that will be rotary mowed no more than two times per year); or

- Other areas of existing forest and/or open space that will be protected during construction and that will remain undisturbed.

### R.1.2 Planting Requirements for the Creation of Natural Cover

Every 1,500 square feet of created natural area shall be vegetated according to the following options of plant material quantity:

- 1 native understory tree: 1.5-inch caliper (minimum), and 2 native canopy trees: 2.5 inch caliper (minimum), or
- 6 native shrubs: 5 to 7-gallon container size (minimum), or
- 50 native perennial herbaceous or woody plants or clump-forming grasses: 1-gallon container size (minimum), or
- 1 native canopy tree: 2.5-inch caliper (minimum), and 25 native perennial herbaceous plants: 1-gallon container size (minimum), or
- 3 native shrubs: 5 to 7-gallon container size (minimum), and 25 native perennial herbaceous plants 1-gallon container size (minimum)

Plantings shall be indigenous to the immediate area and shall be arranged in a natural random pattern (e.g. not a formal composition). To ensure a resilient planting composition, diversity must be provided in the planting plan: at least 2 different species of trees, 3 different species of shrubs, and/or 5 different types of perennials/grasses shall be used in each planting.

If planting near marshes, vegetation should be elevated as much as possible to ease establishment from the saline environment and lessen the impacts of inundation from King Tide events.

Steep slopes greater than 6% grade will require additional plantings, soil stabilization, or a terracing system.

Whip and seedling stock may be used (when approved by *<local jurisdiction>*) as a site's natural cover creation if a stream bank stabilization opportunity falls within the site's footprint. In this instance, whips or seedlings must be planted at a minimum density of 700 plants per acre, and at least 55% of these plants must remain at the end of the 2-year management period.

Natural regeneration (i.e., allowing volunteer plants to propagate from surrounding natural cover as a cover creation technique) may be allowed by *<local jurisdiction>*, when 75% of the proposed planting area is located within 25 feet of adjoining forest, and the adjoining forest contains less than 20% cover of invasive exotic species (as documented by the South Carolina Exotic Pest Plant Council 2014 list here: [https://www.se-eppc.org/southcarolina/SCEPPC\\_LIST2014finalOct.pdf](https://www.se-eppc.org/southcarolina/SCEPPC_LIST2014finalOct.pdf)). In this case, supplemental planting must ensure a density of 400 seedlings per acre.

All plant materials used must be native to the southeastern region and must be installed in areas suitable for their growth. There are several websites that may be consulted to select the most appropriate plantings for the Southern Lowcountry:

- Low Impact Development in Coastal South Carolina: A Planning and Design Guide; see suggested plant lists for bioretention (4.2), open channels (4.8) and stormwater wetlands (4.12)

<http://www.northinlet.sc.edu/wp-content/uploads/2019/12/LID-in-Coastal-SC.pdf>

(Supp. No. 45)

- South Carolina Wildlife Federation: <http://www.scwf.org/native-plant-list>
- South Carolina Native Plant Society: <https://scnps.org/wp-content/uploads/2012/04/CoastalNativePlantList.pdf>
- Carolina Yards Plant Database: <https://www.clemson.edu/extension/carolinayards/plant-database/index.html>
- Clemson University Cooperative Extension Services Home & Garden Information Center factsheet for freshwater shoreline landscaping: <https://hgic.clemson.edu/factsheet/shorescaping-freshwater-shorelines/>

Plant irrigation is recommended until established.

## **R.2 Stormwater Management Plans and Natural Cover**

Sites using preservation of existing areas for the natural cover designation shall include on their Stormwater Management Plan (SWMP) their natural resources inventory, a tree and vegetation survey, identification of location, and extent of preservation areas. Depending on the extent of the preservation area, *<local jurisdiction>* may require the SWMP to include a more detailed schedule for retained trees, noting the tree species, size, canopy, condition, and location.

The SWMP will include the identification of material and equipment staging areas and parking areas. Material and equipment staging areas and parking areas must be sufficiently offset for preservation areas to ensure no adverse impacts.

For areas maintained as meadow in good condition, the SWMP shall document either the preservation of existing conditions or the creation of meadow conditions. A plan submission claiming meadow preservation will note the existing meadow boundaries and include a field survey of the richness and diversity of existing plant species and the existing soil conditions by a qualified individual (see Section 2.1.3). A plan submission claiming meadow creation will note the proposed meadow boundaries, the planting and/or seeding species methods, and provide a soil amendment plan as specified in Appendix C Soil Compost Amendment Requirements.

## **R.3 Construction Requirements for Natural Cover Designation**

The preservation of lands designated as natural cover—such as undisturbed portions of yards, community open space, and any other areas designated on a site’s SWMP as preserved natural cover—must be shown outside the limits of disturbance on the site’s Soil Erosion and Sediment Control Plan. These areas must be clearly demarcated with signage prior to commencement of construction on the site on the site and with fencing during construction.

The creation of lands designated as natural cover as part of a public right-of-way (PROW) project and on sites where soils were not protected from compaction during construction the soils must be conditioned prior to planting with soil compost amendments as prescribed in Appendix C Soil Compost Amendment Requirements.

For maximum survivability, planting of trees, shrubs, and herbaceous vegetation for the creation of natural cover should occur only during the fall and early spring (i.e., September through November and March through May). The work should be done only under the supervision of someone qualified and skilled in landscape installation (see Section 4.14 Tree Planting and Preservation for details on

qualifications). Proper maintenance of the materials after installation will be key in ensuring plants <sup>36 [EST]</sup> (Supp. No. 45)

survival. Prior to inspection, all trees and shrubs planted must be alive and in good health, and native grass and wildflower seeds must have been sown at adequate densities and at the right time of year for each species.

Once a natural cover designation has been assigned to a portion of regulated development site, that area will need to be recorded in the declaration of covenants, documented at the site prior to construction activities, protected during construction activities, and permanently protected/maintained for the life of the regulated site.

Root pruning and fertilizing are examples of preconstruction activities. These measures aim to increase the wellbeing of trees and prepare them for higher stress. Prior to beginning construction, temporary devices such as fences or sediment controls are installed and remain throughout the construction phase. Some devices, like retaining walls and root aeration systems may remain permanently. For example, if part of a root system is collapsed by a built road, permanent aeration may be necessary for the tree to remain healthy.

#### **R.4 Maintenance Requirements for Natural Cover Designation**

All areas that will be considered natural cover for stormwater purposes must have documentation that prescribes that the area will remain in a natural, vegetated state. Appropriate documentation includes subdivision covenants and restrictions; deeded operation and maintenance agreements and plans; parcels of common ownership with maintenance plans; third-party protective easements within the PROW; or other documentation approved by *<local jurisdiction>*.

While the goal is to have natural cover areas remain undisturbed, some activities may be prescribed in the appropriate documentation, as approved by *<local jurisdiction>*, such as forest management, control of invasive species, replanting and revegetation, passive recreation (e.g., trails), limited bush hogging to maintain desired vegetative community, etc.

#### **R.5 Compacted Cover Designation**

The compacted cover designation can apply to all site areas that are disturbed and/or graded for eventual use as managed turf or landscaping. Examples of compacted cover include lawns, portions of residential yards that are graded or disturbed and maintained as turf (including yard areas), residential utility connections, and PROW. Landscaping areas intended to be maintained as vegetation other than turf within residential, commercial, industrial, and institutional settings are also considered compacted cover if regular maintenance practices are employed.

## **Appendix S: Single Family On-Lot Volume Control**

### **Step 2 On-Lot Volume Control**

Beaufort County passed the On-Lot Volume Controls on June 13, 2011. This requires On-Lot Volume Control when constructing new homes in communities that do not meet current community-wide runoff volume control requirements. This section is applicable only for home lots of record platted but not yet developed. Worksheets are available in an online calculator format at <http://stormwaterworksheet.createandsolve.com/>.

#### **Purpose**

The purpose of this worksheet and web-based program is to help a homeowner or builder determine the amount of excess stormwater runoff that will come off the property after construction of the home.

It will also assist in selecting the controls necessary to control this excess runoff so that the County's water resources are not impacted. Scientists have determined that excess freshwater runoff into saltwater tidal waters can impact the area's fishery resources.

The worksheet and program will allow the user to print out a sheet that can be used to document satisfactory controls so a zoning permit can be obtained. This zoning permit is necessary for issuance of a building permit.

#### **Step 1 – Lot Information**

This information is used to compute the excess runoff after construction. If a homeowner is planning an irrigation system, (entered in Section 1), storage and reuse of stormwater from rooftop should be considered for a portion of the irrigation needs. Use of drinking water for irrigation is an expensive alternative for homeowners, and reduction of this can save money as well as reducing amount of water running off the parcel after construction. While this is recommended, storage and reuse is optional because of its initial cost.

#### **Step 2 – Post Construction Stormwater Runoff Calculations**

The amount of excess runoff in gallons can be computed using this web-based program. It will depend on whether the soil is sandy or clay (entered in Section 1). The rainfall event that is used to determine the amount of runoff to be controlled is a 1.95-inch rainfall (95<sup>th</sup> percentile of average events in a year) in a 24-hour period. Before construction, on sandy soils, generally no runoff will occur with the 1.95-inch rainfall event. For clay soils, more than 0.5 inch of a 1.95 rainfall will runoff before construction. Taking this into account, the program will determine the runoff to be controlled, in gallons, after construction.

#### **Step 3 – Application of Best Management Practices**

This section takes the gallons determined in the Step above and guides the user through three steps that will reduce these gallons until they are all being controlled. The first step is an optional (Supp. No. 45)

**storage and reuse/infiltration practice.** This practice will utilize a holding facility of some size and then the water can be utilized for reuse or infiltrated at a slow rate from the storage facility.

When storage is utilized, it will control a certain amount of rooftop impervious surface. The maximum storage allowed for credit is limited to the rooftop impervious surface (in square feet) times 1.15. Additional storage can be added but credit is limited to 1.15 gallon per square foot of rooftop surface. When storage is used, it decreases the amount of impervious surface that needs to be handled by the other practices. This is called unaddressed impervious surface.

The second practice is **disconnected impervious surface**. It can utilize the natural infiltration capacity of the lot to control water running off unaddressed impervious surfaces. It will require a determination of which way the water sheet flows across the lot. The program allows up to two directions to be selected. The user starts with an estimate of the impervious surfaces and pervious portion of the lot. If the lot flows in one direction, the estimate is easy. It would be the unaddressed impervious surface and the previous surface it flows over to the end of the lot. If the ratio of unaddressed impervious surface to pervious area is greater than 5, there will be no credit, and runoff is better controlled by the next step. Figures 5-1 and 5-2 provide examples of one- and two-direction calculations to help in determining input figures for this practice.

If after the employing the first two practices there is still excess runoff to be handled, **rain gardens and other practices** will be used to control the remaining runoff. This will be computed for the user, who will be given a square foot size of a standard rain garden.

This standard size rain garden is 3 ft deep and can have special soil or sand and rock mixture that will store runoff and allow it to infiltrate. There is some flexibility between storage and reuse and rain gardens. If less rain garden is desired, storage can be increased, and vice-versa.

There is an attached sheet at the end of this help sheet that provides examples of alternative practices under this step.

It should be remembered that impervious surface on the property causes the excess volume that needs to be controlled. The amount of controls can be reduced by decreasing the impervious surface on the property by considering pervious driveways and walks, reducing rooftop size (two story versus one story), and other practices.

#### **Step 4 – Summary of Volume Reduction Practices**

This section is computed for the user to show a summary. This program allows the user to print a one-page sheet that summarizes entry and practices being used. This sheet would be attached to zoning and building permits and will be checked at completion of the project.

#### **Definitions:**

**Impervious surface** – hard surface that allows rainfall to run off and not infiltrate the soil.

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**Rooftop impervious surface** – horizontal surface area of rooftops including overhangs and other detached buildings/sheds.

**Other impervious** – generally hard surfaces on the ground like paved driveways, patios, walkways and sidewalks.

**Pervious surface** – surface that is not hard, such as grass, garden or forest area.

**Irrigated area** is area that would be served by an installed irrigation system. **Unaddressed impervious surface** – term used to determine amount of impervious surface or runoff gallons that had not been controlled by a previous practice.

**Standard rain garden** – rain garden that has 3 ft of fill material and a 6-inch maximum ponding depth. Different sizes can be constructed but then credits must be computed from Beaufort County BMP manual.

### Conversions

#### Rainfall to gallons of runoff

Design storm is 1.95 inches, of which 1.85 inches is available to run off impervious surface. 1.85 inch on 1 sq ft of impervious surface is equivalent to 1.15 gallons of runoff

#### Preconstruction runoff

**Clayey soils** – 0.53 inches run off for a 1.95-inch storm. 0.53 inch on 1 sq ft is equivalent to 0.33 gallon of runoff.

**Sandy soils** – No runoff for a 1.95-inch storm

**Storage and reuse** – if irrigation is used on parcel then storage must be between 0.3 gallon/sq ft of rooftop impervious surface to maximum credit of 1.15 gallon/ sq ft of rooftop impervious surface. Storage can be larger but maximum credit is 1.15g/sq ft.

### Rain garden

Square foot of impervious surface per square foot of standard rain garden

Clayey soils 4 sq ft of impervious surface to 1 sq ft of standard rain garden

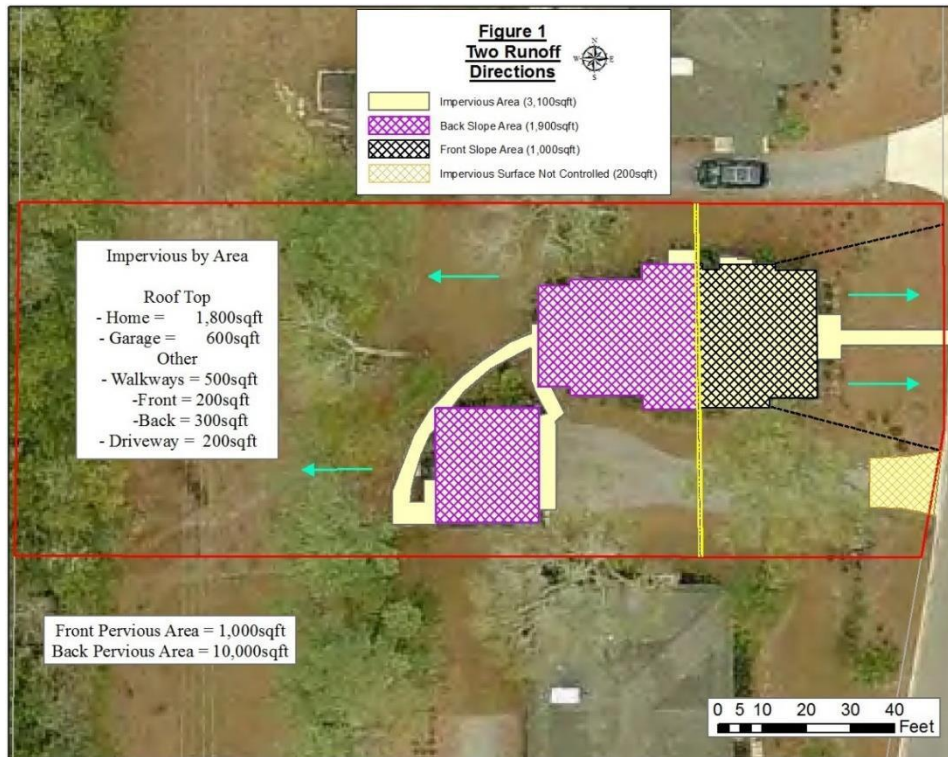
Sandy soils 7 sq ft of impervious surface to 1 sq ft of standard rain garden

**Disconnected imperviousness** – is the practice of running uncontrolled stormwater flow from impervious surfaces over pervious surfaces to take advantage of natural infiltration of the soil. Credit is given in Table 5-8 based on ratio of impervious surface over pervious surface to compute a ratio.



Table 5-8 Credit Table for Disconnected Impervious Area

Disconnected Impervious Ratio	Runoff reduction (Gal/sq. ft-impervious area)	Runoff reduction (Gal/sq. ft-impervious area)
	Clayey	Sandy
0.1	.40	1.15
0.2	.40	1.12
0.4	.38	1.08
0.8	.33	1.01
1.0	.31	.98
2.0	.24	.84
3.0	.19	.74
4.0	.16	.67
5.0	.14	.60



**Figure 5-1**  
**Example of a One-Direction Calculation for Disconnected Impervious Surface**

This is a home on a 16,000 sq ft lot with about 2,500 sq ft of living space.

In this example, runoff from 1,000 sq ft of impervious surface flows towards the front of the house. It can be made to sheet flow over 1,000 sq ft of lawn (pervious surface). Therefore, on the worksheet or web program, enter 1,000 in impervious area and 1,000 in pervious area of the first direction.

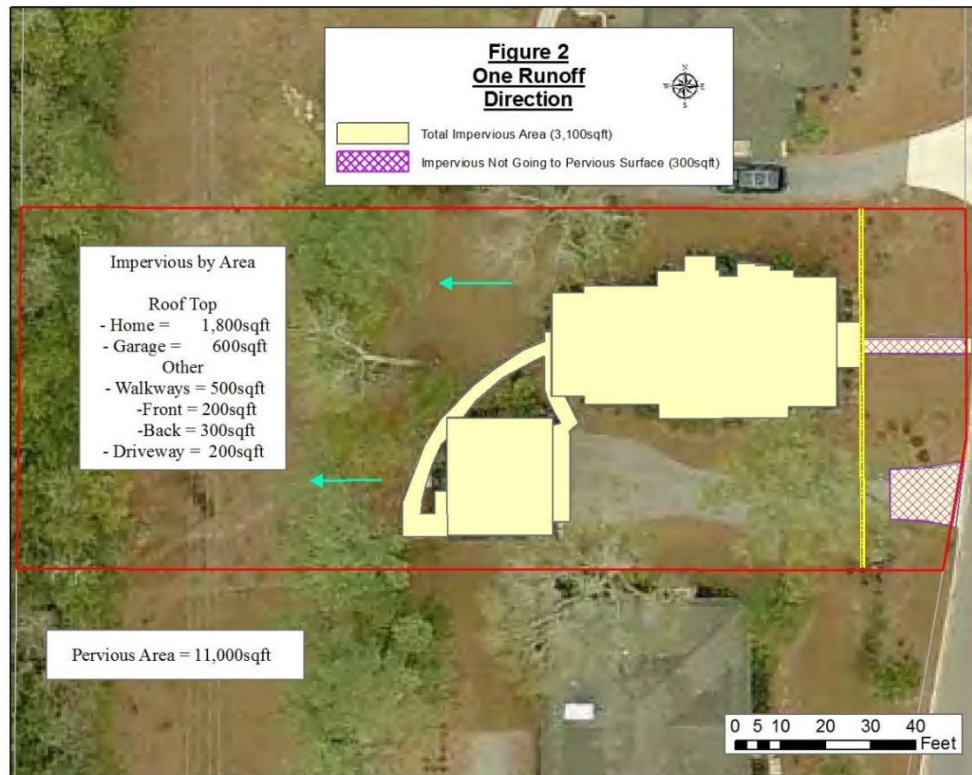
The second direction is to the back of the home, and this 1,900 sq ft of rooftop and other impervious surface flow over 10,000 sq ft of lawn and forest area.

Therefore, enter in the second direction 1,900 sq ft in impervious area and 10,000 in pervious area.

In this example, there is 200 sq ft (paved portion of driveway) that cannot sheet flow over enough pervious area to receive a credit and would not be included in calculations

If storage and reuse/infiltration was used in the first step (say two 500 cisterns/tanks in front of house) then the unaddressed impervious surface would be computed by reducing the first direction impervious surface.

Therefore, the in first direction, enter 130 in impervious surface (reduced by 870 sq ft = 1000 gal/1.15 gal/sq ft) and still 1,000 in pervious surface. See program printout for this example (with storage) in Appendix E.3



**Figure 5-2**  
**Example of a Two-Direction Calculation for Disconnected Impervious Surface**


In this example, there would be 2,800 (3,100 to 300) sq ft of impervious surface sheet flowing over 11,000 sq ft of pervious surface out the back yard.

Therefore, enter 2,800 in the first impervious area and 11,000 in the pervious area. The second direction would have zero entered in both categories.

Again, if storage and reuse/infiltration was used, the impervious surface that included in the worksheet or web program would need to be reduced.

If, for example, two 500-gallon storage devices were used, the impervious surface needs to be reduced by 870 sq ft (1000 gal/1.15 gal/sq ft).

Therefore, enter 1,930 in first impervious area and 11,000 in pervious area. The second direction would have zero in both categories.

 <div style="text-align: center;"> <b>BEAUFORT COUNTY</b>  <b>-STORMWATER PERMIT APPLICATION-</b> </div>					
DATE ACCEPTED	RECEIVED BY	FILING FEE	RECEIPT#	PERMIT#	PIN#
PROJECT NAME:			PROJECT TYPE:		
PROJECT LOCATION:					
APPLICANT/DEVELOPER NAME, ADDRESS, PHONE#			PROPERTY OWNER NAME, ADDRESS, PHONE#		
EMAIL			EMAIL		
SWPPP PREPARER NAME, ADDRESS, PHONE#			CONTRACTOR NAME, ADDRESS, PHONE#		
EMAIL			EMAIL		
QUALIFIED INSPECTOR NAME, ADDRESS, PHONE#			ADDITIONAL INFORMATION:		
EMAIL					
<b>SW01 (Single Family Home)</b>					
<input type="checkbox"/> COPY OF TIER I STORMWATER POLLUTION PREVENTION PLAN (SWPPP) – (See AppendixD) <input type="checkbox"/> PLOT PLAN SHOWING, VICINITY MAP, NORTH ARROW, GRAPHIC SCALE, PROPOSED IMPROVEMENTS <input type="checkbox"/> SITE PLAN SHOWING EXISTING GRADES/CONTOURS/ELEVATIONS AND PROPOSED GRADES/CONTOURS/ELEVATIONS, WITH OFFSITE DISCHARGE POINTS IDENTIFIED <input type="checkbox"/> NATURAL RESOURCE INVENTORY SHOWING TREES, WETLANDS, DRAINAGE COURSES, AND BUFFERS <input type="checkbox"/> GRADING AND DRAINAGE CERTIFICATION <input type="checkbox"/> STEP II VOLUME CONTROL (See Section 5.3) ( <a href="http://stormwaterworksheet.createandsolve.com">http://stormwaterworksheet.createandsolve.com</a> ) <input type="checkbox"/> APPLICATION FEE					
<b>SW02 (Non Residential and Attached Residential)</b>					
<input type="checkbox"/> COPY OF TIER II STORMWATER POLLUTION PREVENTION PLAN (SWPPP) <input type="checkbox"/> POST CONSTRUCTION STORMWATER PLAN CHECKLIST WITH LOCATION OF ALL ITEMS INDICATED. <input type="checkbox"/> SITE PLAN: VICINITY MAP, PROJECT LOCATION, NORTH ARROW, GRAPHIC SCALE, PROPOSED IMPROVEMENTS <input type="checkbox"/> CONSTRUCTION PLANS <input type="checkbox"/> DRAINAGE CALCULATIONS (See Section 5.3) <input type="checkbox"/> APPLICATION FEE					
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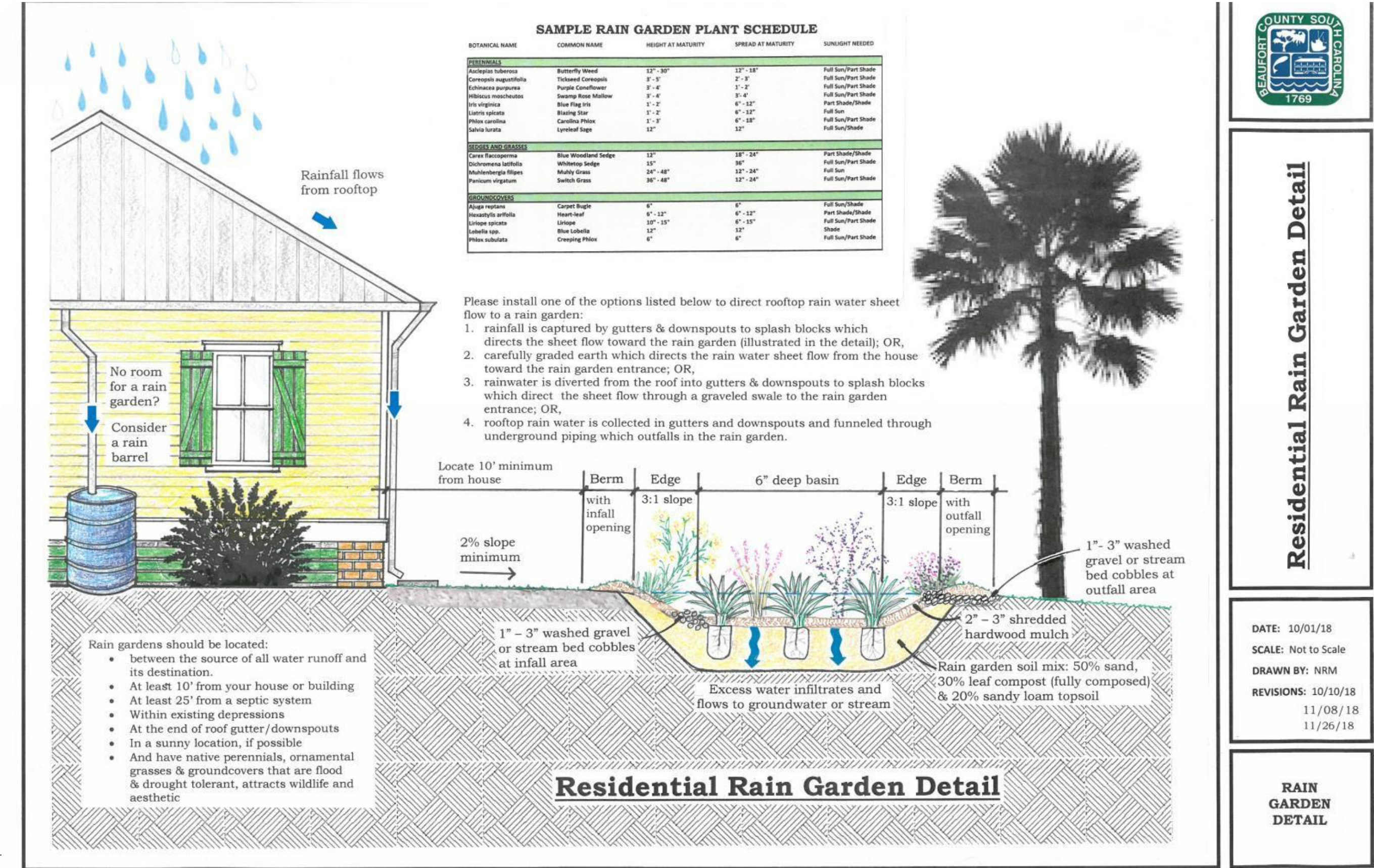
(Supp. No. 45)

**Application Affidavit**

The applicant acknowledges that application and issuance of the local Beaufort County Stormwater Permit does not preclude the need to obtain a NPDES permit from SC-DHEC per the South Carolina Erosion and Sediment Reduction act of 1983 as promulgated via 72-300, Standards for Stormwater Management and Sediment Reduction. Any change to the SWPPP associated with this permit as a result of permitting by DHEC renders this permit void until revised by the applicant to match the DHEC approved plan. The applicant further acknowledges the County may refuse to conduct inspections and may issue Notices of Violation, Stop Work Orders, and/or Civil Penalties for failure to comply with DHEC requirements.

Signature\_\_\_\_\_ Date\_\_\_\_\_





(Supp. No. 45)



# Illicit Discharge Detection and Elimination

## 1.1 Purpose

The purpose of this section is to provide for the health, safety, and general welfare of the citizens of Beaufort County, South Carolina, through regulation of non-storm-water discharges to the storm drainage system to the maximum extent practicable as required by Federal and State law. This ordinance establishes methods for controlling the introduction of pollutants into the MS4 in order to comply with requirements of the NPDES permit process. The objectives of this ordinance are:

1. To regulate the contribution of pollutants to the MS4 by stormwater discharges by any user.
2. To prohibit illicit connections and discharges to the MS4.
3. To establish legal authority to carry out all inspection, surveillance and monitoring procedures necessary to ensure compliance with this ordinance.

## 1.2 Program

The basic organization of this program is outlined below. The plan is developed around eight key components that are recommended by the U.S. Environmental Protection Agency (EPA) and the Center for Watershed Protection (CWP) for effective Illicit Discharge Detection and Elimination (IDDE) programs. These eight components are intended to help:

- Conduct an audit to understand community needs and capabilities
- Establish adequate legal authority
- Develop a tracking system to map outfalls and document reported illicit discharges
- Conduct desktop analyses to prioritize targets for illicit discharge control
- Conduct rapid reconnaissance of the stream corridor to find problem outfalls
- Apply new analytical and field methods to find and fix illicit discharges
- Educate municipal employees and the public to prevent discharges
- Estimate costs to run a program and conduct specific investigations

Technical information that addresses various aspects of the plan and references cited can be found in the following EPA sponsored publication produced by the CWP (<http://www.cwp.org/index.html>) and Robert Pitt from the University of Alabama:

Illicit Discharge Detection and Elimination:  
A Guidance Manual for Program Development and Technical Assessments  
October 2004

### **1.2.1 Ordinance**

In 2016, the County adopted a revised stormwater ordinance that will prohibit illicit discharges along with the necessary enforcement capability. The County will review other potential codes and ordinances that may have potential links to IDDE and make necessary cross-references and statements of supersede as needed to establish consistency.

### **1.2.2 Reporting and Education**

The County has a web application that will allow a person to report a suspecting IDDE to the County staff via the app. The app will allow the individual to provide the GPS location where the suspected discharge has occurred. Records are kept on each report, including the reporting mode (telephone, email, walk-in, etc.), location and nature of the problem, and any actions taken. Citizens can also call the stormwater department at 843.255.2805.

### **1.2.3 Monitoring**

The County has established a dry weather screening program to proactively detect illicit discharge and eliminate them through sampling, testing and enforcement. The County has a separate monitoring plan document that can be found in Appendix C. Inspection protocol and enforcement actions are in the stormwater ordinance found in Appendix G.

## **1.3 Definition of Illicit Discharge**

Illicit discharge is defined in Article V. of Chapter 99: Stormwater Ordinance. A copy of this ordinance is found in Appendix A.





## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 7.

<b>ITEM TITLE:</b>
AN ORDINANCE ADOPTING THE REQUIRED CHAPTER 99 STORMWATER ORDINANCE CHANGES FOR UPDATES TO THE SOUTHERN LOWCOUNTRY DESIGN MANUAL (\$0.00)
<b>MEETING NAME AND DATE:</b>
Natural Resources Committee – November 1, 2021
<b>PRESENTER INFORMATION:</b>
Jared Fralix, ACE – Engineering Neil Desai, P.E - Public Works Director ( <i>Alternate</i> ) (5 min)
<b>ITEM BACKGROUND:</b>
January 11 <sup>th</sup> , 2021 – County Council Approved adoption of Southern Lowcountry Design Manual Ordinance October 13 <sup>th</sup> , 2021 – Stormwater Utility Board approved proposed updates to the Southern Lowcountry Design Manual.
<b>PROJECT / ITEM NARRATIVE:</b>
As Beaufort County has implemented the Southern Lowcountry Design Manual, staff has recognized the need for updates to be made to stay current as knowledge in our field improves. Updates to this manual also include process improvements for the development community in Beaufort County. The manual updates are consistent with the regional standards for those who have adopted the Southern Lowcountry Design Manual. To implement the updates to the Design Manual, Beaufort County needs to update Chapter 99 of the Beaufort County Code of Ordinances.
<b>FISCAL IMPACT:</b>
There are no fiscal impacts associated with the text amendment to Chapter 99 of the Beaufort County Code of Ordinances.
<b>STAFF RECOMMENDATIONS TO COUNCIL:</b>
Staff recommends approval of the text amendment to Chapter 99 of the Beaufort County Code of Ordinances.
<b>OPTIONS FOR COUNCIL MOTION:</b>
Motion to approve/deny the text amendment to Chapter 99 of the Beaufort County Code of Ordinances. <i>(Next Step – Upon approval, send to County Council for First Reading)</i>

## Chapter 99 STORMWATER MANAGEMENT<sup>1</sup>

### ARTICLE I. IN GENERAL

**Secs. 99-1—99-100. Reserved.**

### ARTICLE II. STORMWATER MANAGEMENT UTILITY

#### **Sec. 99-101. Findings of fact.**

The county council of Beaufort County, South Carolina, makes the following findings of fact:

- (a) The professional engineering and financial analyses conducted on behalf of and submitted to the county properly assesses and defines the stormwater management problems, needs, goals, program priorities, costs of service, need for interlocal cooperation, and funding opportunities of the county.
- (b) Given the problems, needs, goals, program priorities, costs of service, needs for interlocal cooperation, and funding opportunities identified in the professional engineering and financial analyses submitted to the county, it is appropriate to authorize the establishment of a separate enterprise accounting unit which shall be dedicated specifically to the management, construction, maintenance, protection, control, regulation, use, and enhancement of stormwater systems and programs in Beaufort County in concert with other water resource management programs.
- (c) Stormwater management is applicable and needed throughout the unincorporated portions of Beaufort County, but interlocal cooperation between the county and the incorporated cities and towns within the county is also essential to the efficient provision of stormwater programs, services, systems, and facilities. Intense urban development in some portions of the county has radically altered the natural hydrology of the area and the hydraulics of stormwater systems, with many natural elements having been replaced or augmented by manmade facilities. Other areas of the county remain very rural in character, with natural stormwater systems predominating except along roads where ditches and culverts have been installed. As a result, the specific program, service, system, and facility demands differ from area to area in the county. While the county manages, operates, and improves stormwater programs, services, systems and facilities in the rural as well as urban areas, the need for improved stormwater management is greatest in the urban areas and nearby, including areas within incorporated cities and towns. Therefore, a stormwater utility service area subject to stormwater service fees should encompass, in so far as possible through interlocal agreements, the entirety of Beaufort County and the stormwater management utility service fee rate structure should reflect the amount of impervious area on individual properties and the runoff impact from water quantity and water quality.

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<sup>1</sup>Editor's note(s)—Ord. No. 2015/24 , adopted Sept. 28, 2015, amended and replaced ch. 99 to read as herein set out. Former ch. 99 pertained to the same subject matter, and derived from Ord. No. 2005/33 , adopted Sept. 22, 2005; and Ord. No. 2009/21 , adopted May 26, 2009.

- (d) The stormwater needs in Beaufort County include, but are not limited to, protecting the public health, safety, and welfare. Provision of stormwater management programs, services, systems, and facilities therefore renders and/or results in both service and benefit to individual properties, property owners, citizens, and residents of the county and to properties, property owners, citizens, and residents of the county concurrently in a variety of ways as identified in the professional engineering and financial analyses.
- (e) The service and benefit rendered or resulting from the provision of stormwater management programs, services, systems, and facilities may differ over time depending on many factors and considerations, including, but not limited to, location, demands and impacts imposed on the stormwater programs, systems, and facilities, and risk exposure. It is not practical to allocate the cost of the county's stormwater management programs, services, systems, and facilities in direct and precise relationship to the services or benefits rendered to or received by individual properties or persons over a brief span of time, but it is both practical and equitable to allocate the cost of stormwater management among properties and persons in proportion to the long-term demands they impose on the county's stormwater programs, services, systems, and facilities which render or result in services and benefits.
- (f) Beaufort County presently owns and operates stormwater management systems and facilities that have been developed, installed, and acquired through various mechanisms over many years. The future usefulness and value of the existing stormwater systems and facilities owned and operated by Beaufort County, and of future additions and improvements thereto, rests on the ability of the county to effectively manage, construct, protect, operate, maintain, control, regulate, use, and enhance the stormwater systems and facilities in the county, in concert with the management of other water resources in the county and in cooperation with the incorporated cities and towns. In order to do so, the county must have adequate and stable funding for its stormwater management program operating and capital investment needs.
- (g) The county council finds, concludes, and determines that a stormwater management utility provides the most practical and appropriate means of properly delivering stormwater management services and benefits throughout the county, and the most equitable means to fund stormwater services in the county through stormwater service fees and other mechanisms as described in the professional engineering and financial analyses prepared for the county.
- (h) The county council finds, concludes, and determines that a schedule of stormwater utility service fees be levied upon and collected from the owners of all lots, parcels of real estate, and buildings that discharge stormwater or subsurface waters, directly or indirectly, to the county stormwater management system and that the proceeds of such charges so derived be used for the stormwater management system.
- (i) The county council finds that adjustments and credits against stormwater utility service fees are an appropriate means to grant properties providing stormwater management program services that would otherwise be provided by the county and will afford Beaufort County cost savings. These reductions will be developed by the public works director and will be reviewed on an annual basis to allow for any modifications to practices required by Beaufort County.

The county council finds that both the total gross area and impervious area on each property are the most important factors influencing the cost of stormwater management in Beaufort County and, the runoff impact from water quantity and water quality.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-102. Establishment of a stormwater management utility and a utility enterprise fund.**

There is hereby established within the environmental engineering division of Beaufort County a stormwater management utility for the purpose of conducting the county's stormwater management program. The county administrator shall establish and maintain a stormwater management utility enterprise fund in the county budget and accounting system, which shall be and remain separate from other funds. All revenues of the utility shall be placed into the stormwater management utility enterprise fund and all expenses of the utility shall be paid from the fund, except that other revenues, receipts, and resources not accounted for in the stormwater management utility enterprise fund may be applied to stormwater management programs, services, systems, and facilities as deemed appropriate by the Beaufort County Council. The county administrator may designate within the stormwater management utility enterprise fund such sub-units as necessary for the purpose of accounting for the geographical generation of revenues and allocation of expenditures pursuant to interlocal governmental agreements with the cities and towns of Beaufort County.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2020/18, 5-26-2020 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-103. Purpose and responsibility of the utility.**

The Beaufort County Stormwater Management Utility is established for the purpose of managing, acquiring, constructing, protecting, operating, maintaining, enhancing, controlling, and regulating the use of stormwater drainage systems in the county. The utility shall, on behalf of the county and the citizens of the county: administer the stormwater management program; perform studies and analyses as required; collect service fees; system development fees, in-lieu of construction fees and other funding as allowed by law, and obtain and administer grants and loans as authorized by the county council; prepare capital improvement plans and designs; perform routine maintenance and remedial repair of the stormwater systems; acquire, construct, and improve stormwater systems; acquire necessary lands, easements, rights-of-way, rights-of-entry and use, and other means of access to properties to perform its duties; regulate the on-site control, conveyance, and discharge of stormwater from properties; obtain federal and state permits required to carry out its purpose; enter into operating agreements with other agencies; allocate funds pursuant to interlocal governmental agreements; educate and inform the public about stormwater management; and perform, without limitation except by law, any stormwater management functions and activities necessary to ensure the public safety, protect private and public properties and habitat, and enhance the natural environment and waters of the county.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-104. Limitation of scope of responsibility.**

The purpose and responsibility of the stormwater management utility shall be limited by the following legal and practical considerations:

- (a) Beaufort County owns or has legal access for purposes of operation, maintenance and improvement only to those stormwater systems and facilities which:
  - (1) Are located within public streets, other rights-of-way, and easements;
  - (2) Are subject to easements, rights-of-entry, rights-of-access, rights-of-use, or other permanent provisions for adequate access for operation, maintenance, monitoring, and/or improvement of systems and facilities; or
  - (3) Are located on public lands to which the county has adequate access for operation, maintenance, and/or improvement of systems and facilities.

- (b) Operation, maintenance, and/or improvement of stormwater systems and facilities which are located on private property or public property not owned by Beaufort County and for which there has been no public dedication of such systems and facilities for operation, maintenance, monitoring, and/or improvement of the systems and facilities shall be and remain the legal responsibility of the property owner, except as that responsibility may be otherwise affected by the laws of the State of South Carolina and the United States of America.
- (c) It is the express intent of this article to protect the public health, safety, and welfare of all properties and persons in general, but not to create any special duty or relationship with any individual person or to any specific property within or outside the boundaries of the county. Beaufort County expressly reserves the right to assert all available immunities and defenses in any action seeking to impose monetary damages upon the county, its officers, employees and agents arising out of any alleged failure or breach of duty or relationship as may now exist or hereafter be created.
- (d) To the extent any permit, plan approval, inspection or similar act is required by the county as a condition precedent to any activity or change upon property not owned by the county, pursuant to this or any other regulatory ordinance, regulation, or rule of the county or under federal or state law, the issuance of such permit, plan approval, or inspection shall not be deemed to constitute a warranty, express or implied, nor shall it afford the basis for any action, including any action based on failure to permit or negligent issuance of a permit, seeking the imposition of money damages against the county, its officers, employees, or agents.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-105. Boundaries and jurisdiction.**

The boundaries and jurisdiction of the stormwater management utility shall encompass all those portions of unincorporated Beaufort County, as they may exist from time to time and such additional areas lying inside the corporate limits of those cities and towns in Beaufort County as shall be subject to interlocal agreements for stormwater management as approved by county council and participating municipal councils.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-106. Definitions.**

Unless the context specifically indicates otherwise, the meaning of words and terms used in this article shall be as set forth in S.C. Code § 48-14-20, and 26 S.C. Code Regulation 72-301, *mutatis mutandis*.

*Abatement.* Any action deemed necessary by the county or its officers or agents to remedy, correct, control, or eliminate a condition within, associated with, or impacting a stormwater drainage system or the water quality of receiving waters shall be deemed an abatement action.

*Adjustments.* Adjustments shall mean a change in the amount of a stormwater service fee predicated upon the determination reached by the public works director and referenced to the adjustments and credit manual.

*Bill class.* Every property falls into one of several bill classes. The bill class determines the fee calculation of that property.

*Condominiums.* Properties with individual ownership of a particular dwelling unit in a building and the common right to share, with other co-owners, in the general and limited common elements of the real property.

*Countywide infrastructure operation and maintenance and capital projects.* The county maintains some typically larger infrastructure within each of the four municipalities in addition to within the unincorporated area.

The rate structure will allocate the costs for the county to maintain just the countywide drainage infrastructure across the entire rate base in all jurisdictions based on infrastructure linear feet per jurisdiction.

*Customers of the stormwater management utility.* Customers of the stormwater management utility shall be broadly defined to include all persons, properties, and entities served by and/or benefiting, directly and indirectly, from the utility's acquisition, management, construction, improvement, operation, maintenance, extension, and enhancement of the stormwater management programs, services, systems, and facilities in the county, and by its control and regulation of public and private stormwater systems, facilities, and activities related thereto.

*Developed land.* Developed land shall mean property altered from its natural state by construction or installation of improvements such as buildings, structures, or other impervious surfaces, or by other alteration of the property that results in a meaningful change in the hydrology of the property during and following rainfall events. Existing county maintained dirt roads which are improved and/or paved as part of Beaufort County's Dirt Road Paving Program as set forth in Beaufort County Policy Statement 15 and Policy Statement 17 and existing private dirt roads which are improved or paved and where the project is not related to a pending or proposed development of adjacent land are deemed not to constitute "developed land".

*Exemption.* Exemption shall mean not applying to or removing the application of the stormwater management utility service fee from a property. No permanent exemption shall be granted based on taxable or non-taxable status or economic status of the property owner.

*Fixed costs.* Costs associated with the public service provided equally to each property owner. These costs include, but are not limited to, the following: billing and collections, data management and updating, programming, and customer support.

*Gross area.* Gross area is the acreage of a parcel as identified by the Beaufort County Assessor records.

*Hydrologic response.* The hydrologic response of a property is the manner whereby stormwater collects, remains, infiltrates, and is conveyed from a property. It is dependent on several factors including, but not limited to, the size and overall intensity of development of each property, its impervious area, shape, topographic, vegetative, and geologic conditions, antecedent moisture conditions, and groundwater conditions and the nature of precipitation events. Extremely large undeveloped properties naturally attenuate but do not eliminate entirely the discharge of stormwater during and following rainfall events.

*Jurisdictional infrastructure operations, maintenance and capital projects.* Each of the five jurisdictions maintains its own stormwater drainage infrastructure and funds those costs from utility revenue. Revenue from this fee component will be returned to the service provider, the individual jurisdiction.

*Impervious surfaces.* Impervious surfaces shall be a consideration in the determination of the development intensity factor. Impervious surfaces are those areas that prevent or impede the infiltration of stormwater into the soil as it entered in natural conditions prior to development. Common impervious surfaces include, but are not limited to, rooftops, sidewalks, walkways, patio areas, driveways, parking lots, storage areas, compacted gravel and soil surfaces, awnings and other fabric or plastic coverings, and other surfaces that prevent or impede the natural infiltration of stormwater runoff that existed prior to development.

*Minimum charge.* A charge that reflects the minimum amount of demand a property will place on the service provider.

*MS4 permit.* Each jurisdiction within Beaufort County will be subject to the federally mandated MS4 permit requirements. Compliance requirements include, but are not limited to, monitoring, plan review, inspections, outreach and public education.

*Nonresidential properties.* Properties developed for uses other than permanent residential dwelling units and designated by the assigned land use code in the Beaufort County tax data system.

*Other developed lands.* Other developed lands shall mean, but not be limited to, mobile home parks, commercial and office buildings, public buildings and structures, industrial and manufacturing buildings, storage

buildings and storage areas covered with impervious surfaces, parking lots, parks, recreation properties, public and private schools and universities, research facilities and stations, hospitals and convalescent centers, airports, agricultural uses covered by impervious surfaces, water and wastewater treatment plants, and lands in other uses which alter the hydrology of the property from that which would exist in a natural state. Properties that are used for other than single-family residential use shall be deemed other developed lands for the purpose of calculating stormwater service fees.

*Residential dwelling classifications.* The following categories will identify the appropriate dwelling unit classifications to be utilized in applying the stormwater utility fee structure to the designations contained in the Beaufort County tax data system:

- Single-family
- Apartments
- Townhouses
- Condominiums
- Mobile home

*Salt water marsh.* Those parcels, typically contiguous to water, identified as inundated daily due to tidal action and unbuildable. These properties are 100 percent below mean high tide and/or beyond established critical line as defined by the South Carolina Department of Health and Environmental Control's Office of Coastal Resource Management (DHEC-OCRM). The county tax assessor's office shall make this determination based on best available data.

*Stormwater management programs, services, systems and facilities.* Stormwater management programs, services, systems and facilities are those administrative, engineering, operational, regulatory, and capital improvement activities and functions performed in the course of managing the stormwater systems of the county, plus all other activities and functions necessary to support the provision of such programs and services. Stormwater management systems and facilities are those natural and manmade channels, swales, ditches, swamps, rivers, streams, creeks, branches, reservoirs, ponds, drainage ways, inlets, catch basins, pipes, head walls, storm sewers, lakes, and other physical works, properties, and improvements which transfer, control, convey or otherwise influence the movement of stormwater runoff and its discharge to and impact upon receiving waters.

*Stormwater service fees.* Stormwater service fees shall mean the service fee imposed pursuant to this article for the purpose of funding costs related to stormwater programs, services, systems, and facilities. These fees will be calculated based upon the impervious and gross area at an 80/20 allocation; stormwater service fee categories; any state agricultural exemptions or caps; an account administrative fee, countywide jurisdiction operation maintenance and capital project fees; and jurisdictional operation, maintenance and capital project fee.

*Single-family unit (SFU).* The single-family unit shall be defined as the impervious area measurements obtained from a statistically representative sample of all detached single-family structures within Beaufort County. The representative value will be 4,906 square feet.

*Stormwater service fee categories.* The appropriate categories for determining SFUs will be as follows:

	SFU Calculation (SFUs equal)
Tier 1: Single-family unit ( $\leq 2,521$ square feet)	Dwelling units x 0.5
Tier 2: Single-family unit (2,522 to 7,265 square feet)	Dwelling units x 1
Tier 3: Single-family unit ( $\geq 7,266$ square feet)	Dwelling units x 1.5
Mobile home	Dwelling units x 0.36
Apartments	Dwelling units x 0.39
Townhouses	Dwelling units x 0.60

Condominiums	Dwelling units x 0.27
Commercial	Impervious area * 4,906 sq. ft.*

\* Commercial billed at a rate of one SFU per 4,906 square feet or a portion thereof.

*Submerged property.* Those parcels, typically contiguous to water, identified as eroded due to tidal action and unbuildable. These properties are 100 percent below mean low tide and/or beyond established critical line as defined by South Carolina Department of Health and Environment Control's Office of Coastal Resource Management (DHEC-OCRM). The county tax assessor's office shall make this determination based on best available data.

*Townhomes.* See Condominiums.

*Variable costs.* An impervious and gross area rate structure that allocates some cost to each of the two variables based on the amount of impervious surface and gross area.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2016/26, 9-26-2016 ; Ord. No. 2018/6, 3-12-2018 ; Ord. No. 2021/04, 1-11-2021)

## **Sec. 99-107. Reserved.**

Editor's note(s)—Ord. No. 2016/38 , adopted Oct. 24, 2016, deleted § 99-107, which pertained to requirements for on-site stormwater systems; enforcement, methods, and inspections, and derived from Ord. No. 2015/24 , adopted Sept. 28, 2015.

## **Sec. 99-108. General funding policy.**

- (a) It shall be the policy of Beaufort County that funding for the stormwater management utility program, services, systems, and facilities shall be equitably derived through methods which have a demonstrable relationship to the varied demands and impacts imposed on the stormwater program, services, systems, and facilities by individual properties or persons and/or the level of service rendered by or resulting from the provision of stormwater programs, systems and facilities. Stormwater service fee rates shall be structured so as to be fair and reasonable, and the resultant service fees shall bear a substantial relationship to the cost of providing services and facilities throughout the county. Similarly situated properties shall be charged similar rentals, rates, fees, or licenses. Service fee rates shall be structured to be consistent in their application and shall be coordinated with the use of any other funding methods employed for stormwater management within the county, whether wholly or partially within the unincorporated portions of the county or within the cities and towns. Plan review and inspection fees, special fees for services, fees in-lieu of regulatory requirements, impact fees, system development fees, special assessments, general obligation and revenue bonding, and other funding methods and mechanisms available to the county may be used in concert with stormwater service fees and shall be coordinated with such fees in their application to ensure a fair and reasonable service fee rate structure and overall allocation of the cost of services and facilities.
- (b) The cost of stormwater management programs, systems, and facilities subject to stormwater service fees may include operating, capital investment, and non-operating expenses, prudent operational and emergency reserve expenses, and stormwater quality as well as stormwater quantity management programs, needs, and requirements.
- (c) To the extent practicable, adjustments to the stormwater service fees will be calculated by the Beaufort County Public Works Director or his/her designee in accordance with the standards and procedures adopted by the public works director's office.



- (d) The stormwater service fee rate may be determined and modified from time to time by the Beaufort County Council so that the total revenue generated by said fees and any other sources of revenues or other resources allocated to stormwater management by the county council to the stormwater management utility shall be sufficient to meet the cost of stormwater management services, systems, and facilities, including, but not limited to, the payment of principle and interest on debt obligations, operating expense, capital outlays, nonoperating expense, provisions for prudent reserves, and other costs as deemed appropriate by the county council.

Beaufort County service fee rate will be based on impervious and gross area at an 80/20 allocation; stormwater service fee categories; any state agricultural exemptions or caps; an account administrative fee, countywide jurisdiction operation maintenance and jurisdictional operation, maintenance and capital project fee. The rates are set by the Beaufort County Stormwater Rate Study adopted August 24, 2015.

The gross area charge for all parcels, except master account properties for condominiums, is calculated in equivalent units as follows:

First 2 acres	\$X
For every acre above 2 acres and up to 10 acres	0.5 x \$X
For every acre above 10 acres, and up to 100 acres	0.4 x \$X
For every acre above 100 acres	0.3 x \$X

Condominium accounts will receive a minimum gross area charge of 0.2 x \$X. The master account associated with the condominium subdivision will not receive a gross area charge.

Each municipal jurisdiction may have a different fee predicated upon the municipal jurisdiction's revenue needs. The stormwater service fee rates shall be adopted by the municipal jurisdictions and may be amended from time to time by the individual governing body.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2016/26, 9-26-2016 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-109. Exemptions and credits applicable to stormwater service fees.**

Except as provided in this section, no public or private property shall be exempt from stormwater utility service fees. No exemption, credit, offset, or other reduction in stormwater service fees shall be granted based on the age, tax, or economic status, race, or religion of the customer, or other condition unrelated to the stormwater management utility's cost of providing stormwater programs, services, systems, and facilities. A stormwater management utility service fee credit manual shall be prepared by the public works director specifying the design and performance standards of on-site stormwater services, systems, facilities, and activities that qualify for application of a service fee credit, and how such credits shall be calculated.

- (a) *Credits.* The following types of credits against stormwater service fees shall be available:
- (1) Freshwater wetlands. All properties except those classified as detached single-family dwelling units may receive a credit against the stormwater service fee applicable to the property based on granting and dedicating a perpetual conservation easement on those portions of the property that are classified as freshwater wetlands and as detailed in the stormwater management utility service fee credit manual. The conservation easement shall remove that portion of the subject property from any future development.
  - (2) Salt water marsh. All properties except those classified as detached single-family dwelling units may receive a credit against the stormwater service fee applicable to the property based on those portions of the property that are classified as salt water marsh and as detailed in the stormwater management utility service fee credit manual.

- (3) Submerged properties. All properties may receive a credit against the stormwater service fee applicable to the property based on those portions of the property that are classified as submerged and as detailed in the stormwater management utility service fee credit manual.
  - (4) Those properties that apply for consideration of an adjustment shall satisfy the requirements established by the Beaufort County Public Works Director or his/her designee and approved reduced stormwater service fee.
- (b) *Exemptions.* The following exemptions from the stormwater service fees shall be allowed:
- (1) Improved public road rights-of-way that have been conveyed to and accepted for maintenance by the state department of transportation and are available for use in common for vehicular transportation by the general public.
  - (2) Improved public road rights-of-way that have been conveyed to and accepted for maintenance by Beaufort County and are available for use in common for vehicular transportation by the general public.
  - (3) Improved private roadways that are shown as a separate parcel of land on the most current Beaufort County tax maps and are used by more than one property owner to access their property.
  - (4) Improved private roadways that are not shown as a separate parcel of land on the most current Beaufort County tax maps but are used by more than one property owner to access their property.
  - (5) Railroad tracks shall be exempt from stormwater service fees. However, railroad stations, maintenance buildings, or other developed land used for railroad purposes shall not be exempt from stormwater service fees.
  - (6) Condominium boat slips shall be exempt from stormwater service fees.
  - (7) Properties determined by the assessor having 100 percent of the gross area of the property submerged, salt water marsh, or freshwater wetland will not receive an administrative charge, if applicable in the utility rate structure, after the applicable credit defined in paragraph (a) above has been applied to the account.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2016/26, 9-26-2016 ; Ord. No. 2020/18, 5-26-2020 ; Ord. No. 2021/04, 1-11-2021 )

## **Sec. 99-110. Stormwater service fee billing, delinquencies and collections.**

- (a) *Method of billing.* A stormwater service fee bill may be attached as a separate line item to the county's property tax billing or may be sent through the United States mail or by alternative means, notifying the customer of the amount of the bill, the date the fee is due (January 15), and the date when past due (March 17 - see Title 12, Section 45-180 of the South Carolina State Code). The stormwater service fee bill may be billed and collected along with other fees, including, but not limited to, the Beaufort County property tax billing, other Beaufort County utility bills, or assessments as deemed most effective and efficient by the Beaufort County Council. Failure to receive a bill is not justification for non-payment. Regardless of the party to whom the bill is initially directed, the owner of each parcel of land shall be ultimately obligated to pay such fees and any associated fines or penalties, including, but not limited to, interest on delinquent service fees. If a customer is under-billed or if no bill is sent for a particular property, Beaufort County may retroactively bill for a period of up to one-year, but shall not assess penalties for any delinquency during that previous unbilled period.

- (b) *Declaration of delinquency.* A stormwater service fee shall be declared delinquent if not paid within 60 days of the date of billing or upon the date (March 17) of delinquency of the annual property tax billing if the stormwater service fee is placed upon the annual property tax billing or enclosed with or attached to the annual property tax billing.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-111. Appeals.**

Any customer who believes the provisions of this article have been applied in error may appeal in the following manner and sequence:

- (a) An appeal of a stormwater service fee must be filed in writing with the Beaufort County Public Works Director, or his/her designee within 30 days of the fee being mailed or delivered to the property owner and stating the reasons for the appeal. In the case of stormwater service fee appeals, the appeal shall include a survey prepared by a registered land surveyor or professional engineer containing information on the impervious surface area and any other feature or conditions that influence the development of the property and its hydrologic response to rainfall events.
- (b) Using information provided by the appellant, the county public works director or his/her designee shall conduct a technical review of the conditions on the property and respond to the appeal in writing within 30 days after receipt of the appeal. In response to an appeal, the county public works director or his/her designee may adjust the stormwater service fee applicable to the property in conformance with the general purposes and intent of this article.
- (c) A decision of the public works director or his/her designee that is adverse to an appellant may be further appealed to the county administrator or his/her designee within 30 days of the adverse decision. The appellant, stating the grounds for further appeal, shall deliver notice of the appeal to the county administrator or his designee. The county administrator or his designee shall issue a written decision on the appeal within 30 days. All decisions by the county administrator or his designee shall be served on the customer personally or by registered or certified mail, sent to the billing address of the customer. All decisions of the county administrator or his designee shall be final.
- (d) The appeal process contained in this section shall be a condition precedent to an aggrieved customer seeking judicial relief. Any decisions of the county administrator or his designee may be reviewed upon application for writ of certiorari before a court of competent jurisdiction, filed within 30 days of the date of the service of the decision.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-112. No suspension of due date.**

No provision of this article allowing for an administrative appeal shall be deemed to suspend the due date of the service fee with payment in full. Any adjustment in the service fee for the person pursuing an appeal shall be made by refund of the amount due.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-113. Enforcement and penalties.**

Any person who violates any provision of this article may be subject to a civil penalty of not more than \$1,000.00, or such additional maximum amount as may become authorized by state law, provided the owner or

other person deemed to be in violation has been notified of a violation. Notice shall be deemed achieved when sent by regular United States mail to the last known address reflected on the county tax records, or such other address as has been provided by the person to the county. Each day of a continuing violation may be deemed a separate violation. If payment is not received or equitable settlement reached within 30 days after demand for payment is made, a civil action may be filed on behalf of the county in the circuit court to recover the full amount of the penalty. This provision on penalties shall be in addition to and not in lieu of other provisions on penalties, civil or criminal, remedies and enforcement that may otherwise apply.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-114. Investment and reinvestment of funds and borrowing.**

Funds generated for the stormwater management utility from service fees, fees, rentals, rates, bond issues, other borrowing, grants, loans, and other sources shall be utilized only for those purposes for which the utility has been established as specified in this article, including, but not limited to: regulation; planning; acquisition of interests in land, including easements; design and construction of facilities; maintenance of the stormwater system; billing and administration; water quantity and water quality management, including monitoring, surveillance, private maintenance inspection, construction inspection; public information and education, and other activities which are reasonably required. Such funds shall be invested and reinvested pursuant to the same procedures and practices established by Title 12, Section 45-70 of the South Carolina State Code for investment and reinvestment of funds. County council may use any form of borrowing authorized by the laws of the State of South Carolina to fund capital acquisitions or expenditures for the stormwater management utility. County council, in its discretion and pursuant to standard budgetary procedures, may supplement such funds with amounts from the general fund.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

### **Sec. 99-115. Responsibilities of the stormwater management utility.**

The county stormwater management utility shall perform adequate studies throughout the area served by the utility to determine the following:

- (1) Baseline study of water quality in the receiving waters;
- (2) Identification of pollutants carried by stormwater runoff into the receiving waters;
- (3) Recommended mitigation efforts to address pollutants carried by stormwater runoff into the receiving waters;
- (4) Inventory of the existing drainage system;
- (5) Recommended maintenance practices and standards of the existing drainage system;
- (6) Identification of capital improvements to the system to include construction or installation of appropriate BMPs;
- (7) A five-year spending plan;
- (8) Ensure compliance with the federally mandated MS4 permit requirements;
- (9) Efficient utility administration including, but not limited to, billing, collection, defining rate structures, data management and customer support.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

## Sec. 99-116. Stormwater management utility board.

- (1) *Purpose.* In compliance with and under authority of Beaufort County Ordinance 2001/23, the Beaufort County Council hereby establishes the stormwater management utility board (hereinafter referred to as the "SWU board") to advise the council as follows:
- (a) To determine appropriate levels of public stormwater management services for residential, commercial, industrial and governmental entities within Beaufort County;
  - (b) To recommend appropriate funding levels for provision of services in the aforementioned sectors;
  - (c) To advise the staff of the stormwater management utility on master planning efforts and cost of service/rate studies; and
  - (d) To support and promote sound stormwater management practices that mitigates non-point source pollution and enhances area drainage within Beaufort County.

Municipal councils are encouraged to organize similar boards to advise them on stormwater management programs and priorities within their boundaries.

In keeping with discussions held during the formation of the stormwater utility, it is anticipated that the municipalities will appoint staff professionals as their representative on the advisory board.

- (2) *Stormwater districts.* Stormwater districts are hereby established as follows:

District 1 - City of Beaufort

District 2 - Town of Port Royal

District 3 - Town of Hilton Head Island

District 4 - Town of Bluffton

District 5 - Unincorporated Sheldon Township

District 6 - Unincorporated Port Royal Island

District 7 - Unincorporated Lady's Island

District 8 - Unincorporated St. Helena Island Islands East

District 9 - Unincorporated Bluffton Township and Daufuskie Island

- (3) *Membership.*

- (a) The SWU board is formed in accordance with Beaufort County Ordinance 92-28 and shall consist of a total of seven voting representatives from each of the following districts as noted below:

No. of Reps.	Stormwater District	Area
1	5	Unincorporated Sheldon Township
1	6	Unincorporated Port Royal Island
1	7	Unincorporated Lady's Island
1	8	Unincorporated St. Helena Island Islands East
2	9	Unincorporated Bluffton Township and Daufuskie Island
1	—	"At large"

All members of the SWU board will be appointed by county council and shall be residents of those districts or "at large" members from unincorporated Beaufort County.

- (b) The SWU board shall also consist of one nonvoting (ex officio) representative from the following districts:

Stormwater District	Municipality
1	City of Beaufort
2	Town of Port Royal
3	Town of Hilton Head Island
4	Town of Bluffton

All ex officio members from municipalities shall be appointed by their respective municipal councils for four-year terms.

- (c) All citizen members shall be appointed for a term of four years. The terms shall be staggered with one or two members appointed each year.
- (d) While no other eligibility criteria is established, it is recommended that members possess experience in one or more of the following areas: Stormwater management (drainage and water quality) issues, strategic planning, budget and finance issues or established professional qualifications in engineering, construction, civil engineering, architectural experience, commercial contractor or similar professions.

(4) *Officers.*

- (a) *Officers.* Selection of officers and their duties as follows:

1. *Chairperson and vice-chair.* At an annual organizational meeting, the members of the SWU board shall elect a chairperson and vice-chairperson from among its members. The chair's and vice-chair's terms shall be for one year with eligibility for reelection. The chair shall be in charge of all procedures before the SWU board, may administer oaths, may compel the attendance of witnesses, and shall take such action as shall be necessary to preserve order and the integrity of all proceedings before the SWU board. In the absence of the chair, the vice-chair shall act as chairperson.
2. *Secretary.* The county professional staff member shall appoint a secretary for the SWU board. The secretary shall keep minutes of all proceedings. The minutes shall contain a summary of all proceedings before the SWU board, which include the vote of all members upon every question, and its recommendations, resolutions, findings and determinations, and shall be attested to by the secretary. The minutes shall be approved by a majority of the SWU board members voting. In addition, the secretary shall maintain a public record of SWU board meetings, hearings, proceedings, and correspondence.
3. *Staff.* The public works director shall be the SWU board's professional staff.

- (b) *Quorum and voting.* Four SWU board members shall constitute a quorum of the SWU board necessary to take action and transact business. All actions shall require a simple majority of the number of SWU board members present.
- (c) *Removal from office.* The county council, by a simple majority vote, shall terminate the appointment of any member of the SWU board and appoint a new member for the following reasons:
1. Absent from more than one-third of the SWU board meetings per annum, whether excused or unexcused;
  2. Is no longer a resident of the county;
  3. Is convicted of a felony; or

4. Violated conflict of interest rules.

Moreover, a member shall be removed automatically for failing to attend any three consecutive regular meetings.

- (d) *Vacancy.* Whenever a vacancy occurs on the SWU board, the county council shall appoint a new member within 60 days of the vacancy, subject to the provisions of this section. A new member shall serve out the former member's term.
- (e) *Compensation.* The SWU board members shall serve without compensation, but may be reimbursed for such travel, mileage and/or per diem expenses as may be authorized by the county council-approved budget.

(5) *Responsibilities and duties.*

- (a) Review and recommend to the county council for approval, a comprehensive Beaufort County Stormwater Management Master Plan and appropriate utility rate study which is in accordance with the South Carolina Stormwater Management and Sediment Reduction Act; and
- (b) Review and comment to the county administrator on the annual stormwater management utility enterprise fund budget; and
- (c) Cooperate with the South Carolina Department of Health and Environmental Control (DHEC), Office of Coastal Resource Management (OCRM), the Oversight Committee of the Special Area Management Plan (SAMP), the Beaufort County Clean Water Task Force as well as other public and private agencies having programs directed toward stormwater management programs; and
- (d) Review and make recommendations concerning development of a multiyear stormwater management capital improvement project (CIP) plan; and
- (e) Review and advise on proposed stormwater management plans and procurement procedures; and
- (f) Provide review and recommendations on studies conducted and/or funded by the utility; and
- (g) Review and advise on actions and programs to comply with regulatory requirements, including permits issued under the State of South Carolina National Pollutant Discharge Elimination System (NPDES) general permit for stormwater discharges from regulated small municipal separate storm sewer systems (MS4).

(6) *Meetings.* Meetings of the SWU board shall be held as established by the SWU board and county staff on a quarterly and an as needed basis and a calendar will be prepared giving the date, time and location of such meetings. Additionally, meetings may be called by the chairperson or at the request of county staff. The location of all SWU board meetings shall be held in a public building in a place accessible to the public. The following shall apply to the conduct of all meetings:

- (a) *Meeting records.* The SWU board shall keep a record of meetings, resolutions, findings, and determinations. The SWU board may provide for transcription of such hearings and proceedings, or portions of hearings and proceedings, as may be deemed necessary.
- (b) *Open to public.* All meetings and public hearings of the SWU board shall be open to the public.
- (c) *Recommendations or decisions.* All recommendations shall be by show of hands of all members present. A tie vote or failure to take action shall constitute a denial recommendation. All recommendations shall be accompanied by a written summary of the action and recommendations.
- (d) *Notice and agenda.* The SWU board must give written public notice of regular meetings at the beginning of each calendar year. The SWU board must post regular meeting agendas at the meeting place 24 hours before any meeting. Notices and agenda for call, special or rescheduled meetings must

be posted at least 24 hours before such meetings. The SWU board must notify any persons, organizations and news media that request such notification of meetings.

( Ord. No. 2015/24, 9-28-2015 ; Ord. No. 2021/04, 1-11-2021 )

**Secs. 99-117—99-199. Reserved.**

### ***ARTICLE III. REGULATORY GENERAL PROVISIONS***

#### **Sec. 99-200. Authority.**

This article is adopted pursuant to the authority conferred upon the Beaufort County (county) by the South Carolina Constitution, the South Carolina General Assembly and in accordance with Federal Clean Water Act, the South Carolina Pollution Control Act, and regulations promulgated there under.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-201. Findings.**

The county council makes the following findings:

- (a) Beaufort County's waters contain some of the few remaining pristine shellfish harvesting areas in the southern coastal counties of South Carolina. Many of its waters have been designated by the State of South Carolina as Outstanding Resource Waters. This use has historical and traditional significance to the area. It is in the public interest that the condition of these areas be maintained and preserved for future generations. Uncontrolled stormwater runoff may have significant, adverse impact on the health, safety and general welfare of the county and the quality of life of its citizens by transporting pollutants into receiving waters and by causing erosion and/or flooding. Development and redevelopment may alter the hydrologic response of local watersheds and increases stormwater runoff rates and volumes, flooding, soil erosion, stream channel erosion, non-point pollution, and sediment transport and deposition, as well as reducing groundwater recharge. These changes in stormwater runoff may contribute to increased quantities of water-borne pollutants and alterations in hydrology which are harmful to public health, safety, and welfare, as well as to the natural environment.
- (b) Point source pollution may have significant, adverse impact on the health, safety and general welfare of the county and the quality of life of its citizens by transporting pollutants into receiving waters. The allowance of discharge pipes and outfalls for non-stormwater discharges, illegal dumping, and improper handling of accidental spills and intentional disposals increase the quantities of water-borne pollutants which are harmful to public health, safety, and welfare, as well as to the natural environment.
- (c) The effects of point and non-point source pollution, such as uncontrolled runoff, have shown evidence of degradation of the county's receiving waters; thereby adversely affecting the unique qualities of the county's receiving waters, its recreational opportunities and commercial, oystering, boating and fishing, the ecosystem's ability to naturally reproduce and thrive, and the general ability of the area to sustain its natural estuarine resources.
- (d) These deleterious effects can be managed and minimized by applying proper design and well-planned controls to manage stormwater runoff from development and redevelopment sites, manage existing natural features that maintain hydrology and provide water quality control, and eliminate potential sources of pollution to receiving waters. Public education regarding the cause and effect of these types



of pollutions and the implementation of the controls and management policies is key to fundamentally changing public behavior.

- (e) This article is not in conflict with any development agreements to which the county is a party and does not prevent the development set forth in any development agreement unless impairments to the county's receiving waters is linked to this development.
- (f) This article is essential to the public health, safety or welfare and shall apply to any development that is subject to a development agreement.
- (g) Laws of general application throughout the county necessary to protect health, safety and welfare are anticipated and are provided for in development agreements.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-202. Purpose.**

- (a) It is the purpose of this article to guide development in Beaufort County to protect, maintain, and enhance the environment of the county and the short- and long-term public health, safety, and general welfare of the citizens of the county by establishing requirements and procedures to control the potential adverse effects of increased stormwater runoff associated with both future development, re-development, and existing developed land. Proper management of stormwater runoff will minimize damage to public and private property, ensure a functional drainage system, reduce the effects of development on land and stream channel erosion, attain and maintain water quality standards, enhance the local environment associated with the drainage system, reduce local flooding, reduce pollutant loading to the maximum extent practicable and maintain to the extent practicable the pre-developed runoff characteristics of the area, and facilitate economic development while minimizing associated pollutant, flooding, and drainage impacts.
- (b) This article specifically authorizes and enables the county to:
  - (1) Prohibit illicit discharges to the stormwater system and receiving waters.
  - (2) Define procedures for site plan design, review, inspection, and enforcement relative to stormwater management. Establish decision-making processes surrounding land development or redevelopment activities that protect the integrity of local aquatic resources.
  - (3) Control the discharge of spills, dumping or disposal of materials other than stormwater to the stormwater system and receiving waters.
  - (4) Address specific categories of non-stormwater discharges and similar other incidental non-stormwater discharges.
  - (5) Control importation of water that adversely impacts our receiving waters.
  - (6) Require temporary erosion and sediment controls to protect water quality to the maximum extent practicable during construction activities, in accordance with current state regulations.
  - (7) Define procedures for receipt and consideration of information submitted by the public.
  - (8) Address runoff, particularly volume, rate, and quality through the control and treatment of stormwater with stormwater management facilities and/or best management practices (BMPs).
  - (9) Develop post-construction stormwater quality performance standards, through enforcement of minimum design standards for BMPs.
  - (10) Ensure effective long-term operation and maintenance of BMPs.

- (11) Carry out all inspection, surveillance, monitoring, and enforcement procedures necessary to determine compliance and noncompliance with this article and stormwater permit conditions including the prohibition of illicit discharges to the county's stormwater system and the protection of water quality of the receiving waters.
  - (12) Development, implement, and enforce regulations any and all other programs or policies to comply with the Municipal Separate Stormsewer System (MS4) permit issued by South Carolina Department of Health and Environmental Control (DHEC).
  - (13) Establish design criteria in the most current version of the Southern Lowcountry Stormwater Design Manual for structural and nonstructural stormwater management practices that can be used to meet the minimum post-development stormwater management standards and design criteria;
  - (14) Establish that Better Site Design (BSD) and site planning has been incorporated, documented, and presented in the development/redevelopment design process.
  - (15) Maintain structural and nonstructural stormwater management practices to ensure that they continue to function as designed and pose no threat to public safety.
  - (16) Streamline administrative procedures for the submission, review, approval and disapproval of stormwater management plans and for the inspection of approved land development projects.
  - (17) If any of the stormwater management standards, as defined in this chapter and in the most current version of the Southern Lowcountry Stormwater Design Manual cannot be attained on the site (due to impractical site characteristics or constraints), a maximum extent practicable analysis shall be prepared and submitted by the applicant for review, discussion, and ultimate approval or rejection of the jurisdiction. Any uncontrolled post-development stormwater quantity or quality volume shall be intercepted and treated in one or more off-site stormwater management practices or a fee-in-lieu shall be required.
  - (18) The stormwater management practices of approved plans shall provide volume control and at least an 80 percent reduction in total suspended solids loads, 30 percent reduction of total nitrogen load, and 60 percent reduction in bacteria load.
- (c) The article requires prudent site planning, including special considerations for the purposes of preserving natural drainage ways incorporating on-site stormwater detention and infiltration to minimize runoff from individual sites to receiving waters by use of effective runoff management, structural and non-structural BMPs, drainage structures, and stormwater facilities. Establish that better site design (BSD) and site planning has been incorporated, documented, and presented in the development/redevelopment design process.
- ( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

## Sec. 99-203. Definitions.

The following definitions shall apply in articles III, IV, V, and VI this chapter. Any term not herein defined shall be given the definition, if any, as is found elsewhere in the Code of Ordinances of Beaufort County, including the community development code (CDC) ordinance.

*Administrators.* The public works director, the stormwater manager and other individuals designated by the county administrator, from time to time, to administer interpret and enforce this article.

*Best management practices ("BMP").* Stormwater management practices, either structural, non-structural or natural that has been demonstrated to effectively control movement of stormwater, pollutants, prevent degradation of soil and water resources, and that are compatible with the planned land use.

*Clean Water Act.* The Federal Water Pollution Control Act, as amended, codified at 33 U.S.C § 1251 et seq.

*Community development code ("CDC").* A form based code to regulate zoning and development in Beaufort County.

*County.* The Beaufort County, South Carolina.

*County council.* The publicly elected official of Beaufort County, South Carolina.

*Department.* The stormwater department, or any duly authorized representatives thereof as designated by the county administrator.

*Development.* All project construction, modification, or use of any lot, parcel, building, or structure on land and on water. Existing dirt roads which are improved and/or paved as part of Beaufort County's Dirt Road Paving Program as set forth in Beaufort County Policy Statement 15 and Policy Statement 17 and existing private dirt roads which are improved or paved and where the project is not related to a pending or proposed development of adjacent land are deemed not to constitute "development".

*Disconnected impervious areas or disconnected impervious surfaces.* Those non-contiguous impervious areas or impervious surfaces which produce stormwater runoff that discharges through or across a pervious area or surface (i.e. vegetated cover), of sufficient width to reduce or eliminate pollutants associated with stormwater runoff, prior to discharge to the stormwater system.

*Environment.* The complex of physical, chemical, and biotic factors that act upon an ecological community and ultimately determine its form and survival.

*Evapotranspiration.* The sum of evaporation and plant transpiration from the earth's land surface to atmosphere.

*Excess stormwater volume.* The additional volume of stormwater runoff leaving the site over and above the runoff volume which existed pre-development.

*Illicit connection.* A connection to the county's stormwater system or receiving water which results in a discharge that is not composed entirely of stormwater runoff and has a detrimental effect on the stormwater system or receiving water except, those granted coverage by an active NPDES permit.

*Illicit discharge.* Any activity, which results in a discharge to the county's stormwater system or receiving waters that is not composed entirely of stormwater except:

- (a) Discharge pursuant to an NPDES permit; and
- (b) Other allowable discharges as defined and exempted in this article.

*Impervious surface.* As defined in the county's best management practices (BMP) manual.

*Improper disposal.* Any disposal through an illicit discharge, including, but not limited to, the disposal of used oil and toxic materials resulting from the improper management of such substances.

*Land disturbance or land disturbing activity.* The use of land by any person that results in a change in the natural vegetated cover or topography, including clearing that may contribute to or alters the quantity and/or quality of stormwater runoff.

*Maintenance.* Any action necessary to preserve stormwater management facilities in proper working condition, in order to serve the intended purposes set forth in this article and to prevent structural failure of such facilities.

*MS4.* Municipal separate storm sewer system.

*NPDES.* National Pollutant Discharge Elimination System (see "Clean Water Act.")

*Natural resources.* Land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources.

*Outfall.* The point where county's stormwater system discharges to waters of the United States or the State of South Carolina.

*Person.* Any and all persons, natural or artificial and includes any individual, association, firm, corporation, business trust, estate, trust, partnership, two or more persons having a joint or common interest, or an agent or employee thereof, or any other legal entity.

*Pollutant.* Those manmade or naturally occurring constituents that when introduced to a specific environment creates a deleterious effect. Typical pollutants found in stormwater include, but are not limited to, sediment (suspended and dissolved), nutrients (nitrogen and phosphorus, etc.), oxygen demanding organic matter, heavy metals (iron, lead, manganese, etc.), bacteria and other pathogens, oil and grease, household hazardous waste (insecticide, pesticide, solvents, paints, etc.) and polycyclic aromatic hydrocarbons (PAHs).

*Property owner or owner.* The legal or equitable owner of land.

*Receiving waters.* All natural water bodies, including oceans, salt and freshwater marsh areas, lakes, rivers, streams, ponds, wetlands, and groundwater which are located within the jurisdictional boundaries of the county. Stormwater management ponds, manmade wetlands, ditches, and swales constructed for the sole purpose of controlling and treating stormwater are not considered receiving waters.

*Record drawings.* A set of drawings prepared by and certified by a South Carolina registered professional engineer or landscape architect that accurately represents the actual final configuration of the stormwater and other related infrastructure constructed in a development.

*Redevelopment.* As defined in the county's best management practices (BMP) manual.

*Regulation.* Any regulation, rule or requirement and promulgated by the county pursuant to this article.

*Southern Lowcountry Stormwater Design Manual.* "The Manual for Stormwater Best Management and Design Practices (BMP)" establishes technical standards as referenced and incorporated into the community development code (CDC).

*Stormwater.* Stormwater runoff, precipitation runoff, and surface runoff.

*Stormwater management.* The collection, conveyance, storage, treatment and disposal of stormwater in a manner to meet the objectives of this article and its terms, including, but not limited to, measures that control the increased volume and rate of stormwater runoff and water quality impacts caused by manmade changes to the land.

*Stormwater management program, services, systems facilities.* Those administrative, engineering, operational, regulatory, and capital improvement activities and functions performed in the course of managing the stormwater systems of the county, plus all services. Stormwater management systems and facilities are those natural and manmade channels, swales, ditches, swamps, rivers, streams, creeks, branches, reservoirs, ponds, drainage ways, inlets, catch basins, pipes, head walls, storm sewers, lakes, and other physical works, properties, and improvements which transfer, control, convey or otherwise influence the movement of stormwater runoff and its discharge to and impact upon receiving waters.

*Stormwater management plan or SWMP.* The set of drawings and other documents that comprise all of the information and specifications for the programs, drainage systems, structures, BMPs, concepts, and techniques for the control of stormwater.

*Stormwater pollution prevention plan or SWPPP.* Erosion prevention and sediment control (EPSC). Also see "stormwater management plan".

*Stormwater system.* The conveyance or system of conveyances (including roads with drainage systems, highways, right-of-way, private streets, catch basins, curbs, gutters, ditches, manmade channels, storm drains, detention ponds, and other stormwater facilities) which is designed or used for collecting or conveying stormwater.

*Structural best management practices ("BMP").* A device designed and constructed to trap and filter pollutants from runoff.

*Total impervious surface.* All impervious surfaces on a site regardless if they are directly connected to another and that is not constructed using permeable pavement technology.

*Utility.* Beaufort County Stormwater Utility as established by county article chapter 99, article II.

*Waiver.* The modification of the minimum stormwater management requirements contained in these articles and the most current version of the Southern Lowcountry Stormwater Design Manual for specific circumstances where strict adherence of the requirements would result in unnecessary hardship and not fulfill the intent of this article.

*Water quality.* Those characteristics of stormwater runoff that relate to the physical, chemical, biological, or radiological integrity of water.

*Water quantity.* Those characteristics of stormwater runoff that relate to the rate and volume of the stormwater runoff.

*Wetlands.* As defined by the Army Corps of Engineers and generally means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar type areas.

*Working day.* Monday through Friday, excluding all county-observed holidays.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2018/6 , 3-12-2018; Ord. No. 2020/18 , 5-26-2020; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-204. Applicability.**

Beginning with and subsequent to its effective date, this article shall be applicable to:

- (a) All development and redevelopment.
- (b) Any illicit discharges.
- (c) The provisions of this article shall apply throughout the unincorporated areas of the county.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-205. Regulations.**

The county council, may, in its discretion, amend or change this article, or adopt additional regulations to implement this article in order to comply with the state regulations, administer the stormwater management department, or to otherwise further the goal of protecting the quality of the receiving waters into which the stormwater system discharges.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-206. County stormwater management administration.**

Stormwater management will be administered by the public works department and the stormwater department to administer and implement the regulations of this article as set forth in the most current version of the Southern Lowcountry Stormwater Design Manual. The manual may include design standards, procedures and

criteria for conducting hydrologic, hydraulic, pollutant load evaluations, and downstream impact for all components of the stormwater management system. It is the intention of the manual to establish uniform design practices; however, it neither replaces the need for engineering judgment nor precludes the use of information not submitted. Other accepted engineering procedures may be used to conduct hydrologic, hydraulic and pollutant load studies if approved by the public works director.

The manual will contain at a minimum the following components:

- (a) Construction activity application contents and approval procedures;
- (b) Construction completion and closeout processes;
- (c) Hydrologic, hydraulic, and water quality design criteria (i.e., design standards) for the purposes of controlling the runoff rate, volume, and pollutant load. Suggested reference material shall be included for guidance in computations needed to meet the design standards;
- (d) Information and requirements for new and re-development projects in special protection areas necessary to address TMDLs, known problem areas and other areas necessary to protect, maintain, and enhance water quality and the environment of Beaufort County and the public health, safety, and general welfare of the citizens of Beaufort County.
- (e) Construction document requirements;
- (f) Long-term maintenance and maintenance plan;
- (g) Minimum easement requirements;
- (h) Required and recommended inspection schedules and activities for all components of the stormwater management system, including construction related BMPs.

The manual will be updated periodically to reflect the advances in technology and experience.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2020/18 , 5-26-2020; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-207. Administrators of operations, power and duties.**

- (a) The administrators, or designee, shall administer, implement, and enforce provisions of this article on behalf of the county.
- (b) In addition to the powers and duties that may be conferred by other provisions of the county and other laws, the administrators shall have the following powers and duties under this article:
  - (1) To create the Southern Lowcountry Stormwater Design Manual. The manual may be used to convey design and engineering standards, construction management processes and procedures, and other aspects necessary for compliance with this chapter;
  - (2) To review and approve, approve with conditions, or disapprove applications for approval of a stormwater management plan pursuant to this article;
  - (3) To make determinations and render interpretations of this article;
  - (4) To establish application requirements, schedules and fees for submittal and review of applications, receipt of appeals, in accordance with the standards for county development permits and stormwater permits under the county's CDC ordinance and this article;
  - (5) To review and make recommendations to the applications for development or redevelopment approvals;
  - (6) To enforce the provisions of this article in accordance with its enforcement provisions;

- (7) To maintain records, maps, and official materials related enforcement, or administration of this article;
- (8) To provide expertise and technical assistance;
- (9) To take any other action necessary to administer the provisions of this article.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-208. Coordination with other agencies.**

The administrators will coordinate the county's activities with other federal, state, and local agencies, which manage and perform functions relating to the protection of receiving waters.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-209. Cooperation with other governments.**

The county may enter into agreements with other governmental and private entities to carry out the purposes of this article. These agreements may include, but are not limited to, enforcement, resolution of disputes, cooperative monitoring, and cooperative management of stormwater systems and cooperative implementation of stormwater management programs.

Nothing in this article or in this section shall be construed as limitation or repeal of any ordinances of these local governments or of the powers granted to these local governments by the South Carolina Constitution or statutes, including, without limitation, the power to require additional or more stringent stormwater management requirements within their jurisdictional boundaries.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-210. Stormwater management standards.**

- (a) Reference to best management practices can be found in the most current version of the Southern Lowcountry Stormwater Design Manual. The administrators shall use the policy, criteria, and information, including technical specifications and standards, in the most current version of the Southern Lowcountry Stormwater Design Manual as the basis for decisions about stormwater plans and about the design, implementation and performance of structural and non-structural stormwater systems. The stormwater management standards shall describe in detail how post-development stormwater runoff will be controlled and managed, the design of all stormwater facilities and practices, and how the proposed project will meet the requirements of this article. The most current version of the Southern Lowcountry Stormwater Design Manual includes a list of acceptable stormwater treatment practices, including the specific design criteria for each stormwater practice. These standards will be updated as technology improves.
- (b) Relationship of stormwater management standards to other laws and regulations. If the specifications or guidelines of the standards are more restrictive or apply a higher standard than other laws or regulations, that fact shall not prevent application of the specifications or guidelines in the standards.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-211. Review of stormwater management plans.**

Stormwater management plans shall be reviewed as a component of the development plan review process by the administrators. They will be reviewed for compliance with standards in this article and requirements in the

CDC and [the most current version of the](#) Southern Lowcountry Stormwater Design Manual Procedures are outlined in [the most current version of the](#) Southern Lowcountry Stormwater Design Manual. Requests for meetings and submission of plans will be submitted to stormwater department. The expected process will be in accordance with the standard procedures for applications described in the community development code.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-212. Approvals.**

- (a) *Effect of approval.* Approval authorizes the applicant to go forward with only the specific plans and activity authorized in the plan. The approval shall not be construed to exempt the applicant from obtaining other applicable approvals from local, state, and federal authorities.
- (b) *Time limit/expiration.* Time limit, expiration and extensions shall be in accordance with the county's community development code.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-213. Appeals.**

- (a) *Scope of appeal.* Any person aggrieved by a decision of the administrators may appeal the same by filing an interim written notice of appeal, with the administrators within 30 days of the issuance of said decision or notice of violation. The interim notice of appeal must specify with reasonable practicality the grounds of the appeal and relief sought. The stormwater management utility board (SWUB) will review and provide a decision within 15 days after the next scheduled board meeting following the appeal. The decision of the SWUB shall be final. Appeals to SWUB's decision shall be processed in accordance with state law.
- (b) *Standards.*
  - (1) The SWUB is limited to the following determinations for an administrative appeal:
    - a. The administrators made an error in reviewing whether a standard was met. The record must indicate that an error in judgment occurred or facts, plans, or regulations were misread in determining whether the particular standard was met.
    - b. Where conflicting evidence exists, the appeal is limited to determining what evidence or testimony bears the greatest credibility in terms of documentation and qualifications of those making the determination.
    - c. The administrators made the decision on standards not contained in this chapter or other county ordinances, regulations, or state law, or a standard more strict or broad was applied. This chapter does not permit administrators to consider or create standards not officially adopted.
    - d. An error in applying a standard or measuring a standard was made.
  - (2) The board, on an appeal, shall not hear any evidence or make any decision based on financial hardships.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Secs. 99-214—99-299. Reserved.**

## **ARTICLE IV. STORMWATER MANAGEMENT STANDARDS TO BE APPLIED**



### Sec. 99-300. General requirements.

- (a) All development and redevelopment, including highways, shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume and duration of flow.
- (b) All development shall connect impervious surfaces to vegetative surfaces to the maximum extent practicable.
- (c) Stormwater runoff shall be controlled in a manner that:
  - (1) Promotes positive drainage from structures resulting from development.
  - (2) Includes the use of vegetated conveyances, such as swales and existing natural channels to promote infiltration and evapotranspiration.
  - (3) Reduces runoff velocities and maintains sheet flow condition to prevent erosion and promote infiltration.
  - (4) Limits its interaction with potential pollutant sources that may become water-borne and create non-point source pollution.
  - (5) Promotes reuse of excess stormwater volume to increase evapotranspiration.
- (d) Natural vegetative buffers play an integral part in minimizing the volume of stormwater runoff by promoting infiltration and increasing evapotranspiration to reduce stormwater volume to receiving waters and acting as a first line of treatment of water quality pollution. Development shall observe the buffer requirements of the county's CDC ordinance or if applicable the relevant development agreement, concept plan, and/or approved master plan.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### Sec. 99-301. Stormwater design requirements for development.

Developments which incorporates engineered stormwater collection, conveyance, and storage systems shall be designed to the criteria established in the ~~latest~~ most current version of county's Southern Lowcountry Stormwater Design Manual.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### Sec. 99-302. BMP requirements.

- (a) Effectiveness of infiltration practices is dependent on the site conditions. The most current version of the Southern Lowcountry Stormwater Design Manual outlines guidance for properly siting infiltration practices and shall be reviewed prior to the design phase.
- (b) The owners of all new developments that receive a stormwater permit from the county shall be required to perform stormwater quantity monitoring at their expense to ensure compliance with the provisions of this article and ensure that volume reduction plans are operated as intended.
- (c) All construction and implementation of erosion and sediment control BMPs shall comply with the requirements of the South Carolina Stormwater Management and Sediment Reduction Act and submit reports in accordance with the most current version of the Southern Lowcountry Stormwater Design Manual.

- (d) The county reserves the right to perform other monitoring as it deems appropriate to determine compliance with the State Sediment and Erosion Control Act.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-303. Reserved.**

( Ord. No. 2016/38 , 10-24-2016)

### **Sec. 99-304. Waiver.**

Individuals seeking a waiver in connection with a stormwater plan may submit to the public works director a request for a waiver from the requirements of this article if exceptional circumstances applicable to a site exist, such that the applicant can provide rational documentation and justification to support a waiver.

Waivers may be granted for water quantity control only and best management practices to achieve water quality goals will still be required.

- (a) *Request of waiver at staff level.* A written request for a waiver is required and shall state the specific waiver sought and the reasons, with supporting data, a waiver should be granted. The request shall include all information necessary to evaluate the proposed waiver. Requests must outline the need for such a waiver, such as site constraints, soil characteristics, or similar engineering limitations. Cost shall not be considered cause for a waiver. The applicant will address the four areas of consideration for waiver approval as follows:
  - (1) What exceptional circumstances to the site are evident?
  - (2) What unnecessary hardship is being caused?
  - (3) How will denial of the waiver be inconsistent with the intent of the ordinance?
  - (4) How will granting waiver comply with intent of ordinance?
- (b) *Review of waivers.* The administrators will conduct a review of the request and will issue a decision within 15 working days of receiving the request.
- (c) *Appeal of decision.* Any person aggrieved by the decision of the administrators concerning a waiver request may appeal such decision in accordance with section 99-213 above.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-305. Maintenance; general requirements.**

- (a) *Function of BMPs as intended.* The owner of each structural BMP installed pursuant to this article shall maintain and operate it to preserve and continue its function in controlling stormwater quality and quantity at the degree or amount of function for which the structural BMP was designed.
- (b) *Right of county to inspection.* Every structural BMP installed pursuant to this article shall be made accessible for adequate inspection by the county.
- (c) *Annual maintenance inspection and report.* The person responsible for maintenance of any structural BMP installed pursuant to this article shall submit to the administrator(s) an inspection report from a CSPR certified inspector, Post-construction BMP certified inspector, an E.I.T. or registered South Carolina Professional Engineer. The inspection report, at a minimum, shall contain all of the following:

- (1) The name and address of the land owner;
- (2) The recorded book and page number of the lot of each structural BMP or a digital representation of the geographic location of each structural BMP;
- (3) A statement that an inspection was made of all structural BMPs;
- (4) The date the inspection was made;
- (5) A statement that all inspected structural BMPs are performing properly and comply with the terms and conditions of the approved maintenance agreement required by this article;
- (6) The original signature and seal of the engineer inspecting the structural BMPs; and
- (7) Digital photographs of the structural BMPs and pertinent components integral to its operation, including, but not limited to, inlet/outlet control structures, downstream receiving channel/area, embankments and spillways, safety features, and vegetation.

An original inspection report shall be provided to the administrators beginning one year from the date of final inspection of the completed structural BMP and each year thereafter on or before the date of the record drawings certification.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-306. Operation and maintenance agreement.**

- (a) Prior to the conveyance or transfer of any lot or building site requiring a structural BMP pursuant to this article, the applicant or owner of the site must execute an operation and maintenance agreement (see [the most current version of the](#) Southern Lowcountry Stormwater Design Manual for form) that shall be binding on all subsequent owners of the site, portions of the site, and lots or parcels served by the structural BMP. Until the transference of all property, sites, or lots served by the structural BMP, the original owner or applicant shall have primary responsibility for carrying out the provisions of the maintenance agreement.
- (b) The operation and maintenance agreement must be approved by the administrators prior to plan approval, and it shall be referenced on the final plat and shall be recorded with the county register of deeds upon final plat approval. If no subdivision plat is recorded for the site, then the operations and maintenance agreement shall be recorded upon the approval of a certificate of completion with the county register of deeds to appear in the chain of title of all subsequent purchasers under generally accepted searching principles. A copy of the recorded maintenance agreement shall be given to the administrators within 14 days following its recordation.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-307. Deed recordation and indications on plat.**

The applicable operations and maintenance agreement pertaining to every structural BMP shall be referenced on the final plat and in covenants and shall be recorded with the county register of deeds upon final plat approval.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

**Sec. 99-308. Records of installation and maintenance activities.**

The owner of each structural BMP shall keep records of inspections, maintenance, and repairs for at least five years from the date of the record and shall submit the same upon reasonable request to the administrator(s).

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

**Sec. 99-309. Nuisance.**

The owner of each stormwater BMP shall maintain it so as not to create or result in a nuisance condition, such as, but not limited to, flooding, erosion, excessive algal growth, overgrown vegetation, mosquito breeding habitat, existence of unsightly debris, or impairments to public safety and health. Maintenance practices must not lead to discharges of harmful pollutants.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

**Secs. 99-310—99-399. Reserved.**

## ***ARTICLE V. ILLICIT DISCHARGES AND CONNECTIONS TO THE STORMWATER SYSTEM***

**Sec. 99-400. Illicit discharges.**

No person shall cause or allow the discharge, emission, disposal, pouring, or pumping directly or indirectly to any stormwater conveyance, receiving water, or upon the land in manner and amount that the substance is likely to reach a stormwater conveyance or the receiving waters, any liquid, solid, gas, or other substance (including animal waste), other than stormwater.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

**Sec. 99-401. Non-stormwater discharges.**

(a) Non-stormwater discharges associated with the following activities are allowed provided that acceptable BMPs are followed:

- (1) Water line and hydrant flushing;
- (2) Landscape irrigation, unless it leads to excess SW volume discharge;
- (3) Diverted stream flows;
- (4) Rising ground waters;
- (5) Uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20));
- (6) Uncontaminated pumped ground water;
- (7) Discharges from potable water sources (with dechlorination BMP utilized);
- (8) Foundation drains;
- (9) Air conditioning condensation;

- (10) Reuse water;
  - (11) Springs;
  - (12) Water from crawl space pumps;
  - (13) Footing drains;
  - (14) Individual residential car washing;
  - (15) Flows from riparian habitats and wetlands;
  - (16) Dechlorinated swimming pool discharges: typically less than one part per million;
  - (17) Street wash water;
  - (18) Other non-stormwater discharge permitted under an NPDES permit, waiver, or waste discharge order issued to the discharger and administered under EPA authority, provided that the discharger is in full compliance with all requirements of the permit, waiver, or order and other applicable laws and regulations, and provided that written approval has been granted for any discharge to the storm drain system;
  - (19) Discharges specified in writing by the authorized agency/entity, as being necessary to protect public health and safety;
  - (20) Dye testing is an allowable discharge, but requires a verbal notification to the authorized enforcement agency prior to the test; and
  - (21) Firefighting.
  - (22) The public works director may develop procedures for allowing other non-stormwater discharges.
- (b) Prohibited substances include, but are not limited to: Oil, anti-freeze, chemicals, animal waste, paints, garbage, and litter.
- ( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-402. Illicit connections.**

- (a) Connections to a receiving water and/or stormwater conveyance system that allow the discharge of non-stormwater, other than the exclusions described in subsection 99-401(a) above are unlawful. Prohibited connections include, but are not limited to, floor drains, waste water from washing machines or sanitary sewers, wash water from commercial vehicle washing or steam cleaning, and waste water from septic systems.
- (b) Where such connections exist in violation of this section and said connections were made prior to the adoption of this article or any other article prohibiting such connections, the property owner or the person using said connection shall remove or correct the connection immediately upon notice.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-403. Spills.**

- (a) Spills or leaks of polluting substances released, discharged to, or having the potential to released or discharged to a receiving water or the stormwater conveyance system, shall be immediately contained, controlled, collected, and properly disposed. All affected areas shall be restored to their preexisting condition.

- (b) Persons in control of the polluting substances shall immediately report the release or discharge to persons owning the property on which the substances were released or discharged, shall within two hours of such an event notify the nearest fire department (which will also notify the administrators), and all required federal and state agencies of the release or discharge. Notification shall not relieve any person of any expenses related to the restoration, loss, damage, or any other liability which may be incurred as a result of said spill or leak, nor shall such notification relieve any person from other liability which may be imposed by state or other law.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-404. Nuisance.**

Illicit discharges and illicit connections which exist within the unincorporated county are hereby found, deemed, and declared to be dangerous and prejudicial to the public health, and welfare, and are found, deemed, and declared to be public nuisances. Such public nuisances shall be abated in accordance with the procedures set forth in subsection 99-503(c) and (d).

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-405. Suspension of a MS4 discharge due to an illicit discharge.**

- (a) Any person discharging to the MS4 in violation of this article may have their MS4 access terminated if such termination would abate or reduce an illicit discharge. The authorized administrators notify a violator of the proposed termination of its MS4 access. The violator may petition the authorized enforcement agency for a reconsideration and hearing.
- (b) A person commits a violation if the person reinstates MS4 access to premises terminated pursuant to this section, without the prior approval of the authorized administrators.
- (c) The Beaufort County, South Carolina administrators may, without prior notice, suspend MS4 discharge access to a person when such suspension is necessary to stop an actual or threatened discharge that presents or may present imminent and substantial danger to the environment, or to the health or welfare of persons, or to the MS4 or waters of the United States. If the violator fails to comply with a suspension order issued in an emergency, the authorized enforcement agency may take such steps as deemed necessary to prevent or minimize damage to the MS4 or waters of the United States, or to minimize danger to persons.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Secs. 99-406—99-499. Reserved.**

### ***ARTICLE VI. INSPECTION, ENFORCEMENT, AND CORRECTION***

#### **Sec. 99-500. Inspections.**

The county administrators will maintain the right to inspect any and all stormwater systems within its jurisdiction as outlined below:

- (a) An inspector designated by the administrators, bearing proper credentials and identification, may enter and inspect all properties for regular inspections, periodic investigations, monitoring, observation

measurement, enforcement, sampling and testing, to ensure compliance with the provisions of this article.

- (b) Upon refusal by any property owner to permit an inspector to enter or continue an inspection, the inspector may terminate the inspection or confine the inspection to areas concerning which no objection is raised. The inspector shall immediately report the refusal and the grounds to the administrators. The administrators will promptly seek the appropriate compulsory process.
- (c) In the event that the administrators or inspector reasonably believes that discharges from the property into the county's stormwater system or receiving waters may cause an imminent and substantial threat to human health or the environment, the inspection may take place at any time after an initial attempt to notify the owner of the property or a representative on site. The inspector shall present proper credentials upon reasonable request by the owner or representative.
- (d) The Beaufort County, South Carolina, administrators shall have the right to set up on any permitted facility such devices as are necessary in the opinion of the authorized enforcement agency to conduct monitoring and/or sampling of the facility's stormwater discharge.
- (e) The Beaufort County, South Carolina, administrators have the right to require the discharger to install monitoring equipment as necessary. The facility's sampling and monitoring equipment shall be maintained at all times in a safe and proper operating condition by the discharger at its own expense. All devices used to measure stormwater flow and quality shall be calibrated to ensure their accuracy.
- (f) Any temporary or permanent obstruction to safe and easy access to the facility to be inspected and/or sampled shall be promptly removed by the operator at the written or oral request of the authorized administrators and shall not be replaced. The costs of clearing such access shall be borne by the operator.
- (g) Unreasonable delays in allowing the Beaufort County, South Carolina, administrators access to a permitted facility is a violation of a stormwater discharge permit and of this article. A person who is the operator of a facility with a NPDES permit to discharge stormwater associated with industrial activity commits an offense if the person denies the authorized enforcement agency reasonable access to the permitted facility for the purpose of conducting any activity authorized or required by this article.
- (h) Inspection reports will be maintained in a permanent file at the offices of the administrators.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-501. Notice and warning.**

- (a) Upon the county's attention to a violation of this article, the administrators shall investigate the violation and prepare a report concerning the violation. If a violation exists, a notice of violation shall be delivered within five working days to any person occupying the property or linked to a discharge, whether the person is the owner, renter, or lessee. If the nature of the violation is not correctable, a stop work order shall be issued immediately. If no one is present or refuses to accept the notice, the administrators shall post the notice of violation on the residence or building entrance.
- (b) The notice of violation shall contain the following:
  - (1) The address and tax ID number of the property.
  - (2) The section of this chapter being violated.
  - (3) The nature and location of the violation and the date by which such violation shall be removed or abated.

- (4) A notice of the penalty for failing to remove or abate the violation, stating that if the nuisance recurs by the same apparent occupant, owner, or person in charge, a notice of violation, stop work order, or notice to appear will be issued without further notice.
- (5) The notice shall specify the number of days in which the violation shall be removed or abated, which time shall be not less than three days nor more than ten days, except in emergency cases.
- (c) If the violation occurs where the residence or building is unoccupied, the property may be posted as provided in this section. If the property is unimproved, the notice may be placed on a tree, a stake, or other such object as available.
- (d) A written notice containing the same information as the notice of violation shall be sent to the owner or any other person having control of the property at the last known address of the owner, or at the address of the person having control, by U.S. mail or email.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-502. Recurring violations.**

Once a notice has been delivered pursuant to this article and the same violation recurs on the same lot or tract of land by the same person previously responsible, no further notice of violation need be given. Each day a violation continues after the expiration of the warning period to abate such a violation shall constitute a separate offence. Thereafter, the county may issue a stop work order, or such person deemed responsible may be notified to appear in court to answer to the charge against such person.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

### **Sec. 99-503. Failure to act upon notice of violation.**

Upon neglect or failure to act upon the notice of violation, and/or stop work order given as provided in sections 99-501 and 99-502, the county shall issue a notice to appear and shall follow the procedures as follows:

- (a) *Service of notice to appear.* If a stop work order is given and, after the time for removal or abatement has lapsed, the property is reinspected and the administrator or designee finds and determines the violation has not been removed or abated, the administrator or designee shall fill out and sign, as the complainant, a complaint and information form or a notice to appear. The notice to appear shall include the following:

- (1) Name of the occupant, owner, or person in charge of the property.
- (2) The address or tax ID number of the property on which the violation is occurring.
- (3) This chapter section or other reference the action or condition violates.
- (4) The date on which the case will be on the court docket for hearing.
- (5) Any other information deemed pertinent by the county official.

The original copy of the notice to appear shall be forwarded to the clerk of the court for inclusion on the court's docket for the date indicated on the notice to appear.

- (b) *Notice to appear; delivery by mail.* If no one is found at the property to accept a notice to appear for failure to remove or abate a violation, the administrator or designee shall fill out and sign the notice to appear as the complainant and deliver the original plus one copy to the clerk of the court. The clerk shall verify or insert the date the case has been set for hearing before the court. The clerk shall mail the copy by certified mail to the person named in the notice to appear at that person's last known address.



- (c) *Abatement by county; costs assessed to person responsible.* If the occupant, owner, or person in charge of the property for which a warning notice has been given fails to remove or abate the violation in the time specified in the notice, whether on public or private property, the administrator or designee may, if severe conditions exist that affect health, welfare, safety or severe environmental degradation, remove the violation and thereby abate the violation. If such conditions exist, the administrator or designee may lawfully enter upon the property on which the violation remains unabated to remove or abate such violation at the cost of the person responsible for creating or maintaining the violation. The violation will be subject to civil fines reflecting the cost to the county, as prosecuted by the county attorney.
- (d) *Payment of costs; special tax bill or judgment.* All costs and expenses incurred by the county in removing or abating any violation on any private property may be assessed against the property as a lien on the property. Alternatively, the cost of removing or abating the violation may be made part of the judgment by the judge, in addition to any other penalties and costs imposed if the person charged either pleads or is found guilty of causing, creating, or maintaining a violation.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-504. Penalty for violation.**

- (a) Enforcement of this article shall fall under the jurisdiction of both the Beaufort County Public Works Department and Beaufort County Codes Enforcement. Officers and inspectors shall have the authority to exercise full discretion in deciding whether to issue a notice of violation, stop work order, or fine when investigating complaints that arise under this article.
- (b) Any person, group, firm, association, or corporation violating any section of this chapter, or the requirements of an approved Beaufort County Stormwater Permit, shall be guilty of a misdemeanor and, upon conviction thereof, shall pay such penalties as the court may decide, as prescribed by state law, not to exceed \$1000.00 or 30 days' imprisonment for each violation. Each day during which such conduct shall continue shall subject the offender to the liability prescribed in this article.
- (c) In addition to the penalties established and authorized in subsection (a) of this section, the county attorney may take other actions at law or in equity as may be required to halt, terminate, remove, or otherwise eliminate any violations of this chapter.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

#### **Sec. 99-505. Interpretation.**

- (a) *Meaning and intent.* All provisions, terms, phrases, and expressions contained in this article shall be construed according to the general and specific purposes set forth in section 99-202, purpose. If a different or more specific meaning is given for a term defined elsewhere in county's Code of Ordinances or in an existing development agreement, the meaning and application of the term in this article shall control for purposes of application of this article.
- (b) *Text controls in event of conflict.* In the event of a conflict or inconsistency between the text of this article and any heading, caption, figure, illustration, table, or map, the text shall control.
- (c) *Authority for interpretation.* The administrators have, after consultation with county attorney, authority to determine the interpretation of this article. Any person may request an interpretation by submitting a written request to the administrators who shall respond in writing within 30 days. The administrators shall keep on file a record of all written interpretations of this article.

- (d) *References to statutes, regulations, and documents.* Whenever reference is made to a resolution, article, statute, regulation, manual (including the **most current version of the** Southern Lowcountry Stormwater Design Manual), or document, it shall be construed as a reference to the most recent edition of such that has been finalized and published with due provision for notice and comment, unless otherwise specifically stated.
- (e) *Delegation of authority.* Any act authorized by this article to be carried out by the county administrator may be carried out by his or her designee.
- (f) *Usage.*
- (1) *Mandatory and discretionary terms.* The words "shall," "must," and "will" are mandatory in nature, establishing an obligation or duty to comply with the particular provision. The words "may" and "should" are permissive in nature.
  - (2) *Conjunctions.* Unless the context clearly indicates the contrary, conjunctions shall be interpreted as follows: The word "and" indicates that all connected items, conditions, provisions or events apply. The word "or" indicates that one or more of the connected items, conditions, provisions or events apply.
  - (3) *Tense, plurals, and gender words used in the present tense include the future tense.* Words used in the singular number include the plural number and the plural number includes the singular number, unless the context of the particular usage clearly indicates otherwise. Words used in the masculine gender include the feminine gender, and vice versa.
- (g) *Measurement and computation.* Lot area refers to the amount of horizontal land area contained inside the lot lines of a lot or site.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-506. Conflict of laws.**

This article is not intended to modify or repeal any other ordinance, rule, regulation or other provision of law. The requirements of this article are in addition to the requirements of any other ordinance, rule, regulation or other provision of law, and where any provision of this article imposes restrictions different from those imposed by any other ordinance, rule, regulation or other provision of law, whichever provision is more restrictive or imposes higher protective standards for human or environmental health, safety, and welfare, shall control.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

## **Sec. 99-507. Severability.**

If the provisions of any section, subsection, paragraph, subdivision or clause of this article shall be adjudged invalid by a court of competent jurisdiction, such judgment shall not affect or invalidate the remainder of any section, subsection, paragraph, subdivision or clause of this article.

( Ord. No. 2016/38 , 10-24-2016; Ord. No. 2021/04 , 1-11-2021)

**ORDINANCE 2021/**

**TEXT AMENDMENT TO THE STORMWATER MANAGEMENT UTILITY  
ORDINANCE AS ADOPTED SEPTEMBER 26<sup>TH</sup>, 2016 TO ADDRESS THE ADOPTION  
OF THE SOUTHERN LOWCOUNTRY DESIGN MANUAL**

**WHEREAS**, pursuant to the requirements mandated by the Municipal Separate Stormsewer System (MS4) permit issued by the South Carolina Department of Health and Environmental Control (DHEC) on December 1, 2015, Beaufort County is required to adopt standards related to Stormwater management and create a regulatory framework to enforce the same; and

**WHEREAS**, the Beaufort County Utility Board has approved the Southern Lowcountry Design Manual as the source of the technical stormwater standards used in the development of Stormwater Plans; and

**WHEREAS**, added text is underlined and deleted text is struck through.

**ADOPTED**, this \_\_\_\_ day of \_\_\_\_\_, 2021.

COUNTY COUNCIL OF BEAUFORT COUNTY

BY: \_\_\_\_\_  
Joseph Passiment, Chairman

ATTEST:

\_\_\_\_\_



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 8.

**ITEM TITLE:**

*Text Amendment to the Community Development Code (CDC): Section A.3.40 (Permitted Activities) to revise the Lady's Island Expanded Home Business district to include short-term rentals as a special use.*

**MEETING NAME AND DATE:**

*Natural Resources Committee Meeting, November 1, 2021*

**PRESENTER INFORMATION:**

*Juliana Smith, Long Range Planner, Beaufort County Planning and Zoning  
(10 minutes need for item discussion)*

**ITEM BACKGROUND:**

*This text amendment was considered by the Lady's Island Community Preservation Committee at their September 20, 2021 meeting. At that time, the Committee was not opposed to the amendment.*

*The Beaufort County Planning Commission considered this text amendment at their October 4, 2021 meeting. At that time, the Commission voted unanimously to recommend approval of the amendment.*

**PROJECT / ITEM NARRATIVE:**

*The applicant seeks to revise the Lady's Island Expanded Home Business district (LIEHB), a Community Preservation district, to include short-term rentals as an allowable special use. The applicant owns 160 Sam's Point Road, located in the LIEHB, and wishes to establish a short-term rental on the property. The property is currently residential.*

**FISCAL IMPACT:**

*Not applicable*

**STAFF RECOMMENDATIONS TO COUNCIL:**

*Staff recommends approval.*

**OPTIONS FOR COUNCIL MOTION:**

*To approve or deny the proposed amendment to the Community Development Code (CDC): Section A.3.40 (Permitted Activities) to revise the Lady's Island Expanded Home Business district to include short-term rentals as a special use.*

**ORDINANCE 2021 / \_\_**

**TEXT AMENDMENT TO THE COMMUNITY DEVELOPMENT CODE (CDC):  
SECTION A.3.40 (PERMITTED ACTIVITIES) TO REVISE THE LADY'S ISLAND  
EXPANDED HOME BUSINESS DISTRICT TO INCLUDE SHORT-TERM RENTALS AS  
A SPECIAL USE.**

**WHEREAS**, added text is highlighted in yellow and underlined.

Adopted this \_\_\_\_ day of \_\_\_\_\_ 2021.

COUNTY COUNCIL OF BEAUFORT COUNTY

By: \_\_\_\_\_  
Joseph Passiment, Chairman

ATTEST:

\_\_\_\_\_  
Sarah W. Brock, JD, Clerk to Council

### A.3.40 Permitted Activities

#### A.3.40 - Permitted Activities

The permitted, conditional, and special uses are listed in Table A.3.40.A. A use not listed in Table A.3.40.A may be permitted by the Director provided it is determined to be substantially similar to a listed use and complies with the purpose established for the LIEHB District. All other uses are prohibited.

Table A.3.40.A: Lady's Island Expanded Home Business Land Uses

Land Use	Use Definition	Use Permission
<b>Residential</b>		
Single-family detached	Detached dwelling unit intended for only one family. Includes any one-family dwelling unit, which complies with the codes used by the Beaufort County Building Codes office.	C
Single-family cluster	Two or more single-family detached residential uses in a subdivision, or on an individual lot that include, as part of the subdivision or lot design, significant common open space that meets the standards in Article 2, Division 2.8.	C
Traditional Community Plan	See Article 2, Division 2.3 (Traditional Community Plans)	C
Multifamily	A building containing two or more dwelling units, specifically permitting duplexes, mansion apartments, and apartment houses.	C
Accessory dwelling unit	A second dwelling unit, clearly subordinate to the principal unit, either in or added to an existing single-family detached dwelling, or in a separate accessory structure on the same lot as the main dwelling, for use as a complete, independent living facility. Maximum building size shall not exceed 50 percent of the principal unit's floor area.	P
Family compound	Form of traditional rural development which provides affordable housing for family members allowing additional family dwelling units on, and/or subdivisions of, a single lot owned by the same family for at least 50 years (see Article 2, Section 2.7.40).	C
Group home	Residential facility for nine or fewer mentally or physically handicapped persons providing care on a 24-hour basis and licensed by a state agency or department,	P

	or is under contract with a state agency or department, for that purpose.	
Home-based business	A business, profession, or trade operated out of a single-family residence and/or accessory structures. The employment of up to three unrelated individuals including independent contractors operating from the facility, but not including farm workers is permitted.	C
<b>Retail and Restaurants</b>		
Gas-convenience marts with no repair bays or facilities	There is no towing, vehicle body and engine repair, painting, or exterior overnight vehicle storage permitted with this use. Single-bay car washes associated with a gas convenience mart are permitted (NAICS 811191, 811192).	S
<b>Offices and Services</b>		
Administrative support services	Activities that provide supporting services for businesses located in another location. No outside storage or vehicle parking is permitted with the exception of parking for office staff and clients.	P
Ambulatory health care services	Provide health care services directly or indirectly to ambulatory and do not usually provide inpatient services. Facilities and equipment are not usually the most significant part of the services. Offices of doctors, dentists, chiropractors, optometrists, and mental health practitioners (NAICS 621).	P
Day care, family	A facility in a private home that is operated by one or more persons duly licensed or qualified to be licensed by the state for the purpose of providing child day care for one to not more than eight children at any one time, who are not relatives of the day care provider (NAICS 62441).	P
Day care, commercial	All day care facilities not classified as "day care, family" and including more than eight children (NAICS 62441).	C
<b>Lodging: Short-Term Housing Rental (STHR)</b>	<u>A property with a residential dwelling where lodging is offered, advertised, or provided to Short-Term Rental Tenants (excluding family members) for a fee or any form of compensation with individual rental terms not exceeding 29 consecutive days. See specific use regulations in Article 4.1.360</u>	<b>S</b>
Personal and professional services	This category includes broker and investment services (NAICS 523), caterers (NAICS 72232), commercial day care (NAICS 6244), educational services (NAICS 611),	P

	electronic and computer repair (NAICS 8112), insurance agents and brokers (NAICS 524, 525), internet service providers (NAICS 518), personal and household goods repair (NAICS 8114), personal care (NAICS 812111, 812112, and 812113), professional and technical services (NAICS 5417), real estate services (NAICS 5312).	
<b>Recreation, Education, Safety, Public Assembly</b>		
Civic and social organizations	Establishments primarily engaged in promoting social welfare activities such as educational, scientific, cultural and health (NAICS 8132-34).	P
Religious establishments (small)	Establishments engaged in operating religious organizations, such as churches, religious temples and /or establishments primarily engaged in administering an organized religion or promoting religious activities with no schools (except Sunday schools occupying no more than 50 percent of the floor area) as part of the complex and having less than 15,000 square feet of floor area.	P
Religious establishments (large)	Establishments engaged in operating religious organizations, such as churches, religious temples and /or establishments primarily engaged in administering an organized religion or promoting religious activities with or without schools (except Sunday schools occupying no more than 50 percent of the floor area) as part of the complex and having 15,000 or greater square feet of floor area (NAICS 813110).	S
Schools, neighborhood (elementary and middle schools) and community (high schools)	Institutions of learning or instruction primarily catering to minors, whether public or private, which are licensed by either the county or the State of South Carolina. The definition includes nursery schools, kindergarten, elementary schools, middle schools, senior high schools or any special institution of learning under the jurisdiction of the state department of education catering to those age groups. This does not include charm schools, dancing schools, music schools or similar limited schools (NAICS 6111).	S
<b>Infrastructure, Transportation, Communications</b>		
Local utility	Utility substations or transmission and local distribution facilities, including telephone, and all government-owned utilities. Not included are generation facilities, storage of combustibles, regional facilities, and landfills or mining operations. (NAICS 221122, 22121)	S



Temporary Uses		
Construction staging or plant	A concrete or asphalt batch plant, or metal forming and cutting facility assembled on the site or located no more than one mile from the site where the construction of a particular road, infrastructure or building is to take place. Such facilities shall be removed within one year.	S
Contractor's office	Security guard buildings and structures, construction equipment sheds, contractor's trailers and similar uses incidental to a construction project.	P
Model homes sales office	A dwelling unit or modular unit in a subdivision used as a sales office for that subdivision.	P
Traditional Community Plan Uses		
General Retail 3,500 SF or less	Stores and shops that sell and/or rent goods and merchandise to the general public. This category does not include "Open Air Retail," "Vehicle Sales and Rental," or "Gas Stations/Fuel Sales."	TCP
Animal Services: Clinic/Hospital	An establishment used by a veterinarian where animals are treated. This use may include boarding and grooming as accessory uses.	TCP
Lodging: Bed & Breakfast (5 rooms or less)	The use of a single residential structure for commercial lodging purposes, with up to 5 guest rooms used for the purpose of lodging transient guests and in which meals may be prepared for them, provided that no meals may be sold to persons other than such guests, and where the owner resides on the property as his/her principal place of residence.	TCP
Lodging: Inn (up to 24 rooms)	A building or group of buildings used as a commercial lodging establishment having up to 24 guest rooms providing lodging accommodations to the general public. This includes the use of any dwelling unit for lodging accommodations on a daily or weekly rate to the general public.	TCP
Restaurant, Café, Coffee Shop	A retail business selling ready-to-eat food and/or beverages for on- or off-premise consumption. These include eating establishments where customers are served from a walk-up ordering counter for either on- or off-premise consumption ("counter service"); and establishments where customers are served food at their tables for on-premise consumption ("table service"), that may also provide food for take-out, but does not include drive-through services, which are separately defined and regulated. This use includes all mobile kitchens.	TCP

Community Oriented Cultural Facility (less than 15,000 SF)	Public or non-profit facilities that provide educational and cultural experiences for the general public, examples of which include: aquariums, arboretums, art galleries, botanical gardens, libraries, museums, planetariums, civic centers and theaters predominantly used for live performances, and zoos. May also include accessory retail uses such as a gift/book shop, restaurant, etc.	TCP
Single-Family attached	A structure containing one dwelling unit on a single lot and connected along a property line to another dwelling unit on an adjoining lot by a common wall or other integral part of the principal building such as a breezeway or carport.	TCP
Live/Work	An integrated housing unit and working space, occupies by a single household. Commercial activities are limited to those listed in this table.	TCP
Community Residence (dorms, convents, assisted living, temporary shelters)	See definition in Article 8, Table 3.1.70	TCP
<p>"P" indicates a Use that is Permitted By Right.</p> <p>"C" indicates a Use that is Permitted with Conditions.</p> <p>"S" indicates a Use that is Permitted as a Special Use.</p> <p>"TCP" indicates a Use that is permitted only as part of a Traditional Community Plan under the requirements in Division 2.3</p>		



**To:** Beaufort County Natural Resources Committee

**From:** Juliana Smith, Long Range Planner, Department of Planning and Zoning

**Subject:** Text Amendment to the Community Development Code (CDC): Section A.3.40 (Permitted Activities) to revise the Lady's Island Expanded Home Business district to include short-term rentals as a special use.

**Date:** November 1, 2021

---

**STAFF REPORT:**

**Case No.** ZTA 2021-03

**Owner/Applicant:** Mary E. Moyd

**Proposed Text Change:** Text Amendment to the Community Development Code (CDC): Section A.3.40 (Permitted Activities) to revise the Lady's Island Expanded Home Business district to include short-term rentals as a special use.

**A. SUMMARY OF REQUEST:** The applicant seeks to revise the Lady's Island Expanded Home Business district (LIEHB), a Community Preservation district, to include short-term rentals as an allowable special use. The applicant owns 160 Sam's Point Road, located in the LIEHB, and wishes to establish a short-term rental on the property. The property is currently residential.

**B. SUMMARY OF PROPOSED AMENDMENT:** The amendment currently under consideration would permit short-term rentals as a special use in the LIEHB. The purpose of the LIEHB, a mixed-use district, is to provide areas that are conducive to the establishment and convenience of small-scale office, service, and civic uses, in addition to a variety of residential land uses. Nonresidential uses in the LIEHB are required to blend into the residential character of the area. Currently, two lodging uses are allowed within Traditional Community Plans in the LIEHB: Bed and Breakfast (5 rooms or less) and Inn (up to 24 rooms).

The LIEHB flanks the Sam's Point Road corridor from Miller Drive to the traffic circle on Lady's Island (see attached map). Current conditions on this portion of the corridor are primarily commercial, except for two PUDs that front the corridor: Oyster Bluff and Newpoint.

Per Ordinance 2020-32, robust short-term rental standards were established in the Community Development Code. At the time of adoption, the short-term rental use was added as a special use to all transect and conventional zones except for T1 Natural Preserve and S1 Industrial. The special use was not added to any of the Community Preservation districts; however, LIEHB is consistent with transect zone districts that allow short-term rentals.

Considering the current conditions of the corridor, the current conditions on the Applicant’s property, and the intent of the LIEHB and its consistency with transect zones that allow short-term rentals, the addition of short-term rentals as a special use to this district is appropriate.

During their September 20, 2021 meeting, the Lady’s Island Community Preservation Committee reviewed the proposed amendment to the LIEHB to include short-term rentals as a special use and were not opposed to the amendment. If adopted, any property owner in the LIEHB seeking to use the short-term rental use will have to apply to the Zoning Board of Appeals for approval.

**C. TEXT AMENDMENT REVIEW STANDARDS:** In determining whether to adopt or deny a proposed Text Amendment, the County Council shall weigh the relevance of and consider whether, and the extent to which, the proposed amendment:

**1. Is consistent with the goals, objectives, and policies of the Comprehensive Plan;**

The proposed text amendment is consistent with the Comprehensive Plan, which envisions this area to be Neighborhood Mixed Use.

**2. Is not in conflict with any provision of this Development Code, or the Code of Ordinances;**

In the LIEHB, the permitted office, service and civic activities tend to produce relatively low volume traffic and may maintain compatibility with nearby residential uses. Compatibility is further accomplished by limiting building size and scale; strict architectural and land use controls; excluding commercial retail uses; beneficent buffer and setback standards; encouraging home uses; and establishing development standards that reflect present patterns. The short-term rental use is not in conflict with this Development Code or the Code of Ordinances.

**3. Is required by changed conditions;**

Per Ordinance 2020-32, short-term rental standards were established as a special use in the Community Development Code within transect and conventional zones. These standards were not added to Community Preservation Districts.

**4. Addresses a demonstrated community need;**

N/A

**5. Is consistent with the purpose and intent of the zones in this Development Code, or would improve compatibility among uses and ensure efficient development within the County;**

See 2 above.

**6. Would result in logical and orderly development pattern;**

As a special use, each applicant seeking to establish a short-term rental property in the LIEHB will be required to apply to the Zoning Board of Appeals for approval. In addition to typical considerations, the Zoning Board of Appeals (ZBOA) may also establish an appropriate rental limit as a condition of approval after conducting the public hearing and finding that conditions exist making such a limitation necessary for short-term rental applications.

**7. Would not result in adverse impacts on the natural environment, including but not limited to water, air, noise, stormwater management, wildlife, vegetation, wetlands, and the natural functioning of the environment;**

See 6 above.

**D. STAFF RECOMMENDATION:** Staff recommends approval.

**E. BEAUFORT COUNTY PLANNING COMMISSION RECOMMENDATION:** At the October 4, 2021 meeting of the Beaufort County Planning Commission, the Commission voted unanimously to recommend approval of the proposed text amendment.

**F. ATTACHMENTS:**

- Revised LIEHB district use table.
- Map of LIEHB district.

**A.3.40 Permitted Activities**

**A.3.40 - Permitted Activities**

The permitted, conditional, and special uses are listed in Table A.3.40.A. A use not listed in Table A.3.40.A may be permitted by the Director provided it is determined to be substantially similar to a listed use and complies with the purpose established for the LIEHB District. All other uses are prohibited.

Table A.3.40.A: Lady's Island Expanded Home Business Land Uses		
Land Use	Use Definition	Use Permission
<b>Residential</b>		
Single-family detached	Detached dwelling unit intended for only one family. Includes any one-family dwelling unit, which complies with the codes used by the Beaufort County Building Codes office.	C
Single-family cluster	Two or more single-family detached residential uses in a subdivision, or on an individual lot that include, as part of the subdivision or lot design, significant common open space that meets the standards in Article 2, Division 2.8.	C
Traditional Community Plan	See Article 2, Division 2.3 (Traditional Community Plans)	C
Multifamily	A building containing two or more dwelling units, specifically permitting duplexes, mansion apartments, and apartment houses.	C
Accessory dwelling unit	A second dwelling unit, clearly subordinate to the principal unit, either in or added to an existing single-family detached dwelling, or in a separate accessory structure on the same lot as the main dwelling, for use as a complete, independent living facility. Maximum building size shall not exceed 50 percent of the principal unit's floor area.	P
Family compound	Form of traditional rural development which provides affordable housing for family members allowing additional family dwelling units on, and/or subdivisions of, a single lot owned by the same family for at least 50 years (see Article 2, Section 2.7.40).	C
Group home	Residential facility for nine or fewer mentally or physically handicapped persons providing care on a 24-hour basis and licensed by a state agency or department, or is under contract with a state agency or department, for that purpose.	P

Home-based business	A business, profession, or trade operated out of a single-family residence and/or accessory structures. The employment of up to three unrelated individuals including independent contractors operating from the facility, but not including farm workers is permitted.	C
<b>Retail and Restaurants</b>		
Gas-convenience marts with no repair bays or facilities	There is no towing, vehicle body and engine repair, painting, or exterior overnight vehicle storage permitted with this use. Single-bay car washes associated with a gas convenience mart are permitted (NAICS 811191, 811192).	S
<b>Offices and Services</b>		
Administrative support services	Activities that provide supporting services for businesses located in another location. No outside storage or vehicle parking is permitted with the exception of parking for office staff and clients.	P
Ambulatory health care services	Provide health care services directly or indirectly to ambulatory and do not usually provide inpatient services. Facilities and equipment are not usually the most significant part of the services. Offices of doctors, dentists, chiropractors, optometrists, and mental health practitioners (NAICS 621).	P
Day care, family	A facility in a private home that is operated by one or more persons duly licensed or qualified to be licensed by the state for the purpose of providing child day care for one to not more than eight children at any one time, who are not relatives of the day care provider (NAICS 62441).	P
Day care, commercial	All day care facilities not classified as "day care, family" and including more than eight children (NAICS 62441).	C
<b>Lodging: Short-Term Housing Rental (STHR)</b>	<b>A property with a residential dwelling where lodging is offered, advertised, or provided to Short-Term Rental Tenants (excluding family members) for a fee or any form of compensation with individual rental terms not exceeding 29 consecutive days. See specific use regulations in Article 4.1.360</b>	<b>S</b>
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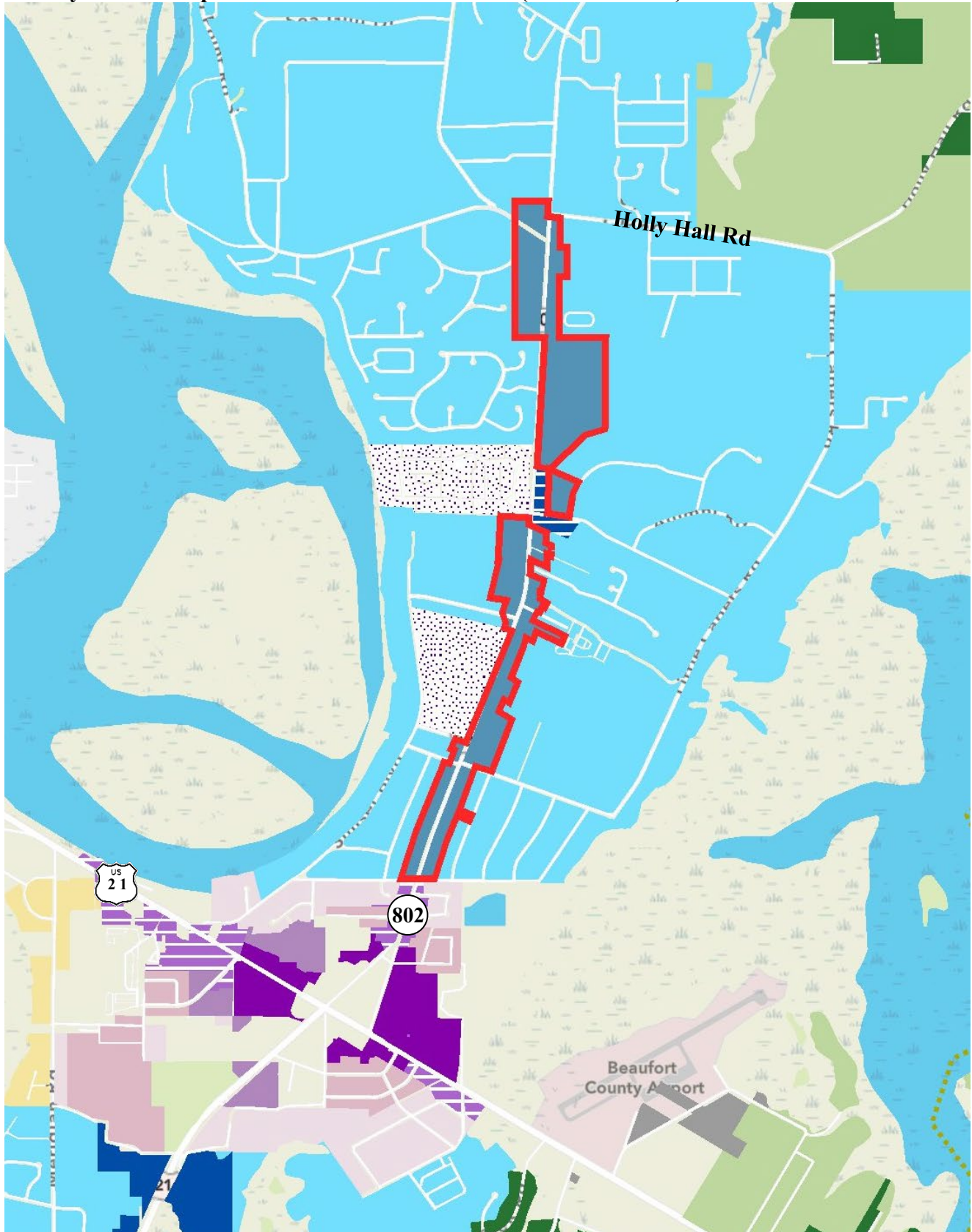
	household goods repair (NAICS 8114), personal care (NAICS 812111, 812112, and 812113), professional and technical services (NAICS 5417), real estate services (NAICS 5312).	
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**Lady’s Island Expanded Home Business District (outlined in red)**





## Beaufort County Council Statement of Conflict of Interest Pursuant to South Carolina Code of Laws § 8-13-700

I, PAUL SONNENBLUM, holding the position as a Beaufort County Council Member, do hereby declare my potential conflict of interest with regards to the below information:

1. Describe the matter pending before County Council with which you may have a conflict of interest: FIRST READING OF A TEXT AMENDMENT OF THE  
CODE REGARDING SHORT TERM RENTALS ON LOTS  
15 LAND

2. Describe the interest that you have that may give rise to the conflict: I OWN A HOUSE IN THE AFFLICK DISTRICT

Based upon the above information, I hereby recuse myself from participating in any discussions of or taking official action relating to said matter.

Signed this 8<sup>TH</sup> day of NOVEMBER, 2021.

  
Signature



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 9.

**ITEM TITLE:**

Adoption of Buckwalter Access Management Plan

**MEETING NAME AND DATE:**

Public Facilities Committee – October 18, 2021

**PRESENTER INFORMATION:**

Jared Fralix, Assistant County Administrator - Engineering  
(5 mins)

**ITEM BACKGROUND:**

In 2007, Beaufort County adopted the Buckwalter Parkway Access Management Study in Ordinance 2008/17 amending the Zoning and Development Standards regarding access management standards for Buckwalter Parkway and Bluffton Parkway, respectively. As this access management plan is 13 years old, Beaufort County procured Bihl Engineering to analysis the corridor from US 278 just short of Bluffton Parkway and update the plan.

**PROJECT / ITEM NARRATIVE:**

Bihl Engineering has identified access management needs and updates to the corridor.

**FISCAL IMPACT:**

N/A

**STAFF RECOMMENDATIONS TO COUNCIL:**

Adopt the Buckwalter Access Management Plan by amending Ordinance 2008/17.

**OPTIONS FOR COUNCIL MOTION:**

Motion to approve/deny adopting the Buckwalter Access Management Plan by amending Ordinance 2008/17.  
*Next Step: Move forward to County Council to adopt the Buckwalter Access Management Plan by amending Ordinance 2008/17.*

*Access Management Plan Update*

**Buckwalter Parkway  
(US 278 to Bluffton Parkway)  
Beaufort County, SC**

*Prepared for:*  
**Beaufort County**

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**Access Management Plan Update – Buckwalter Parkway (US 278 to Bluffton Parkway)  
Beaufort County, South Carolina**

**Prepared for:  
Beaufort County**

**Prepared by:  
Bihl Engineering, LLC  
306 Meeting Street, Suite 300  
Charleston, SC 29401  
Mail:  
P.O. Box 31318  
Charleston, SC 29417  
(843) 637-9187**

**October 2021**

**TABLE OF CONTENTS**

	<b><u>Page No.</u></b>
<b>1.0 EXECUTIVE SUMMARY .....</b>	<b>1</b>
<b>2.0 INTRODUCTION .....</b>	<b>4</b>
<b>3.0 EXISTING CONDITIONS.....</b>	<b>4</b>
3.1 STUDY AREA.....	4
3.2 EXISTING ROADWAY CONDITIONS .....	5
3.3 AADT DATA.....	6
3.4 TURNING MOVEMENT COUNTS .....	6
3.5 WETLANDS .....	8
3.6 PREVIOUS ACCESS MANAGEMENT STUDY (2007) .....	8
3.7 COMMUNITY DEVELOPMENT CODE .....	9
3.8 CRASH ANALYSIS .....	10
3.9 EXISTING LEVEL OF SERVICE ANALYSIS - INTERSECTIONS .....	11
<b>4.0 FUTURE/PLANNED CONDITIONS.....</b>	<b>14</b>
4.1 LATS MODEL – LRTP AND 2040 DAILY TRAFFIC VOLUMES.....	14
4.2 PLANNED DEVELOPMENTS .....	14
4.3 DEVELOPMENTS SUBMITTED FOR CONSIDERATION .....	14
4.4 YEAR 2030 PROJECTED TRAFFIC VOLUMES.....	15
<b>5.0 BENEFITS OF ACCESS MANAGEMENT .....</b>	<b>16</b>
<b>6.0 ACCESS MANAGEMENT PLAN .....</b>	<b>17</b>
6.1 SIGNALIZED INTERSECTION SPACING.....	17
6.2 SCENARIO ADVANTAGES.....	19
6.3 CONNECTIONS AND CROSS ACCESS OPPORTUNITIES .....	19
6.4 SUMMARY .....	20
6.5 NEXT STEPS .....	22

**LIST OF TABLES**

Table 1: Comparison of Traffic Control by Scenario.....	2
Table 2: SCDOT Average Annual Daily Traffic (AADT) Counts by Year .....	7
Table 3: Angle Crashes by Location.....	11
Table 4: Level of Service and Delay – 2021 Conditions .....	13
Table 5: Level of Service and Delay – 2030 Scenario 2 Conditions .....	15
Table 6: Average Crash Rates by Different Ranges of Traffic Signal Densities .....	17
Table 7: Signalized Intersection Spacing by Scenario .....	18



## 1.0 Executive Summary

An access management plan was established in 2007 and further codified in Beaufort County's *Community Development Code* for the Buckwalter Parkway corridor in the Town of Bluffton, located in Beaufort County, South Carolina. Since the establishment of that plan, significant development has occurred along the Buckwalter Parkway corridor. As noted in the *Community Development Code*, there was a need to review and update the 2007 plan based on the current conditions of the corridor and to determine the most appropriate access management plan for the corridor intersections based on the existing and planned developments, existing and future traffic patterns, and crash history.

The corridor for this access management plan update extends from US 278 to Bluffton Parkway. The location of the corridor is shown in **Figure 1 (Appendix)**. The municipal boundaries for the Town of Bluffton along the corridor are shown in **Figure 2 (Appendix)** based on Beaufort County GIS.

Two scenarios were reviewed: the access points recommended in the 2007 plan (Scenario 1) and an updated access management plan (Scenario 2) which adjusts the access points to better fit intersection spacing goals and current development patterns.

The following key points and assumptions, which are based on coordination with Town and County staff, were applied in the analysis:

- It is unlikely that an eastern connection from Ludlow Street to the Woodside neighborhood shown in the 2007 Access Management Plan is feasible based on the current development patterns and the locations of wetlands
- Approximately 2,000 foot spacing between signalized intersections is desired along the corridor
- North-south connectivity is desired between parcels along Buckwalter Parkway
- Future connections to the Willow Run development and the new north-south roadway that connects to US 278 at Eagles Point should be included in the study

Based on a review of the corridor and the associated data, the recommended access management plan is shown in **Figures 3A and 3B (Appendix)** and the access locations are listed below by type of access.

- Signalized Intersection Access
  - Buckwalter Place Boulevard/Lord of Life Driveway (existing)
- Signalized Intersection Access (when warranted)
  - Berkeley Place Driveway #1/Pinellas Drive North (roadway improvements will be required)
  - Mott Street/Parkside Drive
  - Kroger Fuel Driveway
- Full Unsignalized Intersection Access
  - Cassidy Drive (existing)

- Right-in, right-out Intersection Access
  - Berkeley Place Driveway #2/Pinellas Drive South
  - Ludlow Street
  - Innovation Drive
  - Progressive Street (existing)
- Right-in only Intersection Access
  - Buckwalter Place Driveway (existing)

**Table 1** shows a comparison of the access management between the two scenarios.

<b>Table 1: Comparison of Traffic Control by Scenario<sup>1</sup></b>		
<b>Location</b>	<b>Scenario 1 – 2007 Plan</b>	<b>Scenario 2 – 2021 Proposed Plan</b>
US 278	Existing Signal	Existing Signal
Cassidy Drive	Undefined Unsignalized Access	Right-in, Right-out
Pinellas Drive N	Undefined Unsignalized Access	Proposed Signalization, when warranted
Pinellas Drive S	Proposed Signalization, when warranted	Right-in, Right-out
Mott St./Parkside Dr.	Undefined Unsignalized Access	Proposed Signalization, when warranted
Ludlow St.	Proposed Signalization, when warranted	Right-in, Right-out
Kroger Fuel Driveway	Right-in, Right-out	Proposed Signalization, when warranted
Innovation Dr.	Proposed Signalization, when warranted	Right-in, Right-out
Progressive Dr.	Right-in, Right-out	Right-in, Right-out
Buckwalter Place Blvd./Lord of Life Dwy.	Existing Signal	Existing Signal
Buckwalter Place Dwy.	Right-in Only	Right-in Only

<sup>1</sup>Roadway improvements may be required at all locations in both scenarios

In the proposed access management plan update (Scenario 2), all intersections are projected to operate at LOS D or better (assuming the planned intersections are signalized). Signalization implementation would be based on the intersections meeting traffic signal warrants.

In addition, this plan recommends the previously planned and new roadway connection improvements along the corridor. These are shown in **Figures 3A and 3B (Appendix)** as dashed lines. The exact location and design of these connection are conceptual in nature and are expected to be refined in the design process.

- New roadway between US 278 and Berkeley Place Driveway 1 on the west side of Buckwalter Parkway
- New east-west roadway from Cassidy Drive to the future Willow Run development and the planned north/south roadway that will connect future Bluffton Parkway to US 278 near Eagle's Pointe
- New north-south roadway between Cassidy Drive and Pinellas Drive North
- New east-west roadway from Pinellas Drive North to the future Willow Run development and the planned north/south roadway that will connect future Bluffton Parkway to US 278 near Eagle's Pointe
- Realignment and installation of new Berkeley Place Driveway 1, connecting to the Berkeley Place parking area further west and removing the existing curve and parking lot connection
- New east-west roadway from Pinellas Drive South to the future Willow Run development and the planned north/south roadway that will connect future Bluffton Parkway to US 278 near Eagle's Pointe
- New north-south roadway between Pinellas Drive South and Parkside Drive
- Complete north-south connection between Berkeley Place and Bluffton Commons
- New north-south roadway between Innovation Drive and Bluffton Commons
- Conversion of Kroger Fuel Center Drive to full access intersection and installation of a new east-west roadway connecting to the new north-south access roads parallel to Buckwalter Parkway
- New north-south access roadway on the east side of Buckwalter Parkway, connecting the new Kroger Fuel Center Drive intersection and Buckwalter Towne Boulevard
- New connector between Lord of Life Church Road and new north-south access road
- Relocation of intersection of Bluffton Parkway at Buckwalter Parkway intersection (by others)

This study area on Buckwalter Parkway extends to just before Bluffton Parkway (north) signalized intersection. The recommended signalized intersection spacing goal of approximately 2,000 feet between signalized intersections should be applied for the remainder of Buckwalter Parkway to SC 46, as appropriate, to maximize the efficiency of the corridor. This spacing should be reviewed, and the exact locations of these signalized intersections should be studied further as projects develop in the remaining section of the Buckwalter Parkway corridor.

## 2.0 Introduction

An access management plan was established in 2007 for the Buckwalter Parkway corridor in the town of Bluffton, located in Beaufort County, South Carolina. This plan was further codified in the Beaufort County *Community Development Code*. Since the establishment of the access management plan, significant development has occurred along the Buckwalter Parkway corridor. There was a need to review and update the 2007 plan based on the current conditions of the corridor and determine the most appropriate access management plan for the corridor intersections based on the existing and planned developments, existing and future traffic patterns, and crash history.

The corridor extends from US 278 to Bluffton Parkway. The location of the corridor is shown in **Figure 1 (Appendix)**. The municipal boundaries for the Town of Bluffton along the corridor are shown in **Figure 2 (Appendix)** based on Beaufort County GIS.

## 3.0 Existing Conditions

The following section discusses the study area, existing roadway conditions, annual average daily traffic (AADT) data, turning movement counts, previous studies, area roadway projects, and crash analysis for the access management plan.

### 3.1 Study Area

The access management plan study area includes the following existing intersections.

- Buckwalter Parkway at Cassidy Drive
- Buckwalter Parkway at Pinellas Drive North/Berkeley Place Driveway #1
- Buckwalter Parkway at Pinellas Drive South/Berkeley Place Driveway #2
- Buckwalter Parkway at Parkside Drive/Mott Street
- Buckwalter Parkway at Ludlow Street
- Buckwalter Parkway at Kroger Fuel Center Drive
- Buckwalter Parkway at Innovation Drive
- Buckwalter Parkway at Progressive Street
- Buckwalter Parkway at Buckwalter Place Boulevard/Lord of Life Church Driveway
- Buckwalter Parkway at Buckwalter Place Driveway

Existing laneage at the study area intersections is shown in **Figure 4 (Appendix)**.

### 3.2 Existing Roadway Conditions

The study area includes South Carolina Department of Transportation (SCDOT), Beaufort County, Town of Bluffton, and privately owned roadways/driveways.

#### 3.2.1 Study Area Roadways

The following section provides descriptions of the roadways in the study area.

US 278 (Fording Island Road) – US 278 is a six-lane, divided, principal arterial roadway with a grass median and a posted speed limit of 55 miles per hour (mph). Per SCDOT counts, US 278 had a 2019 Annual Average Daily Traffic (AADT) of 48,000 vehicles per day (vpd) within the study area.

Buckwalter Parkway – Buckwalter Parkway is a four-lane, divided, minor arterial with a landscaped median and a posted speed limit of 45 mph. Per SCDOT counts, Buckwalter Parkway had a 2019 AADT of 15,600 vpd between US 278 and Bluffton Parkway and a 2019 AADT of 19,100 vpd south of Bluffton Parkway.

Bluffton Parkway – Bluffton Parkway is a four-lane, divided, minor arterial with a landscaped median and a posted speed limit of 45 mph. Per SCDOT counts, Bluffton Parkway had a 2019 AADT of 17,400 vpd within the study area.

Cassidy Drive – Cassidy Drive is a three-lane, undivided roadway that provides access to the Vineyard Assisted Living & Memory Care facility.

Pinellas Drive – Pinellas Drive is a two-lane roadway that provides access to commercial development. Pinellas Drive intersects Buckwalter Parkway in two locations: once across from Berkeley Place Driveway #1 and again across from Berkeley Place Driveway #2.

Berkeley Place Driveway #1 – Berkeley Place Driveway #1 is a two-lane driveway providing access to the Berkeley Place shopping center. Berkeley Place Driveway #1 is across from Pinellas Drive North at its intersection with Buckwalter Parkway. The throat distance of the existing intersection is 30 feet between the stop bar and the beginning of the sharp curve into the Berkeley Place Shopping Center.

Berkeley Place Driveway #2 – Berkeley Place Driveway #2 is a two-lane driveway providing access to the Berkeley Place shopping center. Berkeley Place Driveway #2 is across from Pinellas Drive South at its intersection with Buckwalter Parkway.

Mott Street – Mott Street is a two-lane, divided roadway for the Bluffton Commons development.

Parkside Drive – Parkside Drive is a two-lane roadway with a posted speed limit of 25 mph that provides access for the Woodbridge community. Parkside Drive is across from Mott Street at its intersection with Buckwalter Parkway.

Ludlow Street – Ludlow Street is a two-lane, divided roadway for the Bluffton Commons development. Due to adjacent wetlands on the east side of the road where Ludlow Street would cross Buckwalter Parkway in the future. The new approach to this intersection would have a short throat distance.

Kroger Fuel Driveway – The Kroger Fuel Driveway is a two-lane driveway with right-in right-out (RIRO) access at its intersection with Buckwalter Parkway.

Innovation Drive – Innovation Drive is a two-lane driveway for the Buckwalter Place shopping center.

Progressive Street – Progressive Street is a two-lane driveway for the Buckwalter Place shopping center. Progressive Street is a RIRO access point at its intersection with Buckwalter Parkway.

Buckwalter Place Boulevard – Buckwalter Place Boulevard is a four-lane, divided roadway with a landscaped median. Buckwalter Place Boulevard is the main entrance for the Buckwalter Place shopping center and is signalized at its intersection with Buckwalter Parkway.

Lord of Life Church Driveway – Lord of Life Church Driveway is a two-lane driveway for the Lord of Life Lutheran Church. Lord of Life Church Driveway is across from Buckwalter Place Boulevard at its intersection with Buckwalter Parkway.

Buckwalter Place Driveway – Buckwalter Place Driveway is a one-lane, one-way entrance driveway for the Buckwalter Place shopping center.

### 3.3 AADT Data

**Table 2** shows the SCDOT annual average daily traffic (AADT) volumes and percent growth per year on the study area roadways from 2011-2019.

The 8-year historic growth rates along the corridor ranged from 1.5% to 6% per year. The 3-year growth rate along the corridor was approximately 0% to 4% per year.

### 3.4 Turning Movement Counts

Peak hour intersection turning movement counts including vehicular, pedestrian, and heavy vehicle traffic were performed in May 2021 from 7:00 AM to 9:00 AM and from 4:00 PM to 6:00 PM at the following intersections:

- Buckwalter Parkway at Cassidy Street
- Buckwalter Parkway at Pinellas Drive North/Berkeley Place Driveway #1
- Buckwalter Parkway at Pinellas Drive South/Berkeley Place Driveway #2
- Buckwalter Parkway at Innovation Drive
- Buckwalter Parkway at Progressive Street
- Buckwalter Parkway at Buckwalter Place Boulevard

<b>Table 2:</b> <b>SCDOT Average Annual Daily Traffic (AADT) Counts by Year</b>												
Roadway	Road Section		Year									% Growth /Year
	Start	End	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Buckwalter Parkway	US 278	Buckwalter Towne Boulevard	9,800	8,700	8,900	8,100	12,200	13,900	13,400	14,100	15,600	6.0%
Buckwalter Parkway	Buckwalter Towne Boulevard	Bluffton Parkway	16,900	16,600	16,900	15,300	17,700	19,400	20,000	21,000	19,100	1.5%

Source: SCDOT traffic count data

Due to the COVID-19 pandemic, traffic volumes and travel patterns have been impacted. All turning movements collected in May 2021 were adjusted using adjustment factors of 1.15 and 1.02 for the AM and PM peak hours, respectively, as stated in the SCDOT District 6 *Traffic Impact Analyses during COVID-19 Pandemic (Update)* memorandum (February 5, 2021). These adjusted traffic volumes were used in the Existing conditions analysis.

Existing peak hour intersection turning movement volumes are shown on **Figure 5 (Appendix)**. The turning movement count data is included in the **Appendix**.

Additional turning movement counts were collected in January 2021 at the following intersections:

- Buckwalter Parkway at Parkside Drive/Mott Street
- Buckwalter Parkway at Ludlow Street

Due to the COVID-19 pandemic, traffic volumes and travel patterns have been impacted. All turning movements collected in January 2021 were adjusted using adjustment factors of 1.19 and 1.13 for the AM and PM peak hours, respectively, as stated in the SCDOT District 6 *Traffic Impact Analyses during COVID-19 Pandemic* memorandum (September 28, 2020). These adjusted traffic volumes were used in the Existing conditions analysis.

### 3.5 Wetlands

Based on the available data in the Beaufort County GIS, **Figure 6 (Appendix)** shows the wetlands along the corridor. The locations of the wetlands should be considered when reviewing potential connectivity of developments along the corridor.

### 3.6 Previous Access Management Study (2007)

The *Access Management Plan: Buckwalter Parkway (Appendix)* was performed by SRS Engineering in 2007 and is incorporated into the *2010 Beaufort County Comprehensive Plan*. The results of that study are shown in **Figure 7**. The study area for the report was the northern segment of Buckwalter Parkway from US 278 to Bluffton Parkway. The purpose of the report was to review the future developments that were planned to access Buckwalter Parkway and to determine appropriate locations for signalized access points based on these future developments and the Bluffton Parkway Phase 4 roadway project.

The report looked at a future year of 2025 and analyzed the level of service for signalized intersections for two different alternatives. It was recommended that signalized intersections be located at Cinema South (now Pinellas Drive South/Berkeley Place Driveway #2), Sea Turtle South (now Ludlow Street), and Buckwalter Town Center North (now Innovation Drive).



The following additional connections were recommended in the plan:

- New roadway connecting US 278 and the west side of Buckwalter Parkway in the vicinity of Pinellas Drive North
- Connection between the Berkeley Place development and Bluffton Commons development
- New roadway from Pinellas Drive North to the future Willow Run development and the new north/south roadway planned by others connecting future Bluffton Parkway to US 278 in the vicinity of Eagle's Point
- New roadway from Pinellas Drive South to the future Willow Run development and the new north/south roadway planned by others connecting future Bluffton Parkway to US 278 in the vicinity of Eagle's Point

### 3.7 Community Development Code

The *Community Development Code* further identifies the access management along Buckwalter Parkway from US 278 to SC 46.

The intersection spacing along the Buckwalter Parkway corridor is recommended to be 2,000 feet between signalized intersections.

The *Community Development Code* outlines three conditions that shall be satisfied if the signalized access locations are desired to be changed.

- “The modified location must meet the warrants for signalization with the proposed development as defined in the Manual on Uniform Traffic Control Devices (MUTCD) by the Federal Highway Administration (FHWA) with the analysis and specific application of traffic signal warrants to be approved by the Beaufort County traffic engineer.”
- “The modified location must provide adequate spacing (as defined in the spacing standards indicated above) from existing traffic signals, programmed traffic signals, and future signalization of primary roadway intersections, including:
  - Buckwalter Parkway at US 278
  - Buckwalter Parkway at Cinema South (2,800 feet south of US 278)
  - Buckwalter Parkway at Sea Turtle South (2,050 feet south of Cinema South)
  - Buckwalter Parkway at Buckwalter Town Center South (2,550 feet south of Cinema South)
  - Buckwalter Parkway at Bluffton Parkway and the Townes of Buckwalter (this signal will be relocated once Phase 5b of the Bluffton Parkway is completed)
  - Buckwalter Parkway at Bluffton Parkway and Hampton Hall
  - Buckwalter Parkway at H.E. McCracken Circle and Old Bridge Drive
  - Buckwalter Parkway at SC 46 (May River Road)”
- “The future signalized intersection location shall not have an adverse impact on existing or future LOS based on comparative analysis of conditions with the recommended signal locations indicated in Appendix 10-D: Buckwalter Parkway Access Management Plan of the Beaufort County

Comprehensive Plan above. The developer shall be required to conduct LOS and signal system progression analysis to demonstrate compatibility of the proposed signal location with operation of the remainder of the signal system.”

For other intersections along the corridor, right-in, right-out operations are desired. The minimum spacing is noted as a minimum of 500 feet with joint access driveways recommended. Single parcel access is “strongly discouraged.” Cross connections between parcels shall be provided. “Driveways should be limited to the number needed to provide adequate access to a development. Factors such as alignment with opposing driveways and minimum spacing requirements will have a bearing on the location and number of driveways approved.”

If a parcel has access to a signalized intersection location, any additional access points shall have a minimum spacing of 800 feet.

The *Community Development Code* also noted that “as changes are made to previously developed property or to the roadway, driveways will be evaluated for the need to be relocated, consolidated, or eliminated if they do not meet the access management standards.”

### 3.8 Crash Analysis

Crash data obtained from the Town of Bluffton was reviewed for the Buckwalter Parkway corridor from US 278 to Bluffton Parkway. From June 9, 2018, thru June 9, 2021, there were 41 crashes on the corridor. Of these 41 crashes, it was found that 20 crashes, or approximately 50%, were angle crashes. **Table 3** summarizes the location along the corridor and the number of angle crashes experienced between June 9, 2013 and June 9, 2021.

Based on the existing intersection configurations, the two Pinellas Drive/Buckwalter Place driveways experienced the greatest number of angle crashes. If a traffic signal is installed, it is expected that many of the left turns or through movements at both locations would favor the signalized intersection due to their close proximity and connectivity. With installation of a signal, the number of angled crashes would likely be reduced.

<b>Table 3:</b> <b>Angle Crashes by Location June 9, 2018 – June 9, 2021</b>	
<b>Intersection</b>	<b># of Angle Crashes</b>
Cassidy Drive	1
Pinellas Drive North	6
Pinellas Drive South	8
Mott Drive/Parkside Drive	2
Innovation Drive	2
Buckwalter Place Drive	1
<b>Total</b>	<b>20</b>

Source: Bluffton PD crash data

### 3.9 Existing Level of Service Analysis - Intersections

Capacity analyses were performed for the AM and PM peak hours in the Existing conditions using the Synchro, Version 10, software to determine the operating characteristics of the adjacent roadway network and the impacts of the proposed project. The analyses were conducted with methodologies contained in the Highway Capacity Manual, 6th Edition (HCM 6) (Transportation Research Board, 2016). The Synchro analysis worksheets are provided in the Appendix.

Capacity of an intersection is defined as the maximum number of vehicles that can pass through an intersection during a specified time, typically an hour. Capacity is described by level of service (LOS) for the operating characteristics of an intersection. LOS is a qualitative measure that describes operational conditions and motorist perceptions within a traffic stream. HCM 6 defines six levels of service, LOS A through LOS F, with A being the best and F being the worst.

LOS for signalized intersections is determined by the overall intersection operations and is reflected in average delay per vehicle. LOS D or better is typically considered acceptable for signalized intersections.

LOS for a two-way stop-controlled (TWSC) intersection is determined by the delay of the poorest performing minor approach, as LOS is not defined for TWSC intersections as a whole. It is not unusual for minor stop-controlled side streets and driveways on major streets to experience longer delays at LOS E and LOS F during peak hours while the majority of the traffic moving through the corridor typically experiences little or no delay.

Capacity analyses were performed for the Existing AM and PM peak hour conditions for the following intersections:

- Buckwalter Parkway at Cassidy Street
- Buckwalter Parkway at Pinellas Drive North/Berkeley Place Driveway #1
- Buckwalter Parkway at Pinellas Drive South/Berkeley Place Driveway #2
- Buckwalter Parkway at Parkside Drive/Mott Street
- Buckwalter Parkway at Ludlow Street
- Buckwalter Parkway at Kroger Gas Driveway
- Buckwalter Parkway at Innovation Drive
- Buckwalter Parkway at Progressive Street
- Buckwalter Parkway at Buckwalter Place Boulevard

**Table 4** summarizes LOS and control delay (average seconds of delay per vehicle) for the Existing AM and PM peak hour conditions at the study area unsignalized intersections.

Based on the results of the analysis shown in **Table 4**, the following intersection approaches are currently operating with elevated delay: Buckwalter Parkway at Berkeley Place Driveway #1 (AM and PM peak hour conditions), Buckwalter Parkway at Pinellas Drive South (AM and PM peak hour conditions), Buckwalter Parkway at Parkside Drive (AM and PM peak hour conditions), and Buckwalter Parkway at Innovation Drive (PM peak hour conditions).

**Table 4:  
2021 Level of Service and delay (average seconds per vehicle)**

Intersection	Traffic Control <sup>1</sup>	Approach Direction	Existing Conditions	
			AM Peak Hour	PM Peak Hour
Buckwalter Parkway at Cassidy Drive	U	WB	C (19.1)	C (16.9)
Buckwalter Parkway at Pinellas Drive North/Berkeley Place Driveway #1	U	EB	E (42.3)	F (60.5)
		WB	C (20.2)	D (26.8)
Buckwalter Parkway at Pinellas Drive South/Berkeley Place Driveway #2	U	EB	C (19.5)	D (33.9)
		WB	F (50.5)	F (*)
Buckwalter Parkway at Parkside Drive/Mott Street	U	EB	A (0.0)	A (0.0)
		WB	F (156.2)	F (298.1)
Buckwalter Parkway at Ludlow Street	U	EB	D (25.5)	C (24.6)
Buckwalter Parkway at Kroger Fuel Driveway <sup>3</sup>	U	EB	B (11.1)	B (11.4)
Buckwalter Parkway at Innovation Drive	U	EB	D (29.8)	F (120.0)
Buckwalter Parkway at Progressive Street	U	EB	B (11.3)	B (12.6)

1. U= Unsignalized, S= Signalized

2. \* = Estimated delay exceeds 300 seconds per vehicle

3. Estimated traffic volumes based on calculated trip generation and adjacent intersection traffic volumes

## 4.0 Future/Planned Conditions

Future traffic volumes were based on a combination of historic data, approved developments, and regional travel demand model data.

### 4.1 LATS Model – LRTP and 2040 Daily Traffic Volumes

The Lowcountry Area Transportation Study (LATS) travel demand model projected future traffic volumes along this corridor as part of the Long Range Transportation Plan (LRTP) for the metropolitan planning organization (MPO).

The 2010 AADT for this segment of Buckwalter Parkway in the LATS model was 10,600 vpd. The 2040 loaded network AADT for this segment was approximately 15,000 vpd with a volume to capacity ratio of 0.67, resulting in a level of service B.

The annual growth rate based on the traffic model volumes from year 2010 and year 2040 was 1.5% per year.

### 4.2 Planned Developments

There are two developments that have been approved along the corridor but have not yet been constructed, Willow Run and Bluffton Commons. **Figure 8** shows the current planned unit developments along the corridor per Town of Bluffton GIS.

Willow Run is a planned unit development in the Town of Bluffton that encompasses the area on the east side of the corridor east of the development on Pinellas Drive generally between US 278 and the existing neighborhoods. This development will be accessed on Buckwalter Parkway via Cassidy Drive, Pinellas Drive North and Pinellas Drive South.

Bluffton Commons is located west of Buckwalter Parkway between Mott Street and Ludlow Street. The proposed development is planned to include 100,000 square feet (sf) of retail space, a 100-room hotel, a 100-bed assisted living facility, and 100 mid-rise apartments. Bluffton Commons will access Buckwalter Parkway at Mott Street and Ludlow Street.

### 4.3 Developments Submitted for Consideration

The May River Marketplace is a development under consideration east of Buckwalter Parkway between Parkside Drive and Ludlow Street. The site is currently planned to have approximately 42,000 square feet of retail space and 6,000 square feet of retail space. Access for this project would be via Parkside Drive and a new access point across from Ludlow Street.

#### 4.4 Year 2030 Projected Traffic Volumes

Year 2030 projected traffic volumes for the corridor were determined using a combination of historic growth for the non-specific growth and specific development traffic for the Bluffton Commons and May River Marketplace projects. For non-specific growth, a 2%/year growth rate was used for the Buckwalter Parkway corridor while a 1%/year growth rate was used for side street traffic volumes.

**Table 5** summarizes LOS and control delay (average seconds of delay per vehicle) for the projected Year 2030 AM and PM peak hour conditions at the study area intersections.

<b>Table 5:</b> <b>Level of Service and delay (average seconds per vehicle)</b> <b>2030 Scenario 2 Conditions</b>				
Intersection	Traffic Control <sup>1</sup>	Approach Direction	Existing Conditions	
			AM Peak Hour	PM Peak Hour
Buckwalter Parkway at Cassidy Drive	U	WB	D (31.1)	D (27.4)
Buckwalter Parkway at Pinellas Drive North/Berkeley Place Driveway #1	S	N/A	A (5.5)	A (9.5)
Buckwalter Parkway at Pinellas Drive South/Berkeley Place Driveway #2	U	EB	B (11.9)	B (14.8)
		WB	C (15.3)	B (14.8)
Buckwalter Parkway at Parkside Drive/Mott Street	S	N/A	A (9.4)	B (10.7)
Buckwalter Parkway at Ludlow Street	U	EB	B (12.4)	D (29.7)
		WB	B (12.9)	B (13.0)
Buckwalter Parkway at Kroger Fuel Driveway <sup>2</sup>	S	N/A	A (3.4)	A (6.6)
Buckwalter Parkway at Innovation Drive	U	EB	B (12.4)	B (14.9)
Buckwalter Parkway at Progressive Street	U	EB	B (11.2)	C (16.3)

1. U= Unsignalized, S= Signalized

2. Estimated traffic volumes based on calculated trip generation and adjacent intersection traffic volumes

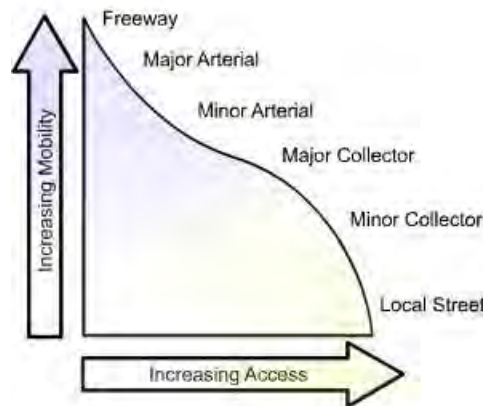
3. N/A = Average delay per vehicle shown for overall intersection

The 2030 analysis assumed that the three planned intersections are signalized for the purposes of the study. These traffic signals would need to be warranted prior to installation.

Based on the 2030 analysis shown in **Table 5**, all intersections in Scenario 2 are projected to operate at LOS D or better.

## 5.0 Benefits of Access Management

Based on information provided by the Federal Highway Administration (FHWA) in “What is Access Management?”, access management is the proactive management of vehicular access points to land parcels adjacent to all manner of roadways. In general, as the number of vehicular access points increases, the number of conflict points along a roadway also increases, which causes a decrease in mobility. **Figure 9** shows the relationship between mobility and access within the Roadway Functional Hierarchy.



**Figure 9: Conceptual Roadway Functional Hierarchy**

Source: Figure 1 “What is Access Management?”, FHWA. [https://ops.fhwa.dot.gov/access\\_mgmt/what\\_is\\_accsmgmt.htm](https://ops.fhwa.dot.gov/access_mgmt/what_is_accsmgmt.htm)

FHWA identifies the following five main types of access management that can be applied to the transportation system: signalized intersection spacing (signal density), driveway spacing, turning lanes (implementation of designated left- and right-turn lanes at intersections), median treatments, and right-of-way management. Implementation of access management has been found to increase roadway capacity, reduce crashes, and provide economic benefit.

*Guide for the Analysis of Multimodal Corridor Access Management* (National Cooperative Highway Research Program (NCHRP) Research Report 900, 2018) found that travel speeds increase by two to three miles per hour (mph) for each one-signal-per-mile reduction. This report also shows that as the number of signals per mile decreases, the crash rate (in crashes per million vehicle miles) decreases as well. **Table 6** shows the average crash rate by signal density.

This report also found that providing left-and right-turn lanes increases free-flow and travel speeds along a corridor by a few miles per hour and decreases crash rates. The installation of left-turn lanes has a more significant impact on the reduction of crash rates than right-turn lanes.



<b>Table 6: Average crash rates by different ranges of traffic signal densities</b>	
<b>Signals Per Mile</b>	<b>Crash Rate (crashes per million vehicle miles)</b>
$\leq 2$	3.5
2.01 – 4	6.9
4.01 – 6	7.5
$> 6$	9.1

Source: Table 21 *Guide for the Analysis of Multimodal Corridor Access Management*, NCHRP Research Report 900, 2018)

Installing an access management plan that uses techniques such as installing non-traversable medians or restricting driveway spacing can often create some concern from business owners along a corridor due to there being limited access to their property. However, based on multiple studies compiled by FHWA in “Intersection Proven Safety Countermeasure”, access management plans were shown to have little to no negative impact on business operations across many parts of the United States. In some cases, businesses reported sales increases or property value increases after access management plans were completed.

Access management plans are created to improve the efficiency and the safety of a roadway. Studies have shown that implementing access management techniques along a roadway can increase free-flow and travel speeds as well as decrease the number of accidents that can occur. Access management plans have also shown in some cases to be economically beneficial for businesses as well.

## 6.0 Access Management Plan

Based on the principles outlined in Section 5.0, the existing conditions and building on the previous 2007 Access Management Plan, an updated Access Management Plan was developed for the Buckwalter Parkway corridor for the study area.

**Figures 3A and 3B** show each intersection along the corridor, the distance of each intersection from US 278 and the spacing between each of the intersections.

### 6.1 Signalized Intersection Spacing

The existing intersections on the Buckwalter Parkway corridor are approximately 1,000 feet apart.

The goal for this corridor from the 2007 plan is 1,500 to 1,700 feet spacing between signalized intersections to “allow progression speeds along Buckwalter Parkway that are in the 30 mph range.” The SCDOT Access and Roadside Management Standards (ARMS) Manual (2012) guidelines for intersection spacing is 1,320 feet between signalized intersections in urban areas and 2,640 feet between signalized intersection in rural areas.

Therefore, based on the preferred spacing of the signalized access points, two scenarios for proposed future signalized intersections were found to be feasible:

- Scenario 1: Consistent with existing access management plan - Signalized intersections at Buckwalter Parkway at Pinellas Drive South/Berkeley Place Driveway #2, Buckwalter Parkway at Ludlow Street, Buckwalter Parkway at Innovation Drive and Buckwalter Parkway at Buckwalter Place Boulevard
- Scenario 2: Signalized intersections at Buckwalter Parkway at Pinellas Drive North/Berkeley Place Driveway #1, Buckwalter Parkway at Parkside Drive/Mott Street, Buckwalter Parkway at Kroger Fuel Center Drive, and Buckwalter Parkway at Buckwalter Place Boulevard

**Table 7** shows the signalized intersection spacing for each Scenario.

<b>Table 7: Signalized Intersection Spacing by Scenario</b>		
<b>Segment Start</b>	<b>Segment End</b>	<b>Approximate Distance between Intersections (feet)</b>
<b>Scenario 1</b>		
US 278	Pinellas Drive South/Berkeley Place Driveway #2	2,946
Pinellas Drive South/Berkeley Place Driveway #2	Ludlow Street	1,960
Ludlow Street	Innovation Drive	1,585
Innovation Drive	Buckwalter Place Boulevard	995
Buckwalter Place Boulevard	Bluffton Parkway	1,077
<b>Scenario 2</b>		
US 278	Pinellas Drive North/Berkeley Place Driveway #1	2,026
Pinellas Drive South/Berkeley Place Driveway #1	Mott Street/Parkside Drive	1,788
Mott Street/Parkside Drive	Kroger Fuel Center Drive	2,176
Kroger Fuel Center Drive	Buckwalter Place Boulevard	1,496
Buckwalter Place Boulevard	Bluffton Parkway	1,077

This study area on Buckwalter Parkway extends to just before Bluffton Parkway (north) signalized intersection. The recommended signalized intersection spacing goal of approximately 2,000 feet between signalized intersections should be applied for the remainder of Buckwalter Parkway to SC 46, as appropriate, to maximize the efficiency of the corridor. This spacing should be reviewed, and the exact locations of these signalized intersections should be studied further as projects develop in the remaining section of the Buckwalter Parkway corridor.

## 6.2 Scenario Advantages

The advantages of the two scenarios are summarized below.

Advantages for Scenario 1:

- Consistent with planning based on 2007 Access Management Plan for corridor
- Existing geometric configuration of the intersection of Buckwalter Parkway at Pinellas Drive South/Berkeley Place Driveway #2 is more conducive for future signalization with fewer improvements required than signalization of the intersection of Buckwalter Parkway at Pinellas Drive North/Berkeley Place Driveway #1 in Scenario 2

Advantages for Scenario 2:

- A connection to Woodbridge community across from Ludlow Street as shown in the 2007 access management plan is not feasible based on the current development layout; the plan allows for planned signalization for Washington Square and Parkside Drive at an adjusted location
- Increased minimum traffic signal spacing on corridor
- Remove all unsignalized full access intersections

Both scenarios include:

- Improved connectivity along corridor and to adjacent properties

## 6.3 Connections and Cross Access Opportunities

Cross access and connectivity allow for travel between the parcels along Buckwalter Parkway. This reduces travel along Buckwalter Parkway and reduces the number of access and egress movements at intersections along the corridor.

The following new roadway connections continue to be recommended along the corridor:

- New roadway between US 278 and Berkeley Place Driveway 1 on the west side of Buckwalter Parkway
- New east-west roadway from Cassidy Drive to the future Willow Run development and the planned north/south roadway that will connect future Bluffton Parkway to US 278 near Eagle's Pointe
- New north-south roadway between Cassidy Drive and Pinellas Drive North

- New east-west roadway from Pinellas Drive North to the future Willow Run development and the planned north/south roadway that will connect future Bluffton Parkway to US 278 near Eagle's Pointe
- Realignment and installation of new Berkeley Place Driveway 1, connecting to the Berkeley Place parking area further west and removing the existing curve and parking lot connection
- New east-west roadway from Pinellas Drive South to the future Willow Run development and the planned north/south roadway that will connect future Bluffton Parkway to US 278 near Eagle's Pointe
- New north-south roadway between Pinellas Drive South and Parkside Drive
- Complete north-south connection between Berkeley Place and Bluffton Commons
- New north-south roadway between Innovation Drive and Bluffton Commons
- Conversion of Kroger Fuel Center Drive to full access intersection and installation of a new east-west roadway connecting to the new north-south access roads parallel to Buckwalter Parkway
- New north-south access roadway on the east side of Buckwalter Parkway, connecting the new Kroger Fuel Center Drive intersection and Buckwalter Towne Boulevard
- New connector between Lord of Life Church Road and new north-south access road
- Relocation of intersection of Bluffton Parkway at Buckwalter Parkway intersection (by others)

As recommended in the 2007 plan, cross access between the Berkeley Place development and Bluffton Commons development is recommended. It is our understanding that the Bluffton Commons' portion of the connection has been constructed.

Additional cross access connectivity is recommended as feasible.

#### 6.4 Summary

Based on a review of the corridor and the associated data, the recommended access management plan is shown in **Figures 3A and 3B (Appendix)** and the access locations are listed below by type of access. Existing intersection types are noted.

- Signalized Intersection Access
  - Buckwalter Place Boulevard/Lord of Life Driveway (existing)
- Signalized Intersection Access (when warranted)
  - Berkeley Place Driveway #1/Pinellas Drive North (roadway improvements will be required)
  - Mott Street/Parkside Drive
  - Kroger Fuel Driveway
- Full Unsignalized Intersection Access
  - Cassidy Drive
- Right-in, right-out Intersection Access
  - Berkeley Place Driveway #2/Pinellas Drive South
  - Ludlow Street

- Innovation Drive
- Progressive Street (existing)
- Right-in only Intersection Access
  - Buckwalter Place Driveway (existing)

With the implementation of the access management plan, the intersection of Berkeley Place Driveway #1/Pinellas Drive North will require improvements on both side street approaches prior to redesign and signalization of the intersection. These improvements would include but are not limited to increase in throat distance, installation of turn lanes, and sight distance improvements. All improvements should be based on Beaufort County and SCDOT standards.

In addition, this plan recommends the previously planned and new roadway connection improvements along the corridor. These are shown in **Figures 3A and 3B (Appendix)** as dashed lines. The exact location and design of these connection are conceptual in nature and are expected to be refined in the design process.

- New roadway between US 278 and Berkeley Place Driveway 1 on the west side of Buckwalter Parkway
- New east-west roadway from Cassidy Drive to the future Willow Run development and the planned north/south roadway that will connect future Bluffton Parkway to US 278 near Eagle's Pointe
- New north-south roadway between Cassidy Drive and Pinellas Drive North
- New east-west roadway from Pinellas Drive North to the future Willow Run development and the planned north/south roadway that will connect future Bluffton Parkway to US 278 near Eagle's Pointe
- Realignment and installation of new Berkeley Place Driveway 1, connecting to the Berkeley Place parking area further west and removing the existing curve and parking lot connection
- New east-west roadway from Pinellas Drive South to the future Willow Run development and the planned north/south roadway that will connect future Bluffton Parkway to US 278 near Eagle's Pointe
- New north-south roadway between Pinellas Drive South and Parkside Drive
- Complete north-south connection between Berkeley Place and Bluffton Commons
- New north-south roadway between Innovation Drive and Bluffton Commons
- Conversion of Kroger Fuel Center Drive to full access intersection and installation of a new east-west roadway connecting to the new north-south access roads parallel to Buckwalter Parkway
- New north-south access roadway on the east side of Buckwalter Parkway, connecting the new Kroger Fuel Center Drive intersection and Buckwalter Towne Boulevard
- New connector between Lord of Life Church Road and new north-south access road
- Relocation of intersection of Bluffton Parkway at Buckwalter Parkway intersection (by others)

This study area on Buckwalter Parkway extends to just before Bluffton Parkway (north) signalized intersection. The recommended signalized intersection spacing goal of approximately 2,000 feet between

signalized intersections should be applied for the remainder of Buckwalter Parkway to SC 46, as appropriate, to maximize the efficiency of the corridor. This spacing should be reviewed, and the exact locations of these signalized intersections should be studied further as projects develop in the remaining section of the Buckwalter Parkway corridor.

### 6.5 Next Steps

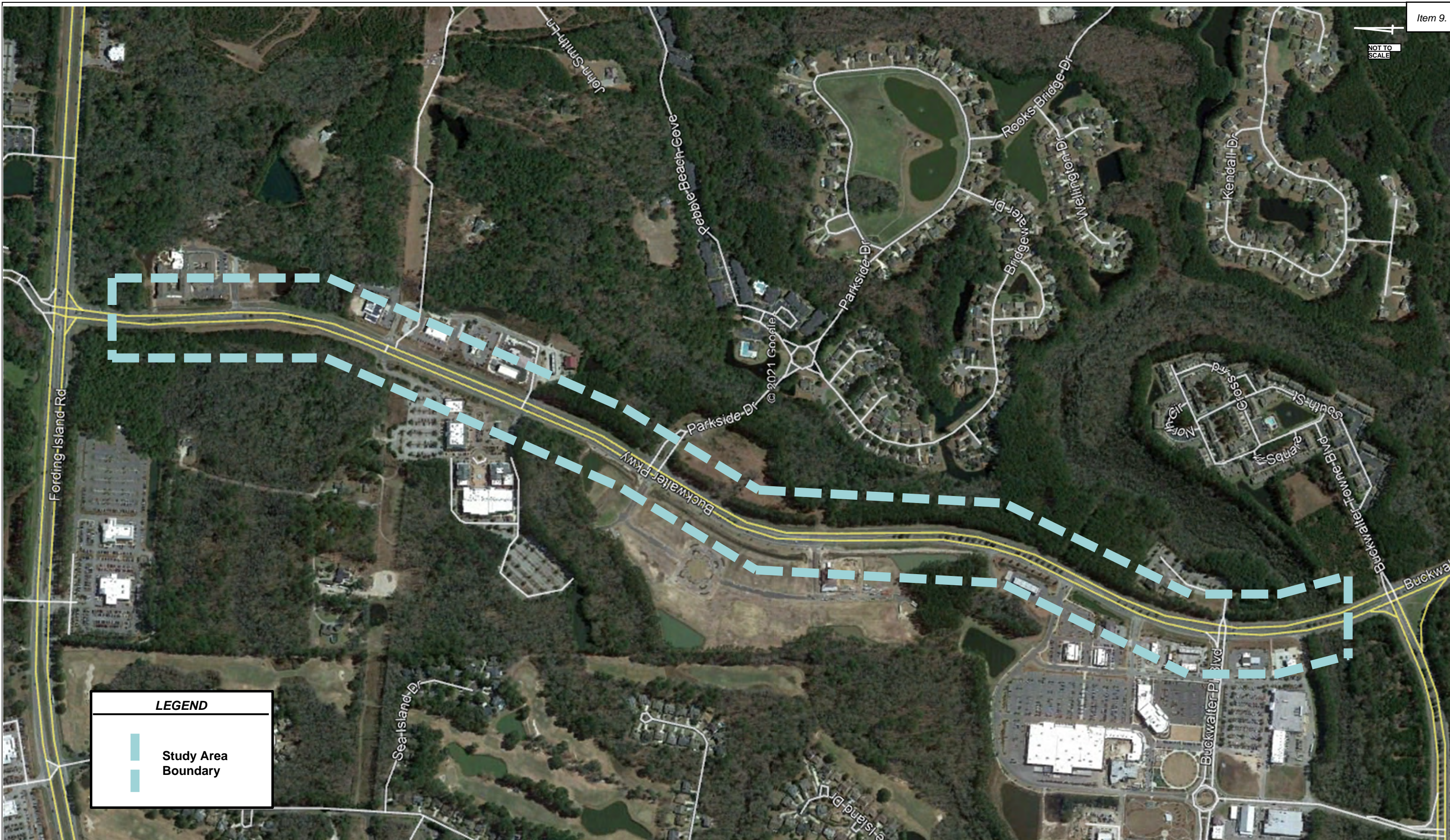
The following steps should be completed in the near term:

- Installation of a new roadway between Innovation Drive and Bluffton Commons – it is our understanding that an existing wetlands permit will expire in the near term
- Development of conceptual design of the intersection of Buckwalter Parkway at Pinellas Drive North/Berkeley Place Driveway #1
- Coordination and additional planning of the connection roadways with the Town of Bluffton
- Coordination with property owners along the corridor regarding the updated access management plan for the corridor
- Perform traffic signal warrant analysis for planned signalized intersection locations

## Appendix

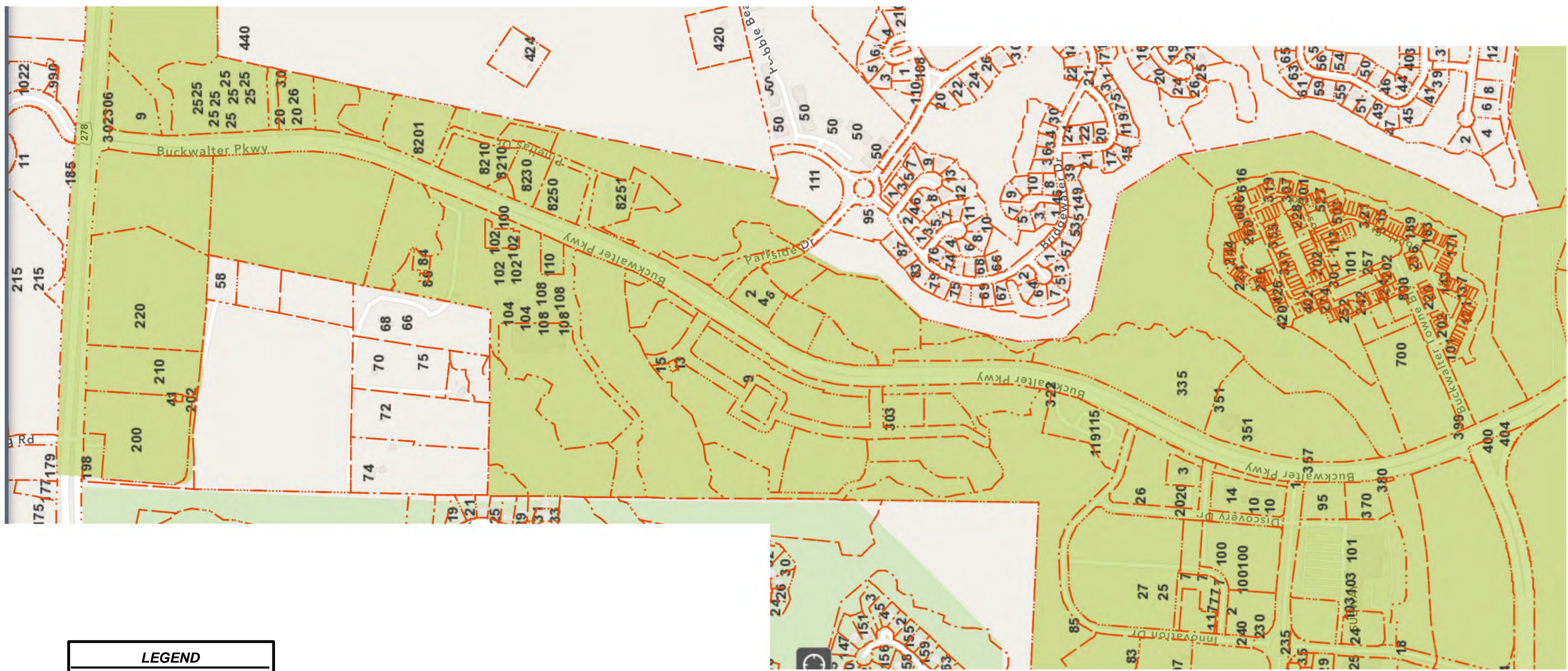


NOT TO  
SCALE





NOT TO  
SCALE



**LEGEND**

Bluffton Town Limits

Source: Beaufort County GIS

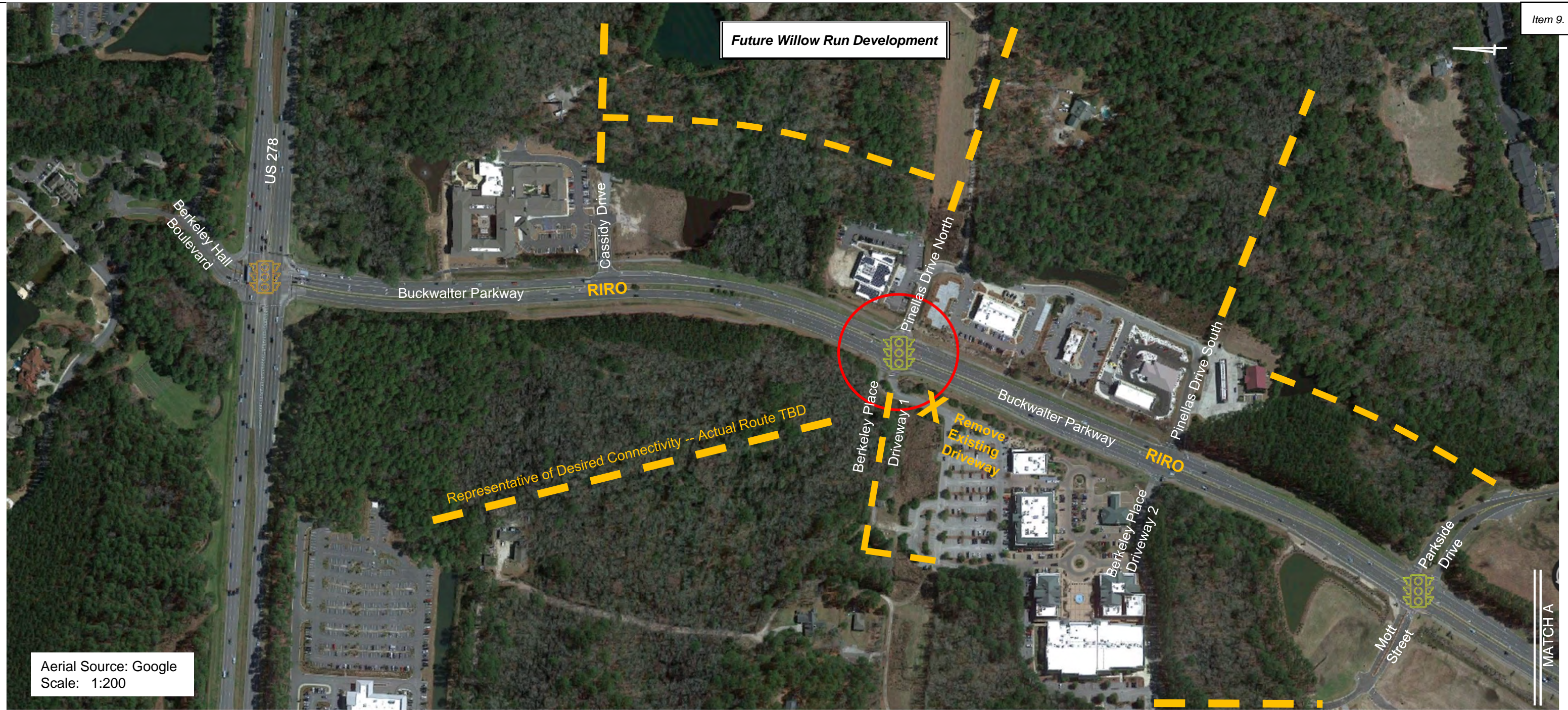


# Buckwalter Access Management Plan Update

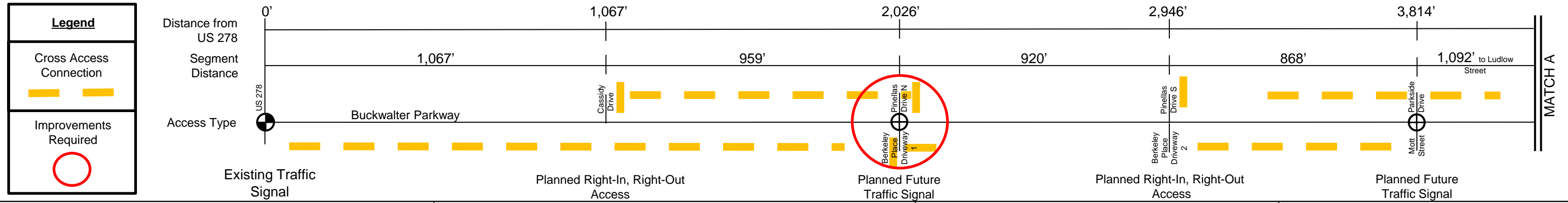
Bluffton Town Limits

Figure 2





Aerial Source: Google  
Scale: 1:200

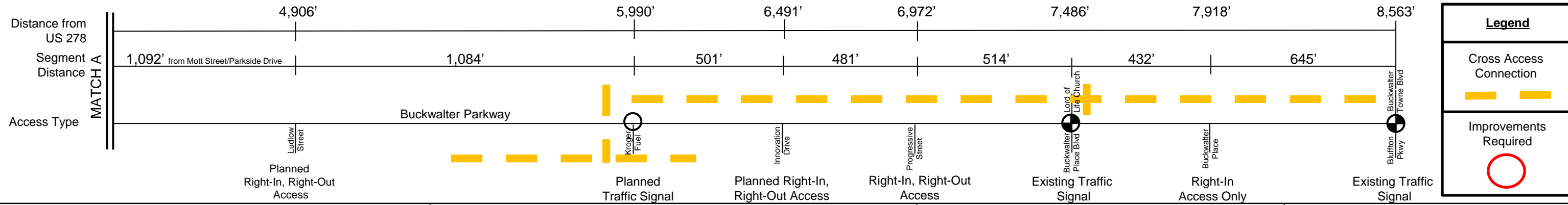
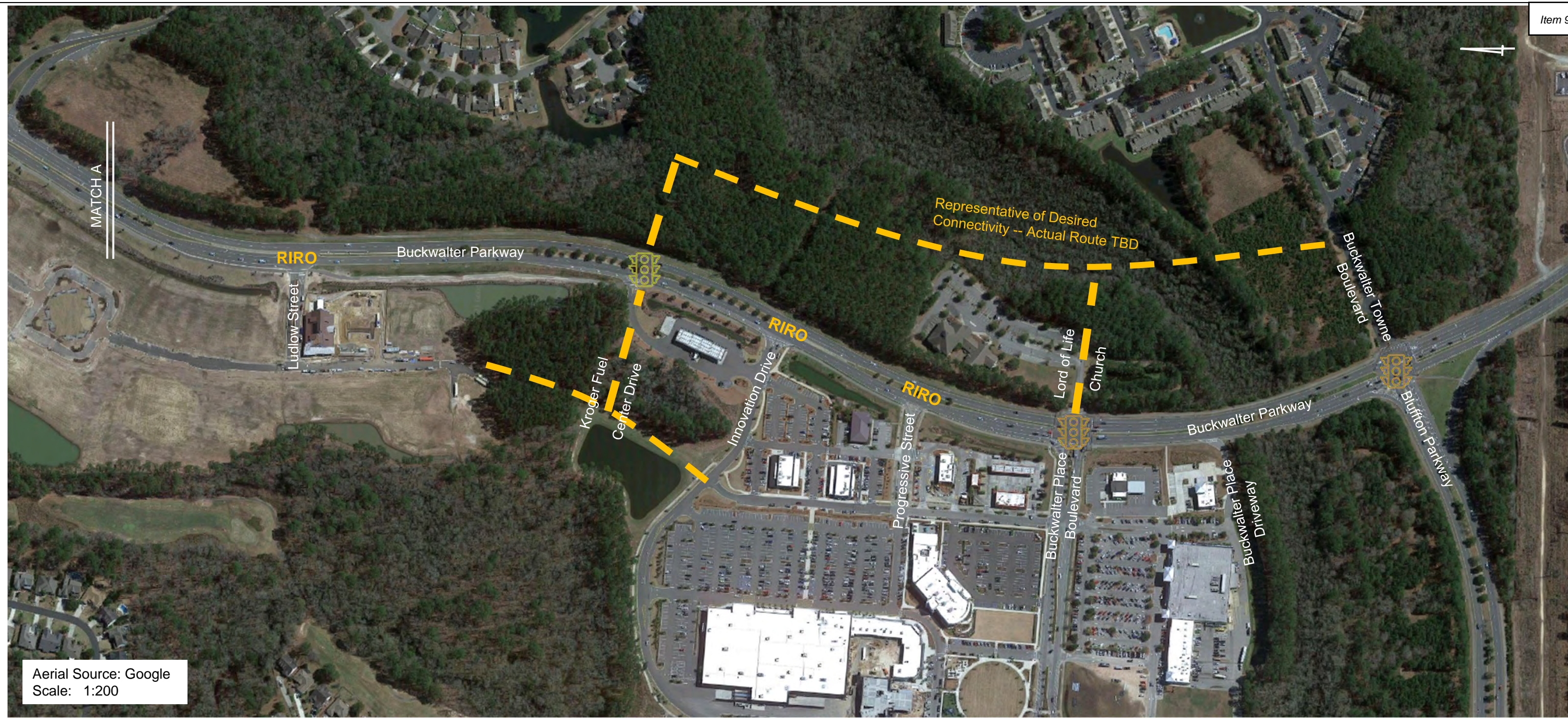


# Buckwalter Access Management Plan Update

## Access Management Plan

## Figure 3A



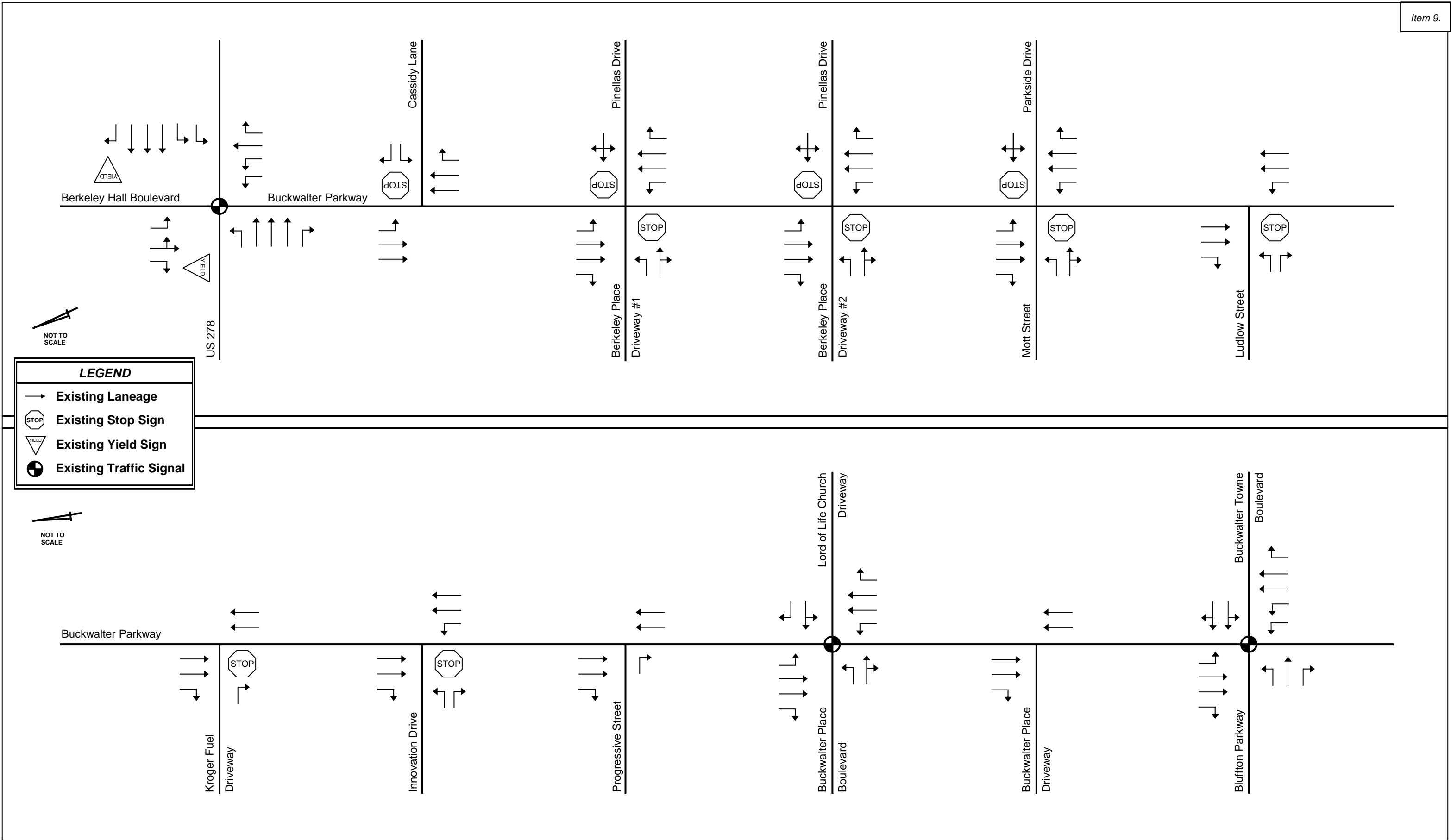


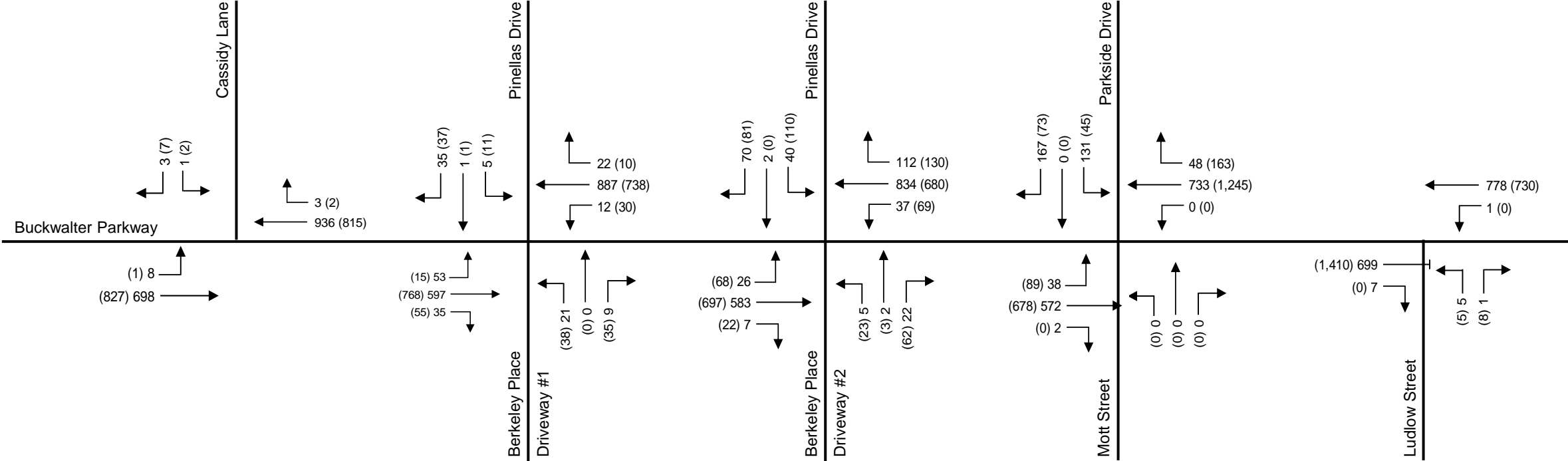
## Buckwalter Access Management Plan Update

## Access Management Plan

## Figure 3B







NOT TO SCALE

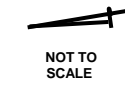
**LEGEND**

XX

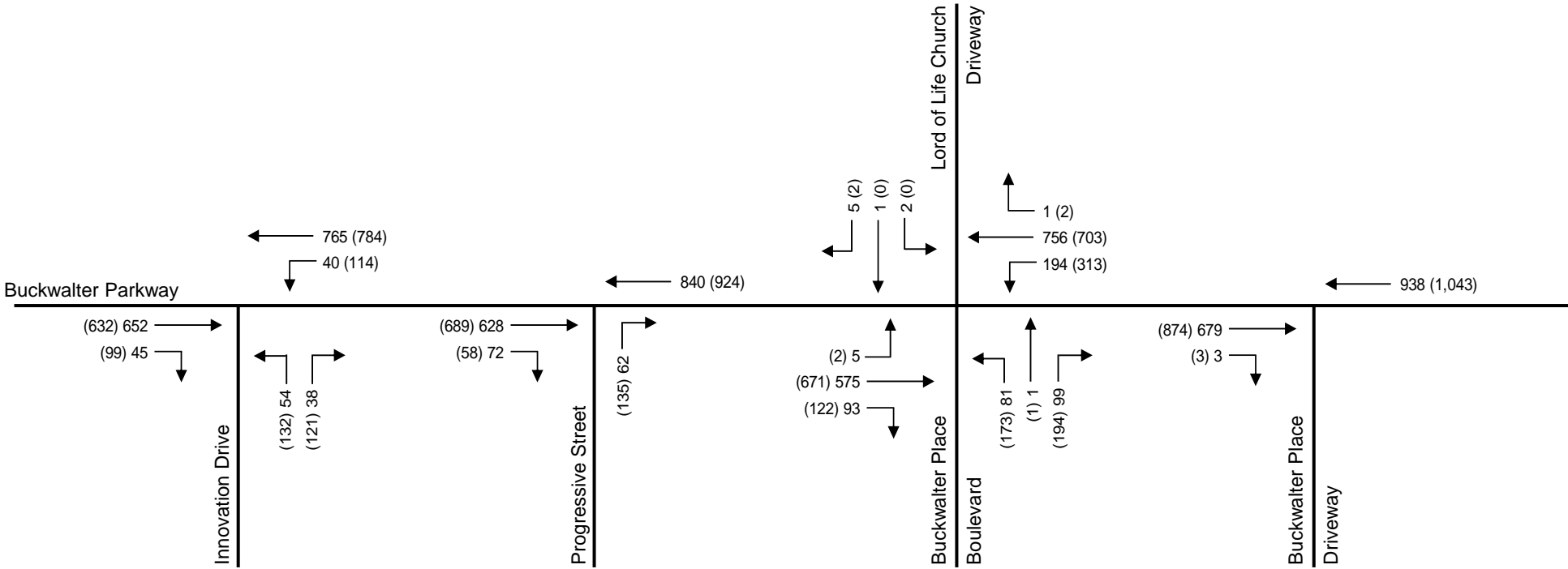
AM Peak Hour Traffic

(XX)

PM Peak Hour Traffic



NOT TO SCALE

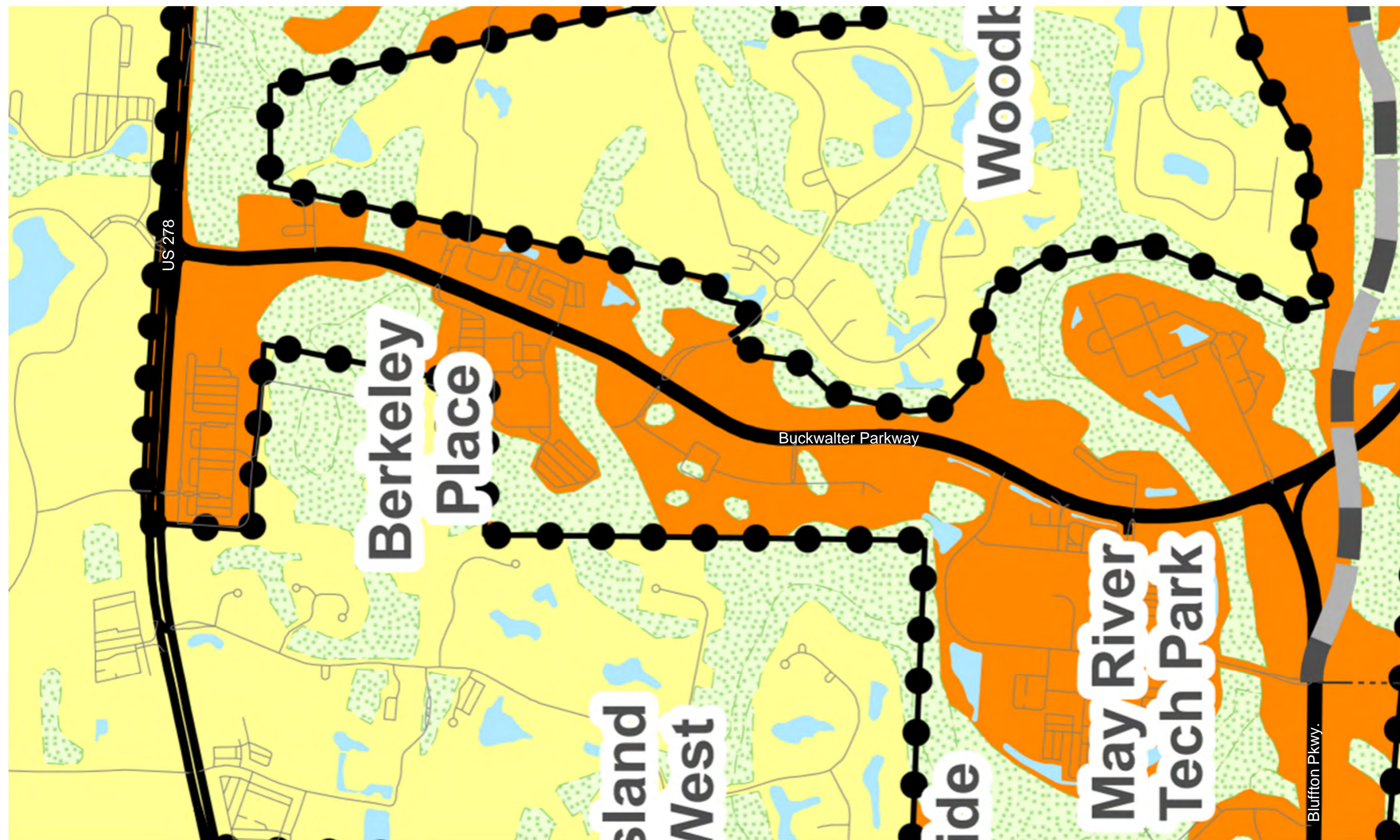


Buckwalter Access Management Plan Update

Existing Traffic Volumes

Figure 5





Source: Town of Bluffton GIS

# Town of Bluffton

Beaufort County, SC

GROWTH MANAGEMENT  
DEPARTMENT

## BLUFFTON WATER RESOURCES

Adopted: 9/04/2007  
Revised: 12/09/2014  
Updated: 1/13/2021

### Legend

#### JURISDICTIONAL

- Bluffton
- Hilton Head Island
- Hardeeville
- Beaufort County
- Jasper County
- Bluffton Town Limits

#### TRANSPORTATION

- Roads
- Interstate
- Bluffton Parkway (Proposed)

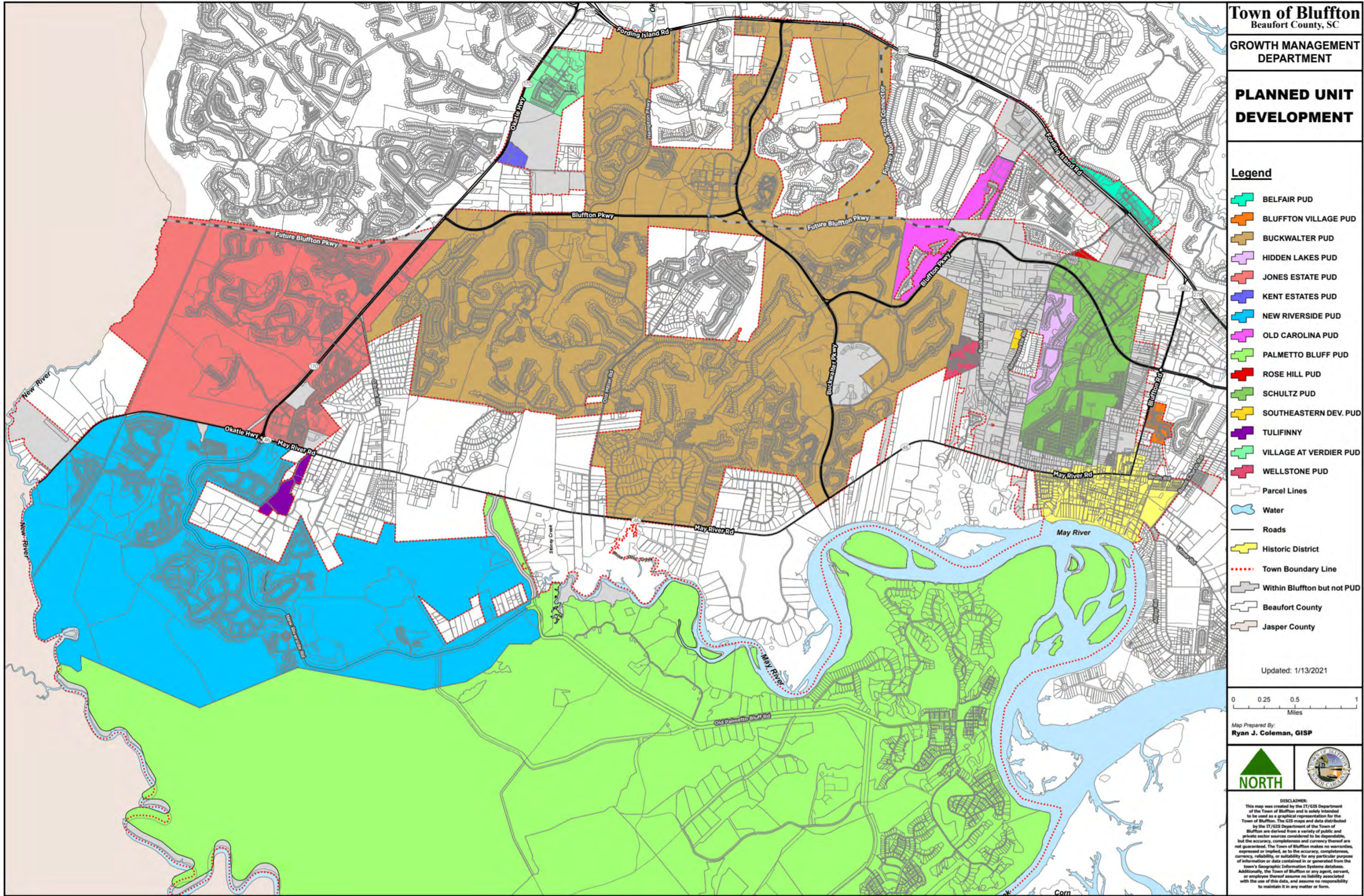
#### HYDROLOGY

- Water
- Marsh
- Wetland









Source: Town of Bluffton GIS



**Buckwalter Access Management Plan  
Update**

**Town of Bluffton  
PUD Boundaries**

**Figure 8**





# SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Apartments DW (Cassidy St)  
 Site Code :  
 Start Date : 5/11/2021  
 Page No : 1

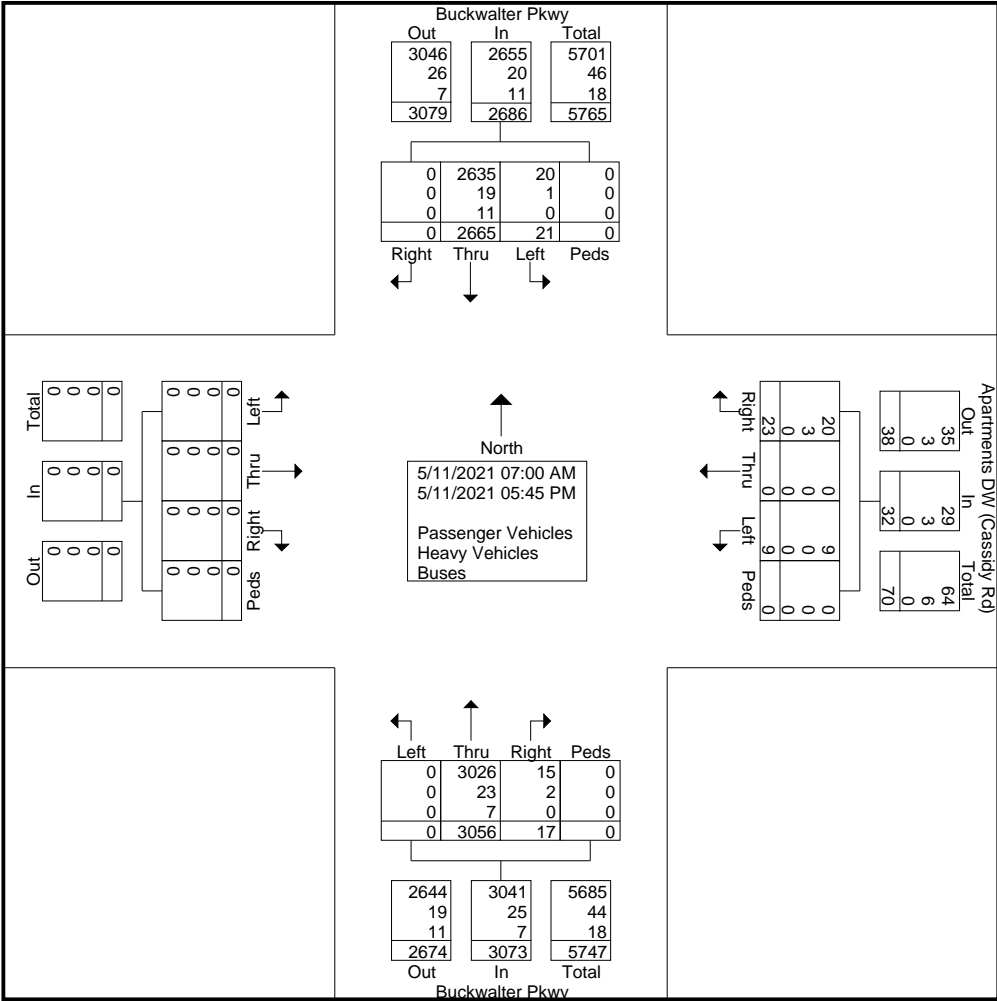
## Groups Printed- Passenger Vehicles - Heavy Vehicles - Buses

Start Time	Buckwalter Pkwy From North				Apartments DW (Cassidy Rd) From East				Buckwalter Pkwy From South				From West				Int. Total
	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	
07:00 AM	3	81	0	0	0	0	1	0	0	161	0	0	0	0	0	0	246
07:15 AM	2	121	0	0	0	0	2	0	0	165	1	0	0	0	0	0	291
07:30 AM	1	158	0	0	1	0	1	0	0	211	0	0	0	0	0	0	372
07:45 AM	2	155	0	0	0	0	0	0	0	208	0	0	0	0	0	0	365
Total	8	515	0	0	1	0	4	0	0	745	1	0	0	0	0	0	1274
08:00 AM	1	159	0	0	0	0	0	0	0	197	1	0	0	0	0	0	358
08:15 AM	3	135	0	0	0	0	2	0	0	198	2	0	0	0	0	0	340
08:30 AM	2	138	0	0	0	0	2	0	0	180	5	0	0	0	0	0	327
08:45 AM	3	127	0	0	0	0	3	0	0	187	3	0	0	0	0	0	323
Total	9	559	0	0	0	0	7	0	0	762	11	0	0	0	0	0	1348
04:00 PM	1	209	0	0	0	0	0	0	0	201	1	0	0	0	0	0	412
04:15 PM	2	196	0	0	1	0	1	0	0	190	1	0	0	0	0	0	391
04:30 PM	0	204	0	0	4	0	3	0	0	173	0	0	0	0	0	0	384
04:45 PM	0	171	0	0	1	0	1	0	0	186	1	0	0	0	0	0	360
Total	3	780	0	0	6	0	5	0	0	750	3	0	0	0	0	0	1547
05:00 PM	1	191	0	0	0	0	4	0	0	232	1	0	0	0	0	0	429
05:15 PM	0	188	0	0	2	0	0	0	0	190	1	0	0	0	0	0	381
05:30 PM	0	201	0	0	0	0	3	0	0	217	0	0	0	0	0	0	421
05:45 PM	0	231	0	0	0	0	0	0	0	160	0	0	0	0	0	0	391
Total	1	811	0	0	2	0	7	0	0	799	2	0	0	0	0	0	1622
Grand Total	21	2665	0	0	9	0	23	0	0	3056	17	0	0	0	0	0	5791
Apprch %	0.8	99.2	0	0	28.1	0	71.9	0	0	99.4	0.6	0	0	0	0	0	
Total %	0.4	46	0	0	0.2	0	0.4	0	0	52.8	0.3	0	0	0	0	0	
Passenger Vehicles	20	2635	0	0	9	0	20	0	0	3026	15	0	0	0	0	0	5725
% Passenger Vehicles	95.2	98.9	0	0	100	0	87	0	0	99	88.2	0	0	0	0	0	98.9
Heavy Vehicles	1	19	0	0	0	0	3	0	0	23	2	0	0	0	0	0	48
% Heavy Vehicles	4.8	0.7	0	0	0	0	13	0	0	0.8	11.8	0	0	0	0	0	0.8
Buses	0	11	0	0	0	0	0	0	0	7	0	0	0	0	0	0	18
% Buses	0	0.4	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0.3

SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Apartments DW (Cassidy St)  
Site Code :  
Start Date : 5/11/2021  
Page No : 2

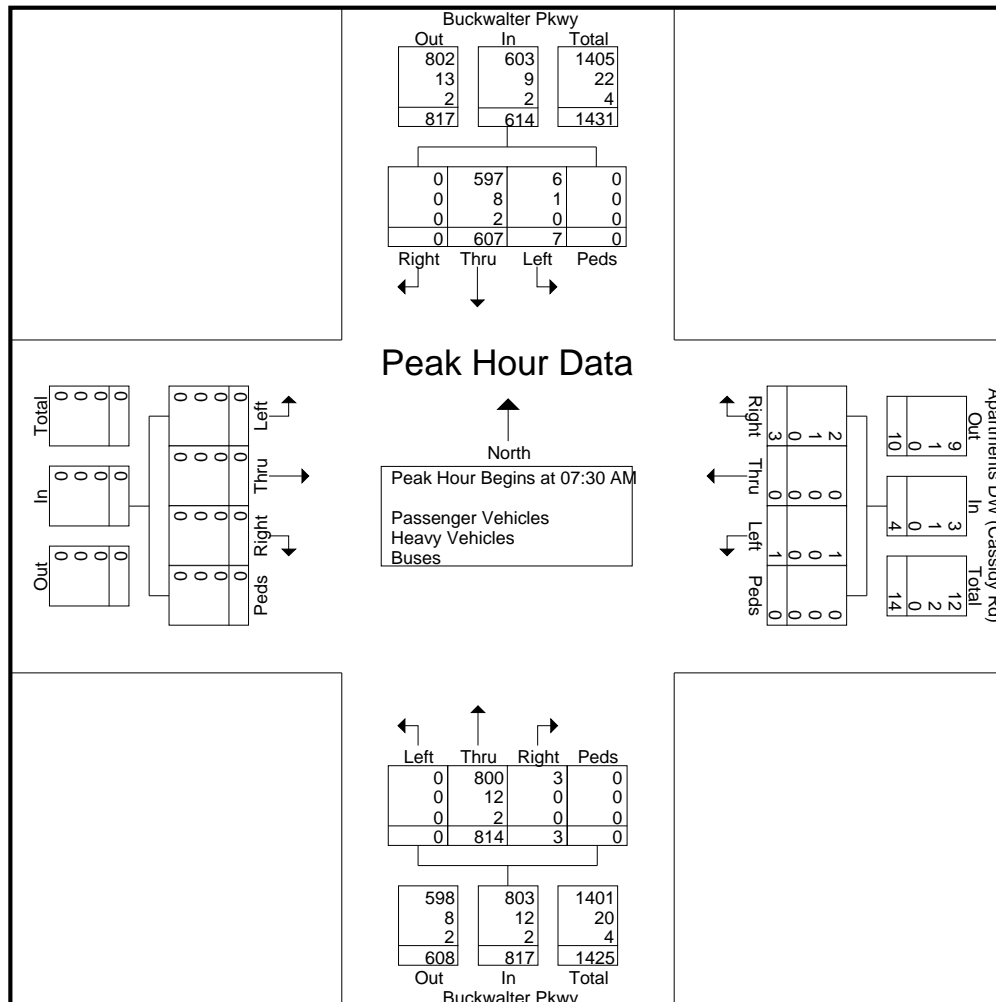


# SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Apartments DW (Cassidy St)  
 Site Code :  
 Start Date : 5/11/2021  
 Page No : 3

	Buckwalter Pkwy From North					Apartments DW (Cassidy Rd) From East					Buckwalter Pkwy From South					From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 11:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:30 AM																					
07:30 AM	1	158	0	0	159	1	0	1	0	2	0	211	0	0	211	0	0	0	0	0	372
07:45 AM	2	155	0	0	157	0	0	0	0	0	0	208	0	0	208	0	0	0	0	0	365
08:00 AM	1	159	0	0	160	0	0	0	0	0	0	197	1	0	198	0	0	0	0	0	358
08:15 AM	3	135	0	0	138	0	0	2	0	2	0	198	2	0	200	0	0	0	0	0	340
Total Volume	7	607	0	0	614	1	0	3	0	4	0	814	3	0	817	0	0	0	0	0	1435
% App. Total	1.1	98.9	0	0		25	0	75	0		0	99.6	0.4	0		0	0	0	0		
PHF	.583	.954	.000	.000	.959	.250	.000	.375	.000	.500	.000	.964	.375	.000	.968	.000	.000	.000	.000	.000	.964
Passenger Vehicles	6	597	0	0	603	1	0	2	0	3	0	800	3	0	803	0	0	0	0	0	1409
% Passenger Vehicles	85.7	98.4						66.7				98.3									
Heavy Vehicles	1	8	0	0	9	0	0	1	0	1	0	12	0	0	12	0	0	0	0	0	22
% Heavy Vehicles	14.3	1.3	0	0	1.5	0	0	33.3	0	25.0	0	1.5	0	0	1.5	0	0	0	0	0	1.5
Buses	0	2	0	0	2	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	4
% Buses	0	0.3	0	0	0.3	0	0	0	0	0	0	0.2	0	0	0.2	0	0	0	0	0	0.3

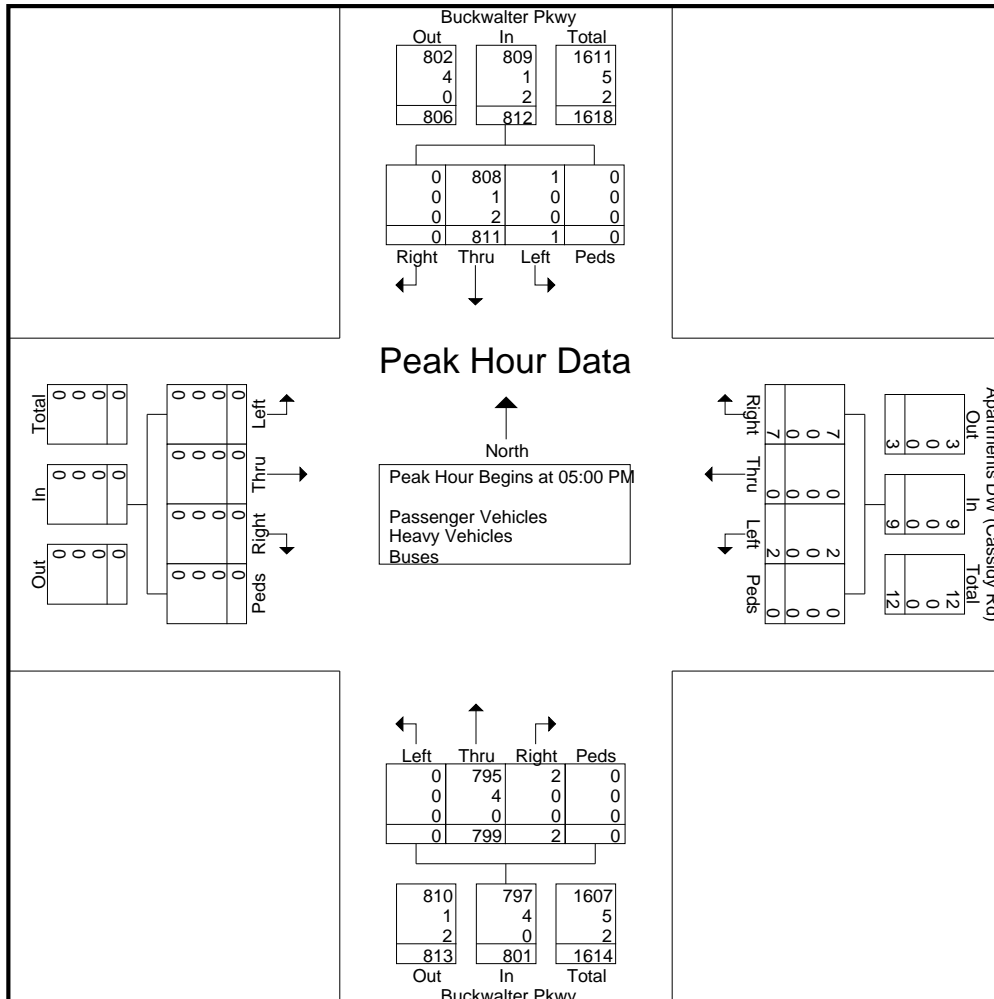


# SHORT COUNTS

Item 9.

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 Site Code :  
 Start Date : 5/11/2021  
 Page No : 4

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Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 12:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 05:00 PM																					
05:00 PM	1	191	0	0	192	0	0	4	0	4	0	232	1	0	233	0	0	0	0	0	429
05:15 PM	0	188	0	0	188	2	0	0	0	2	0	190	1	0	191	0	0	0	0	0	381
05:30 PM	0	201	0	0	201	0	0	3	0	3	0	217	0	0	217	0	0	0	0	0	421
05:45 PM	0	231	0	0	231	0	0	0	0	0	0	160	0	0	160	0	0	0	0	0	391
Total Volume	1	811	0	0	812	2	0	7	0	9	0	799	2	0	801	0	0	0	0	0	1622
% App. Total	0.1	99.9	0	0		22.2	0	77.8	0		0	99.8	0.2	0		0	0	0	0	0	
PHF	.250	.878	.000	.000	.879	.250	.000	.438	.000	.563	.000	.861	.500	.000	.859	.000	.000	.000	.000	.000	.945
Passenger Vehicles	1	808	0	0	809	2	0	7	0	9	0	795	2	0	797	0	0	0	0	0	1615
% Passenger Vehicles		99.6										99.5									
Heavy Vehicles	0	1	0	0	1	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	5
% Heavy Vehicles	0	0.1	0	0	0.1	0	0	0	0	0	0	0.5	0	0	0.5	0	0	0	0	0	0.3
Buses	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
% Buses	0	0.2	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1



# SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Pinellas North

Site Code :

Start Date : 5/11/2021

Page No : 1

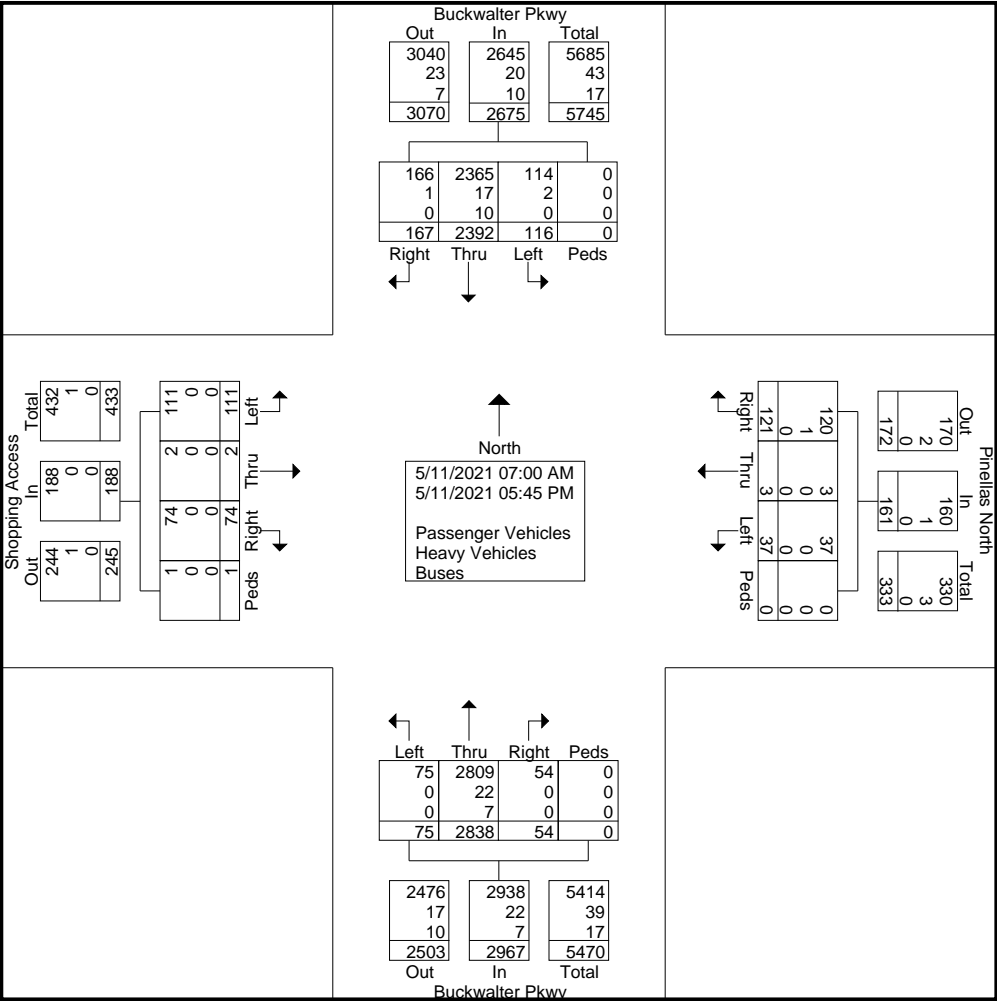
## Groups Printed- Passenger Vehicles - Heavy Vehicles - Buses

	Buckwalter Pkwy From North				Pinellas North From East				Buckwalter Pkwy From South				Shopping Access From West				
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Int. Total
07:00 AM	5	72	2	0	1	0	6	0	0	151	2	0	3	0	0	0	242
07:15 AM	11	111	4	0	0	0	8	0	0	161	0	0	1	0	0	0	296
07:30 AM	10	142	1	0	3	0	4	0	1	215	4	0	0	0	1	0	381
07:45 AM	13	128	9	0	0	1	11	0	3	182	5	0	8	0	2	0	362
Total	39	453	16	0	4	1	29	0	4	709	11	0	12	0	3	0	1281
08:00 AM	12	141	8	0	1	0	6	0	4	189	5	0	5	0	4	0	375
08:15 AM	11	108	12	0	0	0	9	0	2	185	5	0	5	0	1	0	338
08:30 AM	11	116	9	0	1	0	6	0	1	182	0	0	3	0	0	0	329
08:45 AM	10	103	14	0	5	0	9	0	8	170	8	0	6	0	3	0	336
Total	44	468	43	0	7	0	30	0	15	726	18	0	19	0	8	0	1378
04:00 PM	7	186	17	0	3	1	5	0	9	189	3	0	13	0	9	0	442
04:15 PM	6	193	11	0	5	0	8	0	7	163	3	0	9	1	7	0	413
04:30 PM	2	188	12	0	5	0	9	0	7	167	5	0	5	1	5	0	406
04:45 PM	3	151	14	0	2	0	4	0	4	160	4	0	16	0	8	0	366
Total	18	718	54	0	15	1	26	0	27	679	15	0	43	2	29	0	1627
05:00 PM	1	179	15	0	5	0	14	0	7	205	4	0	17	0	6	1	454
05:15 PM	6	173	13	0	0	1	7	0	9	179	1	0	7	0	11	0	407
05:30 PM	4	184	9	0	4	0	4	0	5	204	2	0	7	0	8	0	431
05:45 PM	4	217	17	0	2	0	11	0	8	136	3	0	6	0	9	0	413
Total	15	753	54	0	11	1	36	0	29	724	10	0	37	0	34	1	1705
Grand Total	116	2392	167	0	37	3	121	0	75	2838	54	0	111	2	74	1	5991
Apprch %	4.3	89.4	6.2	0	23	1.9	75.2	0	2.5	95.7	1.8	0	59	1.1	39.4	0.5	
Total %	1.9	39.9	2.8	0	0.6	0.1	2	0	1.3	47.4	0.9	0	1.9	0	1.2	0	
Passenger Vehicles	114	2365	166	0	37	3	120	0	75	2809	54	0	111	2	74	1	5931
% Passenger Vehicles	98.3	98.9	99.4	0	100	100	99.2	0	100	99	100	0	100	100	100	100	99
Heavy Vehicles	2	17	1	0	0	0	1	0	0	22	0	0	0	0	0	0	43
% Heavy Vehicles	1.7	0.7	0.6	0	0	0	0.8	0	0	0.8	0	0	0	0	0	0	0.7
Buses	0	10	0	0	0	0	0	0	0	7	0	0	0	0	0	0	17
% Buses	0	0.4	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0.3

SHORT COUNTS

Item 9.

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Site Code :  
Start Date : 5/11/2021  
Page No : 2



# SHORT COUNTS

Item 9.

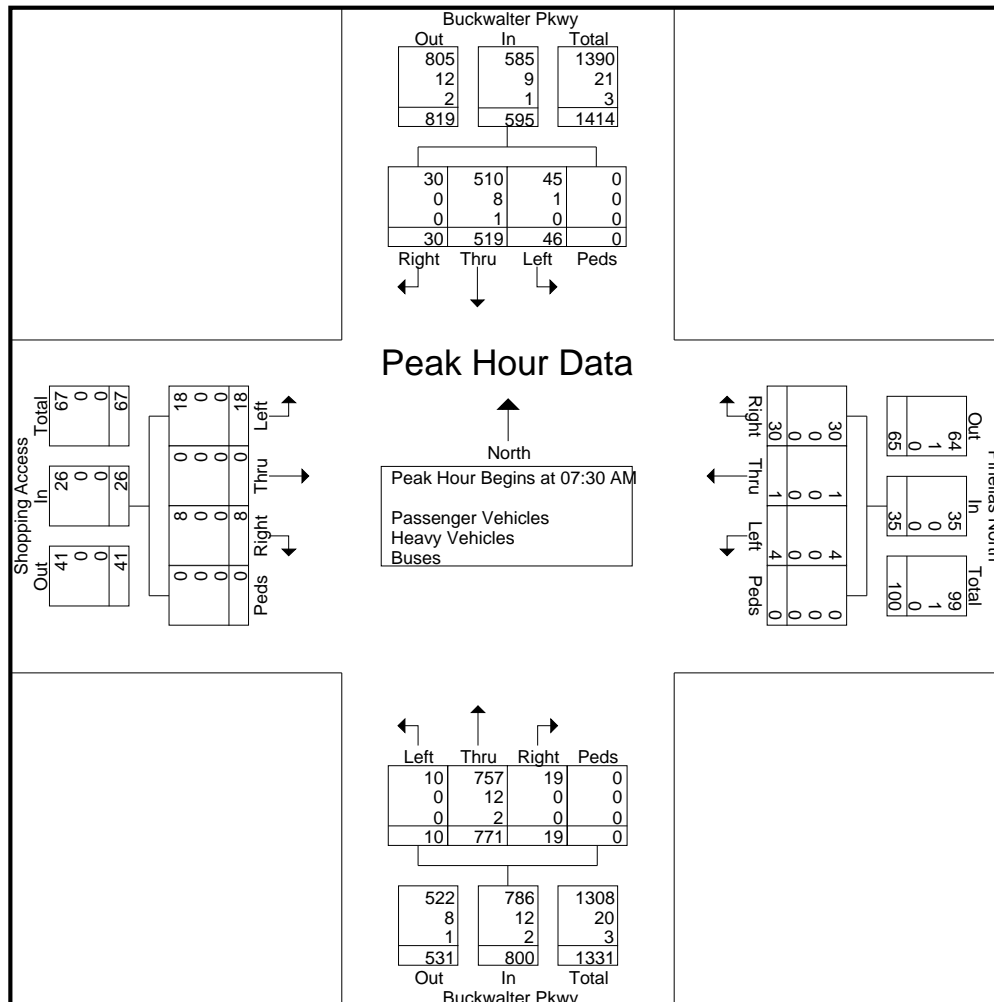
File Name : Buckwalter Pkwy @ Pinellas North

Site Code :

Start Date : 5/11/2021

Page No : 3

	Buckwalter Pkwy From North					Pinellas North From East					Buckwalter Pkwy From South					Shopping Access From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 11:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:30 AM																					
07:30 AM	10	142	1	0	153	3	0	4	0	7	1	215	4	0	220	0	0	1	0	1	381
07:45 AM	13	128	9	0	150	0	1	11	0	12	3	182	5	0	190	8	0	2	0	10	362
08:00 AM	12	141	8	0	161	1	0	6	0	7	4	189	5	0	198	5	0	4	0	9	375
08:15 AM	11	108	12	0	131	0	0	9	0	9	2	185	5	0	192	5	0	1	0	6	338
Total Volume	46	519	30	0	595	4	1	30	0	35	10	771	19	0	800	18	0	8	0	26	1456
% App. Total	7.7	87.2	5	0		11.4	2.9	85.7	0		1.2	96.4	2.4	0		69.2	0	30.8	0		
PHF	.885	.914	.625	.000	.924	.333	.250	.682	.000	.729	.625	.897	.950	.000	.909	.563	.000	.500	.000	.650	.955
Passenger Vehicles	45	510	30	0	585	4	1	30	0	35	10	757	19	0	786	18	0	8	0	26	1432
% Passenger Vehicles	97.8	98.3									98.2										
Heavy Vehicles	1	8	0	0	9	0	0	0	0	0	0	12	0	0	12	0	0	0	0	0	21
% Heavy Vehicles	2.2	1.5	0	0	1.5	0	0	0	0	0	0	1.6	0	0	1.5	0	0	0	0	0	1.4
Buses	0	1	0	0	1	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	3
% Buses	0	0.2	0	0	0.2	0	0	0	0	0	0	0.3	0	0	0.3	0	0	0	0	0	0.2





# SHORT COUNTS

Item 9.

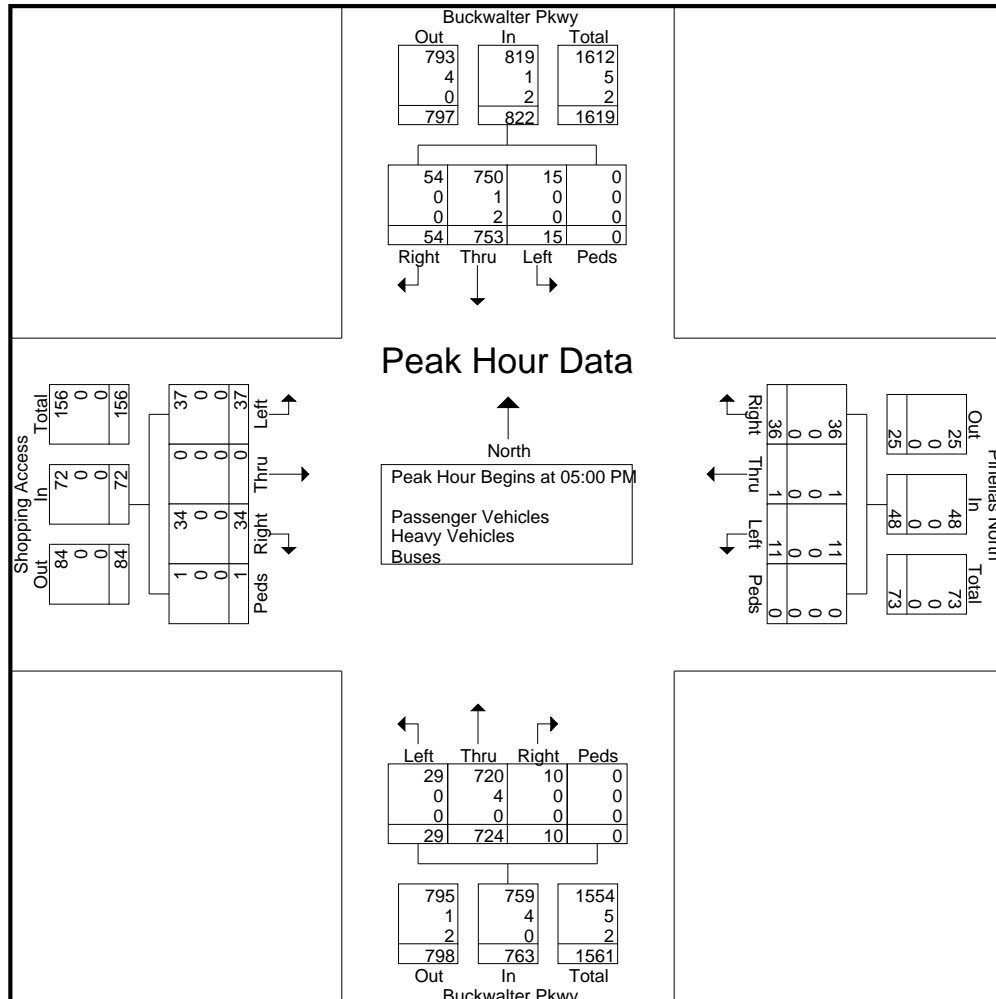
File Name : Buckwalter Pkwy @ Pinellas North

Site Code :

Start Date : 5/11/2021

Page No : 4

	Buckwalter Pkwy From North					Pinellas North From East					Buckwalter Pkwy From South					Shopping Access From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 12:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 05:00 PM																					
05:00 PM	1	179	15	0	195	5	0	14	0	19	7	205	4	0	216	17	0	6	1	24	454
05:15 PM	6	173	13	0	192	0	1	7	0	8	9	179	1	0	189	7	0	11	0	18	407
05:30 PM	4	184	9	0	197	4	0	4	0	8	5	204	2	0	211	7	0	8	0	15	431
05:45 PM	4	217	17	0	238	2	0	11	0	13	8	136	3	0	147	6	0	9	0	15	413
Total Volume	15	753	54	0	822	11	1	36	0	48	29	724	10	0	763	37	0	34	1	72	1705
% App. Total	1.8	91.6	6.6	0		22.9	2.1	75	0		3.8	94.9	1.3	0		51.4	0	47.2	1.4		
PHF	.625	.868	.794	.000	.863	.550	.250	.643	.000	.632	.806	.883	.625	.000	.883	.544	.000	.773	.250	.750	.939
Passenger Vehicles	15	750	54	0	819	11	1	36	0	48	29	720	10	0	759	37	0	34	1	72	1698
% Passenger Vehicles		99.6										99.4									
Heavy Vehicles	0	1	0	0	1	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	5
% Heavy Vehicles	0	0.1	0	0	0.1	0	0	0	0	0	0	0.6	0	0	0.5	0	0	0	0	0	0.3
Buses	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
% Buses	0	0.3	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1



# SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Pinellas South

Site Code :

Start Date : 5/11/2021

Page No : 1

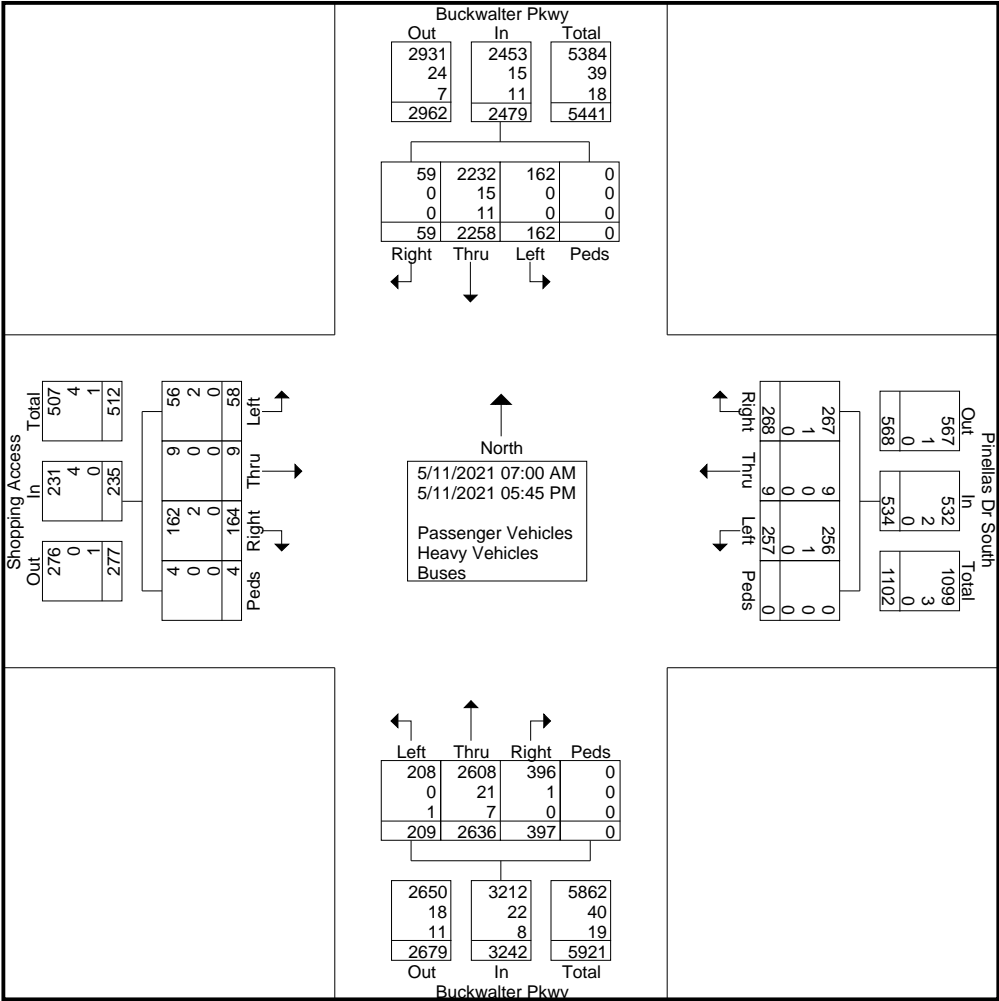
## Groups Printed- Passenger Vehicles - Heavy Vehicles - Buses

	Buckwalter Pkwy From North				Pinellas Dr South From East				Buckwalter Pkwy From South				Shopping Access From West				
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Int. Total
07:00 AM	2	77	2	0	6	0	7	0	4	142	13	0	1	0	2	0	256
07:15 AM	5	98	1	0	4	1	16	0	9	143	18	0	2	1	1	0	299
07:30 AM	10	134	0	0	5	2	16	0	11	192	23	0	1	0	2	0	396
07:45 AM	3	120	1	0	12	0	11	0	7	182	29	0	2	1	3	0	371
Total	20	429	4	0	27	3	50	0	31	659	83	0	6	2	8	0	1322
08:00 AM	3	145	1	0	10	0	18	0	6	176	25	0	1	1	8	0	394
08:15 AM	7	108	4	0	8	0	16	0	8	175	20	0	0	0	6	2	354
08:30 AM	11	93	3	0	12	1	9	0	8	168	15	0	2	1	1	0	324
08:45 AM	7	114	1	0	10	0	14	0	6	170	18	0	3	0	8	0	351
Total	28	460	9	0	40	1	57	0	28	689	78	0	6	2	23	2	1423
04:00 PM	12	164	5	0	16	1	13	0	18	176	27	0	8	0	16	0	456
04:15 PM	14	198	6	0	23	2	22	0	19	157	29	0	7	0	18	0	495
04:30 PM	14	174	7	0	24	1	30	0	22	132	24	0	6	2	21	0	457
04:45 PM	7	150	6	0	19	1	17	0	23	156	29	0	2	0	17	0	427
Total	47	686	24	0	82	5	82	0	82	621	109	0	23	2	72	0	1835
05:00 PM	20	165	7	0	20	0	23	0	22	180	19	0	9	1	18	0	484
05:15 PM	15	169	6	0	19	0	13	0	11	171	31	0	6	0	16	2	459
05:30 PM	16	172	4	0	30	0	25	0	16	178	34	0	6	2	15	0	498
05:45 PM	16	177	5	0	39	0	18	0	19	138	43	0	2	0	12	0	469
Total	67	683	22	0	108	0	79	0	68	667	127	0	23	3	61	2	1910
Grand Total	162	2258	59	0	257	9	268	0	209	2636	397	0	58	9	164	4	6490
Apprch %	6.5	91.1	2.4	0	48.1	1.7	50.2	0	6.4	81.3	12.2	0	24.7	3.8	69.8	1.7	
Total %	2.5	34.8	0.9	0	4	0.1	4.1	0	3.2	40.6	6.1	0	0.9	0.1	2.5	0.1	
Passenger Vehicles	162	2232	59	0	256	9	267	0	208	2608	396	0	56	9	162	4	6428
% Passenger Vehicles	100	98.8	100	0	99.6	100	99.6	0	99.5	98.9	99.7	0	96.6	100	98.8	100	99
Heavy Vehicles	0	15	0	0	1	0	1	0	0	21	1	0	2	0	2	0	43
% Heavy Vehicles	0	0.7	0	0	0.4	0	0.4	0	0	0.8	0.3	0	3.4	0	1.2	0	0.7
Buses	0	11	0	0	0	0	0	0	1	7	0	0	0	0	0	0	19
% Buses	0	0.5	0	0	0	0	0	0	0.5	0.3	0	0	0	0	0	0	0.3

SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Pinellas South  
Site Code :  
Start Date : 5/11/2021  
Page No : 2



# SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Innovation Dr

Site Code :

Start Date : 5/11/2021

Page No : 1

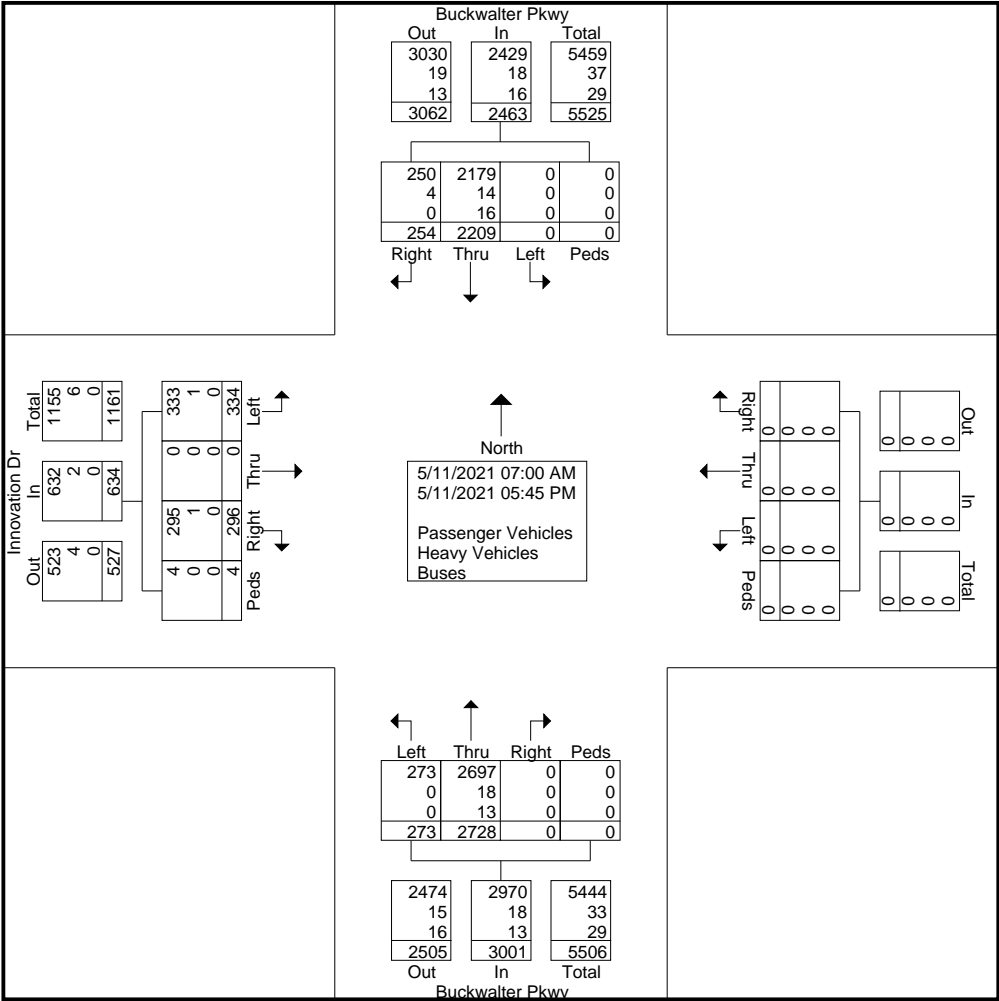
## Groups Printed- Passenger Vehicles - Heavy Vehicles - Buses

Start Time	Buckwalter Pkwy From North				From East				Buckwalter Pkwy From South				Innovation Dr From West				Int. Total
	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	
07:00 AM	0	74	4	0	0	0	0	0	2	115	0	0	11	0	3	0	209
07:15 AM	0	100	10	0	0	0	0	0	4	129	0	0	7	0	6	0	256
07:30 AM	0	125	10	0	0	0	0	0	7	179	0	0	9	0	5	0	335
07:45 AM	0	140	11	0	0	0	0	0	13	156	0	0	13	0	6	0	339
Total	0	439	35	0	0	0	0	0	26	579	0	0	40	0	20	0	1139
08:00 AM	0	163	12	0	0	0	0	0	6	152	0	0	13	0	10	0	356
08:15 AM	0	139	6	0	0	0	0	0	9	178	0	0	12	0	12	0	356
08:30 AM	0	94	14	0	0	0	0	0	16	159	0	0	10	0	11	0	304
08:45 AM	0	108	8	0	0	0	0	0	17	178	0	0	13	0	20	1	345
Total	0	504	40	0	0	0	0	0	48	667	0	0	48	0	53	1	1361
04:00 PM	0	156	18	0	0	0	0	0	18	210	0	0	27	0	24	0	453
04:15 PM	0	168	28	0	0	0	0	0	20	172	0	0	28	0	23	0	439
04:30 PM	0	166	19	0	0	0	0	0	28	172	0	0	27	0	32	1	445
04:45 PM	0	156	17	0	0	0	0	0	21	159	0	0	35	0	25	1	414
Total	0	646	82	0	0	0	0	0	87	713	0	0	117	0	104	2	1751
05:00 PM	0	160	24	0	0	0	0	0	19	210	0	0	24	0	32	0	469
05:15 PM	0	157	30	0	0	0	0	0	34	189	0	0	34	0	24	0	468
05:30 PM	0	149	23	0	0	0	0	0	31	198	0	0	36	0	25	0	462
05:45 PM	0	154	20	0	0	0	0	0	28	172	0	0	35	0	38	1	448
Total	0	620	97	0	0	0	0	0	112	769	0	0	129	0	119	1	1847
Grand Total	0	2209	254	0	0	0	0	0	273	2728	0	0	334	0	296	4	6098
Apprch %	0	89.7	10.3	0	0	0	0	0	9.1	90.9	0	0	52.7	0	46.7	0.6	
Total %	0	36.2	4.2	0	0	0	0	0	4.5	44.7	0	0	5.5	0	4.9	0.1	
Passenger Vehicles	0	2179	250	0	0	0	0	0	273	2697	0	0	333	0	295	4	6031
% Passenger Vehicles	0	98.6	98.4	0	0	0	0	0	100	98.9	0	0	99.7	0	99.7	100	98.9
Heavy Vehicles	0	14	4	0	0	0	0	0	0	18	0	0	1	0	1	0	38
% Heavy Vehicles	0	0.6	1.6	0	0	0	0	0	0	0.7	0	0	0.3	0	0.3	0	0.6
Buses	0	16	0	0	0	0	0	0	0	13	0	0	0	0	0	0	29
% Buses	0	0.7	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0.5

SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Innovation Dr  
Site Code :  
Start Date : 5/11/2021  
Page No : 2



# SHORT COUNTS

Item 9.

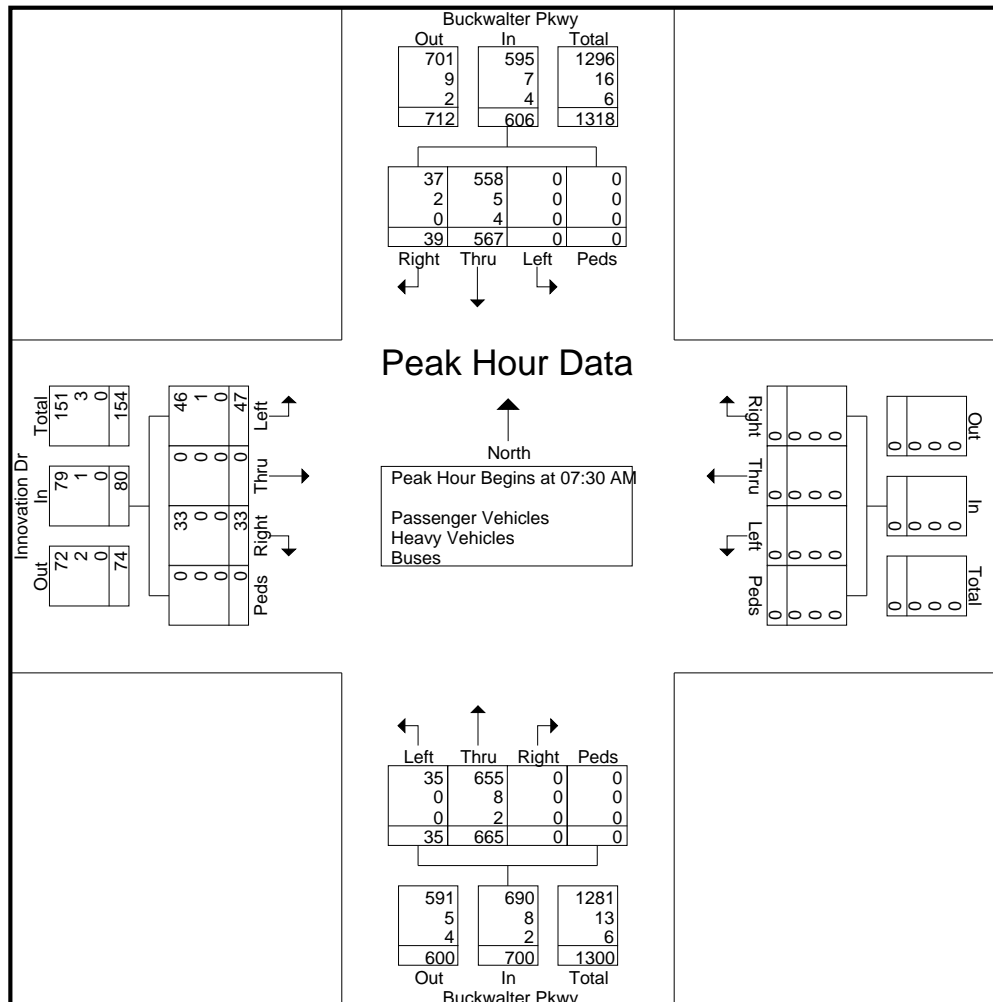
File Name : Buckwalter Pkwy @ Innovation Dr

Site Code :

Start Date : 5/11/2021

Page No : 3

	Buckwalter Pkwy From North					From East					Buckwalter Pkwy From South					Innovation Dr From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 11:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:30 AM																					
07:30 AM	0	125	10	0	135	0	0	0	0	0	7	179	0	0	186	9	0	5	0	14	335
07:45 AM	0	140	11	0	151	0	0	0	0	0	13	156	0	0	169	13	0	6	0	19	339
08:00 AM	0	163	12	0	175	0	0	0	0	0	6	152	0	0	158	13	0	10	0	23	356
08:15 AM	0	139	6	0	145	0	0	0	0	0	9	178	0	0	187	12	0	12	0	24	356
Total Volume	0	567	39	0	606	0	0	0	0	0	35	665	0	0	700	47	0	33	0	80	1386
% App. Total	0	93.6	6.4	0		0	0	0	0	0	5	95	0	0		58.8	0	41.2	0		
PHF	.000	.870	.813	.000	.866	.000	.000	.000	.000	.000	.673	.929	.000	.000	.936	.904	.000	.688	.000	.833	.973
Passenger Vehicles	0	558	37	0	595	0	0	0	0	0	35	655	0	0	690	46	0	33	0	79	1364
% Passenger Vehicles		98.4	94.9									98.5				97.9					
Heavy Vehicles	0	5	2	0	7	0	0	0	0	0	0	8	0	0	8	1	0	0	0	1	16
% Heavy Vehicles	0	0.9	5.1	0	1.2	0	0	0	0	0	0	1.2	0	0	1.1	2.1	0	0	0	1.3	1.2
Buses	0	4	0	0	4	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	6
% Buses	0	0.7	0	0	0.7	0	0	0	0	0	0	0.3	0	0	0.3	0	0	0	0	0	0.4



# SHORT COUNTS

Item 9.

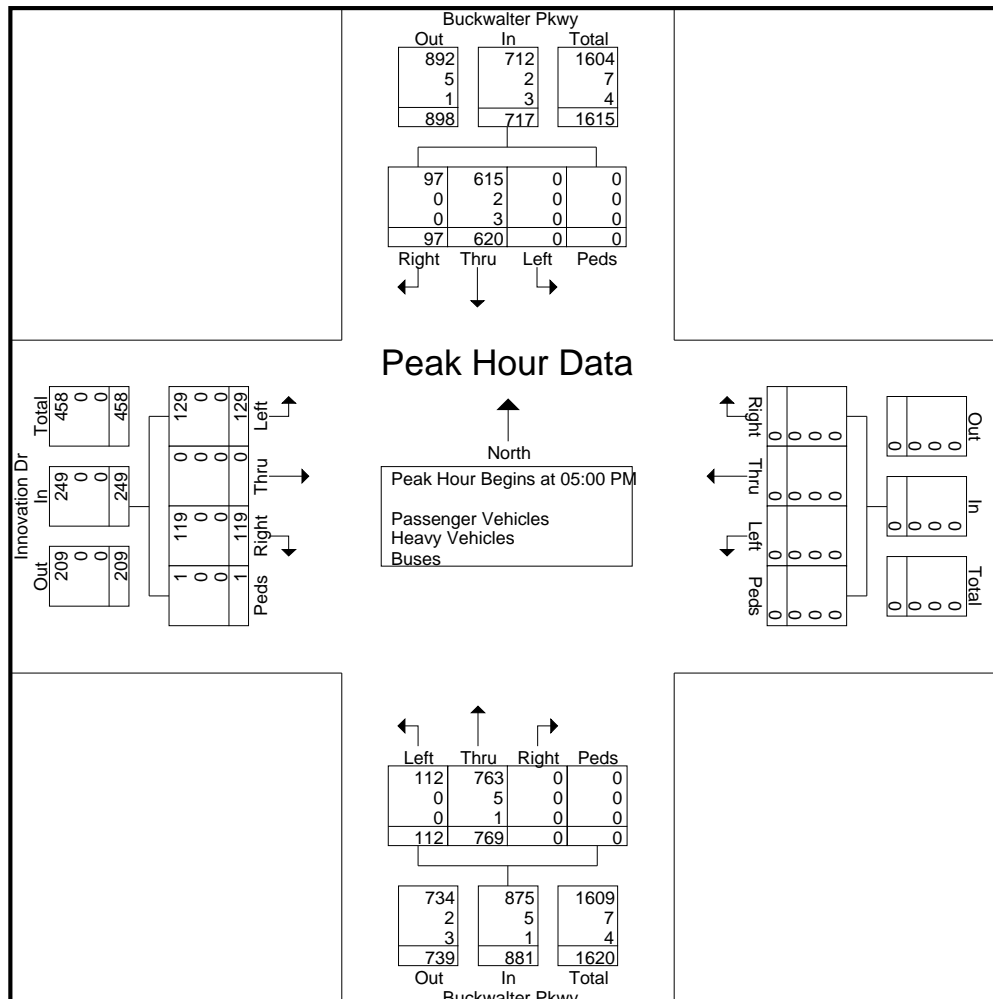
File Name : Buckwalter Pkwy @ Innovation Dr

Site Code :

Start Date : 5/11/2021

Page No : 4

	Buckwalter Pkwy From North					From East					Buckwalter Pkwy From South					Innovation Dr From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 12:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 05:00 PM																					
05:00 PM	0	160	24	0	184	0	0	0	0	0	19	210	0	0	229	24	0	32	0	56	469
05:15 PM	0	157	30	0	187	0	0	0	0	0	34	189	0	0	223	34	0	24	0	58	468
05:30 PM	0	149	23	0	172	0	0	0	0	0	31	198	0	0	229	36	0	25	0	61	462
05:45 PM	0	154	20	0	174	0	0	0	0	0	28	172	0	0	200	35	0	38	1	74	448
Total Volume	0	620	97	0	717	0	0	0	0	0	112	769	0	0	881	129	0	119	1	249	1847
% App. Total	0	86.5	13.5	0		0	0	0	0	0	12.7	87.3	0	0		51.8	0	47.8	0.4		
PHF	.000	.969	.808	.000	.959	.000	.000	.000	.000	.000	.824	.915	.000	.000	.962	.896	.000	.783	.250	.841	.985
Passenger Vehicles	0	615	97	0	712	0	0	0	0	0	112	763	0	0	875	129	0	119	1	249	1836
% Passenger Vehicles		99.2										99.2									
Heavy Vehicles	0	2	0	0	2	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	7
% Heavy Vehicles	0	0.3	0	0	0.3	0	0	0	0	0	0	0.7	0	0	0.6	0	0	0	0	0	0.4
Buses	0	3	0	0	3	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	4
% Buses	0	0.5	0	0	0.4	0	0	0	0	0	0	0.1	0	0	0.1	0	0	0	0	0	0.2



# SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Progressive St  
 Site Code :  
 Start Date : 5/11/2021  
 Page No : 1

## Groups Printed- Passenger Vehicles - Heavy Vehicles - Buses

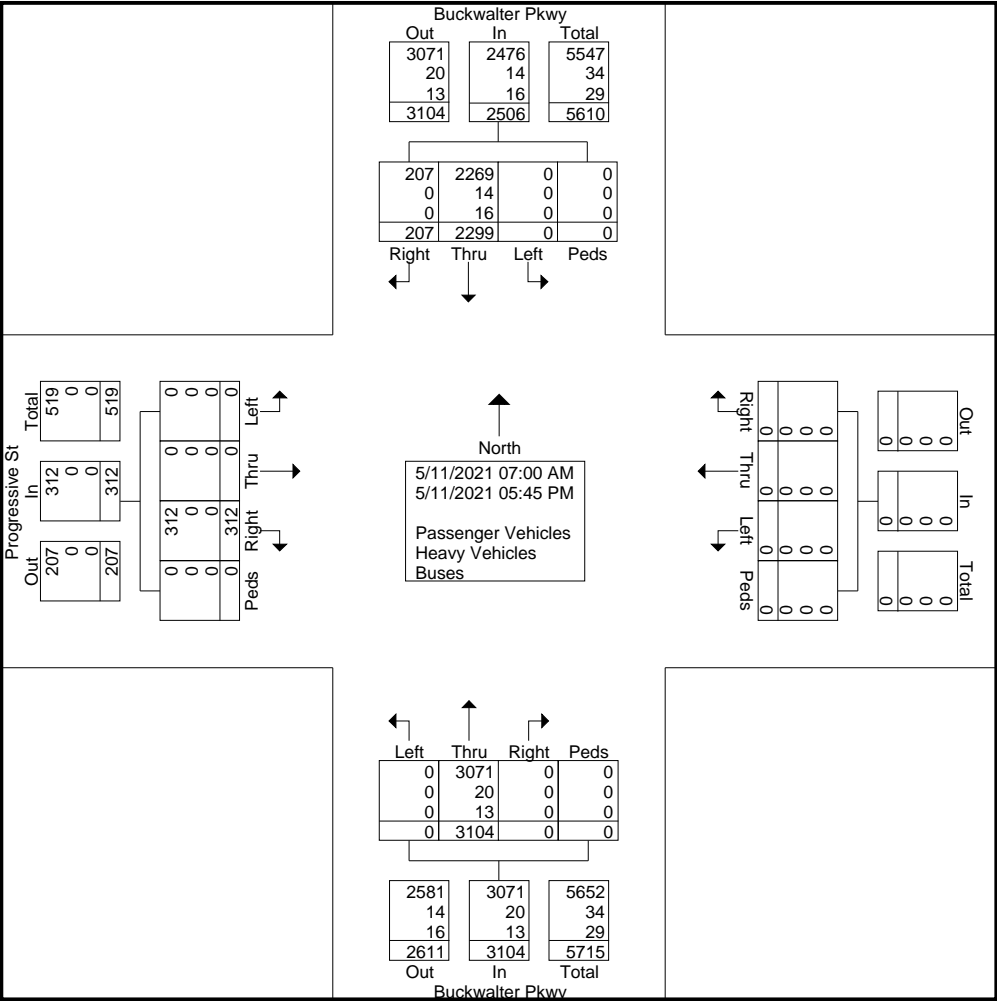
Start Time	Buckwalter Pkwy From North				From East				Buckwalter Pkwy From South				Progressive St From West				Int. Total
	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	
07:00 AM	0	80	5	0	0	0	0	0	0	121	0	0	0	0	2	0	208
07:15 AM	0	86	7	0	0	0	0	0	0	132	0	0	0	0	7	0	232
07:30 AM	0	116	15	0	0	0	0	0	0	184	0	0	0	0	12	0	327
07:45 AM	0	133	15	0	0	0	0	0	0	186	0	0	0	0	14	0	348
Total	0	415	42	0	0	0	0	0	0	623	0	0	0	0	35	0	1115
08:00 AM	0	143	18	0	0	0	0	0	0	171	0	0	0	0	17	0	349
08:15 AM	0	154	15	0	0	0	0	0	0	189	0	0	0	0	11	0	369
08:30 AM	0	99	9	0	0	0	0	0	0	191	0	0	0	0	9	0	308
08:45 AM	0	109	15	0	0	0	0	0	0	206	0	0	0	0	22	0	352
Total	0	505	57	0	0	0	0	0	0	757	0	0	0	0	59	0	1378
04:00 PM	0	166	13	0	0	0	0	0	0	231	0	0	0	0	17	0	427
04:15 PM	0	168	11	0	0	0	0	0	0	206	0	0	0	0	26	0	411
04:30 PM	0	197	13	0	0	0	0	0	0	176	0	0	0	0	20	0	406
04:45 PM	0	173	14	0	0	0	0	0	0	205	0	0	0	0	23	0	415
Total	0	704	51	0	0	0	0	0	0	818	0	0	0	0	86	0	1659
05:00 PM	0	154	17	0	0	0	0	0	0	228	0	0	0	0	38	0	437
05:15 PM	0	182	11	0	0	0	0	0	0	231	0	0	0	0	25	0	449
05:30 PM	0	161	19	0	0	0	0	0	0	242	0	0	0	0	30	0	452
05:45 PM	0	178	10	0	0	0	0	0	0	205	0	0	0	0	39	0	432
Total	0	675	57	0	0	0	0	0	0	906	0	0	0	0	132	0	1770
Grand Total	0	2299	207	0	0	0	0	0	0	3104	0	0	0	0	312	0	5922
Apprch %	0	91.7	8.3	0	0	0	0	0	0	100	0	0	0	0	100	0	
Total %	0	38.8	3.5	0	0	0	0	0	0	52.4	0	0	0	0	5.3	0	
Passenger Vehicles	0	2269	207	0	0	0	0	0	0	3071	0	0	0	0	312	0	5859
% Passenger Vehicles	0	98.7	100	0	0	0	0	0	0	98.9	0	0	0	0	100	0	98.9
Heavy Vehicles	0	14	0	0	0	0	0	0	0	20	0	0	0	0	0	0	34
% Heavy Vehicles	0	0.6	0	0	0	0	0	0	0	0.6	0	0	0	0	0	0	0.6
Buses	0	16	0	0	0	0	0	0	0	13	0	0	0	0	0	0	29
% Buses	0	0.7	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0.5



SHORT COUNTS

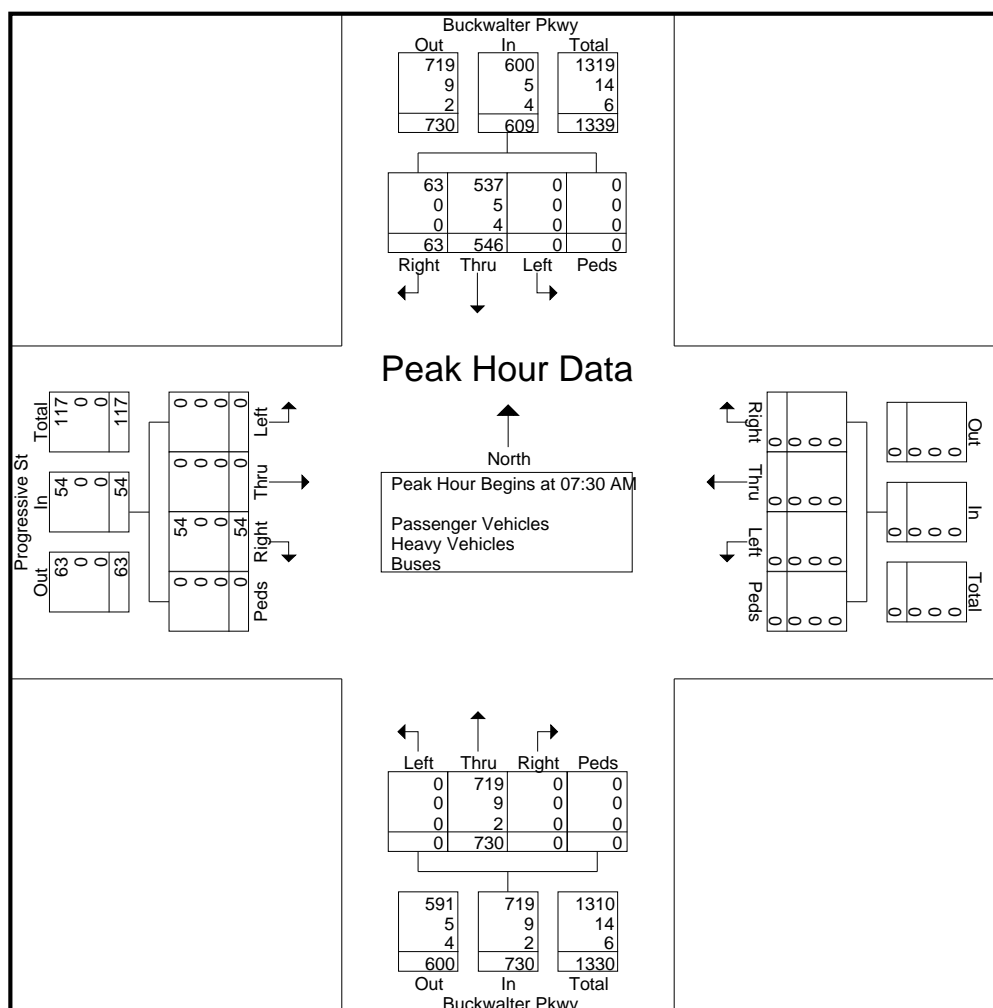
Item 9.

File Name : Buckwalter Pkwy @ Progressive St  
Site Code :  
Start Date : 5/11/2021  
Page No : 2



*Item 9.*

	Buckwalter Pkwy From North					From East					Buckwalter Pkwy From South					Progressive St From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 11:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:30 AM																					
07:30 AM	0	116	15	0	131	0	0	0	0	0	0	184	0	0	184	0	0	12	0	12	327
07:45 AM	0	133	15	0	148	0	0	0	0	0	0	186	0	0	186	0	0	14	0	14	348
08:00 AM	0	143	18	0	161	0	0	0	0	0	0	171	0	0	171	0	0	17	0	17	349
08:15 AM	0	154	15	0	169	0	0	0	0	0	0	189	0	0	189	0	0	11	0	11	369
Total Volume	0	546	63	0	609	0	0	0	0	0	0	730	0	0	730	0	0	54	0	54	1393
% App. Total	0	89.7	10.3	0		0	0	0	0	0	0	100	0	0		0	0	100	0		
PHF	.000	.886	.875	.000	.901	.000	.000	.000	.000	.000	.000	.966	.000	.000	.966	.000	.000	.794	.000	.794	.944
Passenger Vehicles	0	537	63	0	600	0	0	0	0	0	0	719	0	0	719	0	0	54	0	54	1373
% Passenger Vehicles		98.4										98.5									
Heavy Vehicles	0	5	0	0	5	0	0	0	0	0	0	9	0	0	9	0	0	0	0	0	14
% Heavy Vehicles	0	0.9	0	0	0.8	0	0	0	0	0	0	1.2	0	0	1.2	0	0	0	0	0	1.0
Buses	0	4	0	0	4	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	6
% Buses	0	0.7	0	0	0.7	0	0	0	0	0	0	0.3	0	0	0.3	0	0	0	0	0	0.4

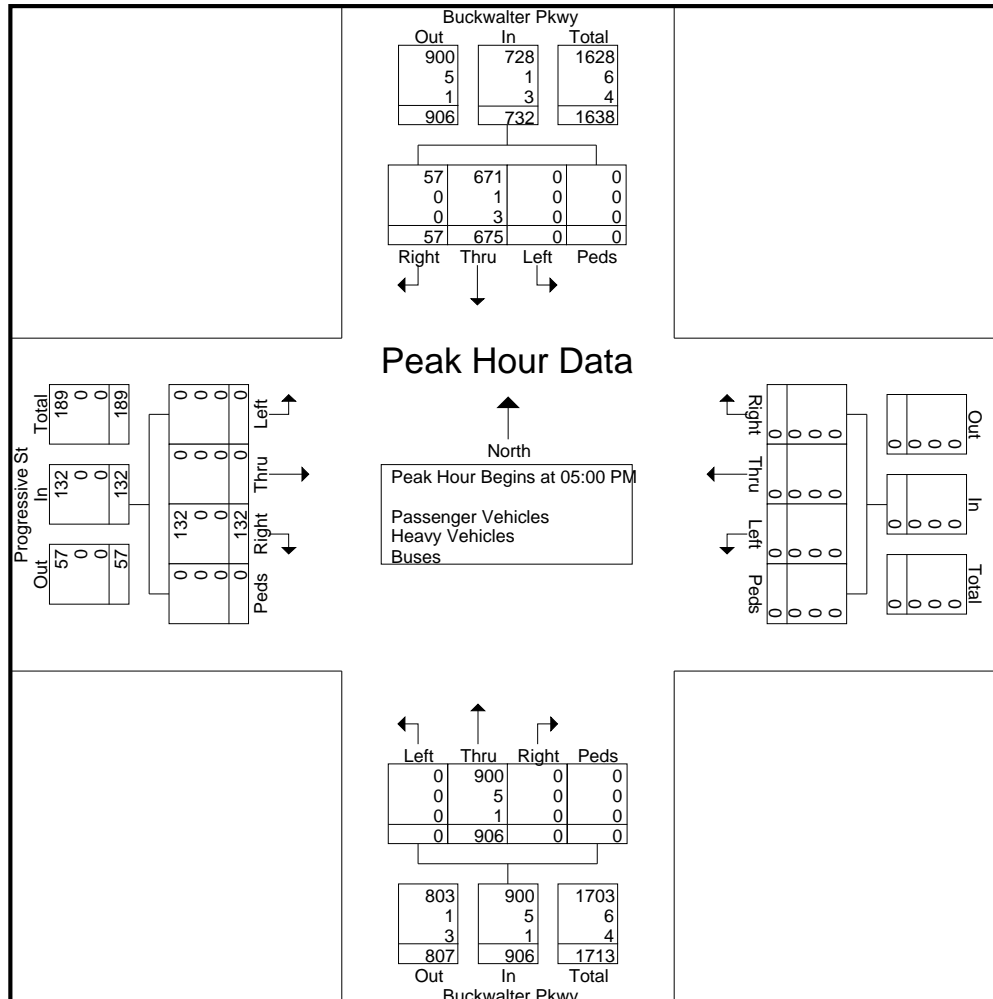


# SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Progressive St  
 Site Code :  
 Start Date : 5/11/2021  
 Page No : 4

	Buckwalter Pkwy From North					From East					Buckwalter Pkwy From South					Progressive St From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 12:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 05:00 PM																					
05:00 PM	0	154	17	0	171	0	0	0	0	0	0	228	0	0	228	0	0	38	0	38	437
05:15 PM	0	<b>182</b>	11	0	<b>193</b>	0	0	0	0	0	0	231	0	0	231	0	0	25	0	25	449
05:30 PM	0	161	<b>19</b>	0	180	0	0	0	0	0	0	<b>242</b>	0	0	<b>242</b>	0	0	30	0	30	<b>452</b>
05:45 PM	0	178	10	0	188	0	0	0	0	0	0	205	0	0	205	0	0	<b>39</b>	0	<b>39</b>	432
Total Volume	0	675	57	0	732	0	0	0	0	0	0	906	0	0	906	0	0	132	0	132	1770
% App. Total	0	92.2	7.8	0		0	0	0	0	0	0	100	0	0		0	0	100	0		
PHF	.000	.927	.750	.000	.948	.000	.000	.000	.000	.000	.000	.936	.000	.000	.936	.000	.000	.846	.000	.846	.979
Passenger Vehicles	0	671	57	0	728	0	0	0	0	0	0	900	0	0	900	0	0	132	0	132	1760
% Passenger Vehicles		99.4										99.3									
Heavy Vehicles	0	1	0	0	1	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	6
% Heavy Vehicles	0	0.1	0	0	0.1	0	0	0	0	0	0	0.6	0	0	0.6	0	0	0	0	0	0.3
Buses	0	3	0	0	3	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	4
% Buses	0	0.4	0	0	0.4	0	0	0	0	0	0	0.1	0	0	0.1	0	0	0	0	0	0.2

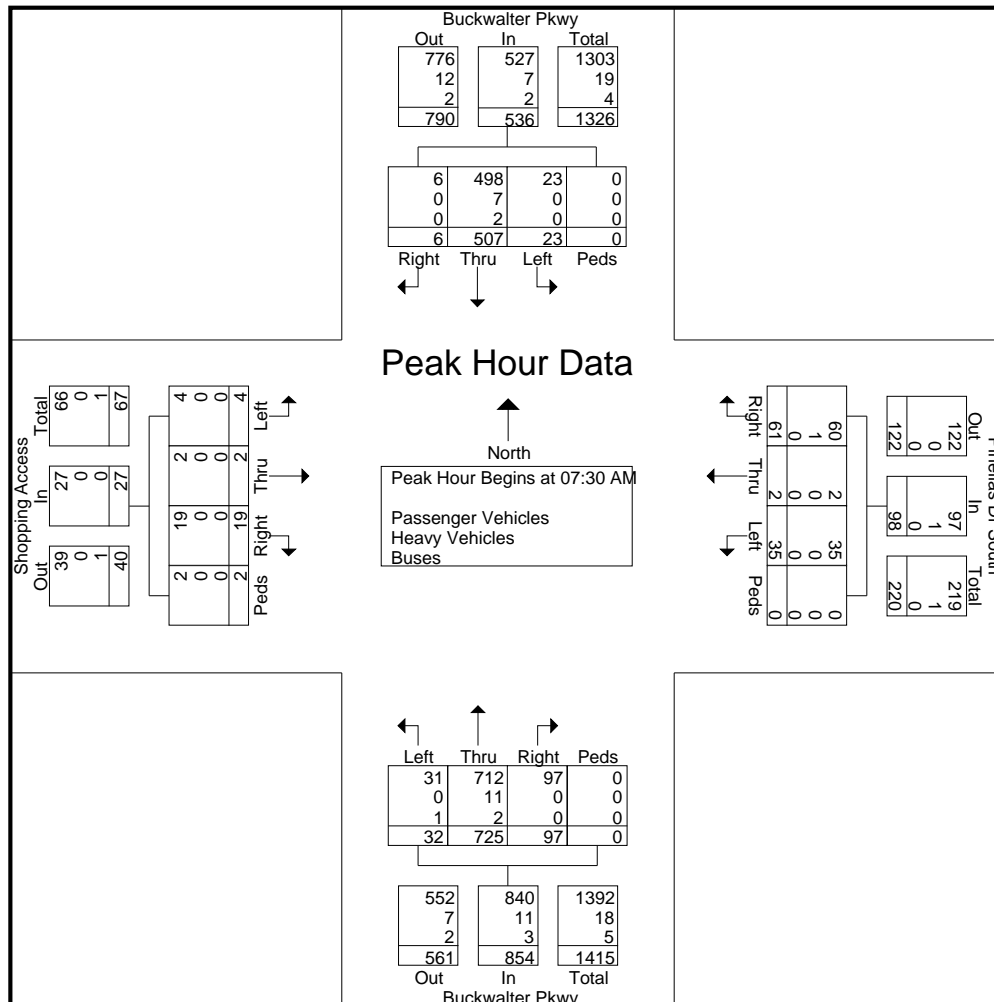


# SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Pinellas South  
 Site Code :  
 Start Date : 5/11/2021  
 Page No : 3

	Buckwalter Pkwy From North					Pinellas Dr South From East					Buckwalter Pkwy From South					Shopping Access From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 11:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:30 AM																					
07:30 AM	10	134	0	0	144	5	2	16	0	23	11	192	23	0	226	1	0	2	0	3	396
07:45 AM	3	120	1	0	124	12	0	11	0	23	7	182	29	0	218	2	1	3	0	6	371
08:00 AM	3	145	1	0	149	10	0	18	0	28	6	176	25	0	207	1	1	8	0	10	394
08:15 AM	7	108	4	0	119	8	0	16	0	24	8	175	20	0	203	0	0	6	2	8	354
Total Volume	23	507	6	0	536	35	2	61	0	98	32	725	97	0	854	4	2	19	2	27	1515
% App. Total	4.3	94.6	1.1	0		35.7	2	62.2	0		3.7	84.9	11.4	0		14.8	7.4	70.4	7.4		
PHF	.575	.874	.375	.000	.899	.729	.250	.847	.000	.875	.727	.944	.836	.000	.945	.500	.500	.594	.250	.675	.956
Passenger Vehicles	23	498	6	0	527	35	2	60	0	97	31	712	97	0	840	4	2	19	2	27	1491
% Passenger Vehicles		98.2						98.4			96.9	98.2									
Heavy Vehicles	0	7	0	0	7	0	0	1	0	1	0	11	0	0	11	0	0	0	0	0	19
% Heavy Vehicles	0	1.4	0	0	1.3	0	0	1.6	0	1.0	0	1.5	0	0	1.3	0	0	0	0	0	1.3
Buses	0	2	0	0	2	0	0	0	0	0	1	2	0	0	3	0	0	0	0	0	5
% Buses	0	0.4	0	0	0.4	0	0	0	0	0	3.1	0.3	0	0	0.4	0	0	0	0	0	0.3



*Item 9.*

Page No : 4

[illegible]

# SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Buckwalter PI Blvd

Site Code :

Start Date : 5/11/2021

Page No : 1

## Groups Printed- Passenger Vehicles - Heavy Vehicles - Buses

Start Time	Buckwalter Pkwy From North				Church Access From East				Buckwalter Pkwy From South				Buckwalter PI Blvd From West				Int. Total
	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	
07:00 AM	3	57	15	0	0	0	0	0	21	104	3	0	16	0	15	0	234
07:15 AM	4	86	13	0	0	0	0	0	29	124	1	0	9	0	23	0	289
07:30 AM	0	93	26	0	0	0	0	0	39	171	1	0	19	1	29	0	379
07:45 AM	1	129	18	0	0	0	1	0	48	165	0	0	14	0	22	0	398
Total	8	365	72	0	0	0	1	0	137	564	5	0	58	1	89	0	1300
08:00 AM	2	145	15	0	1	0	1	1	34	144	0	0	21	0	13	0	377
08:15 AM	1	133	22	0	1	1	2	0	48	177	0	0	16	0	22	1	424
08:30 AM	2	90	15	0	3	1	4	0	45	163	1	0	19	0	22	0	365
08:45 AM	0	102	25	0	1	1	2	0	45	170	1	0	26	0	28	0	401
Total	5	470	77	0	6	3	9	1	172	654	2	0	82	0	85	1	1567
04:00 PM	0	179	26	0	0	0	0	0	75	175	0	0	46	0	37	0	538
04:15 PM	0	188	33	0	0	0	0	0	52	163	0	0	41	0	39	0	516
04:30 PM	0	168	31	0	0	0	0	0	84	157	0	0	39	0	48	0	527
04:45 PM	0	176	27	0	0	0	0	0	58	160	0	0	40	0	42	0	503
Total	0	711	117	0	0	0	0	0	269	655	0	0	166	0	166	0	2084
05:00 PM	1	164	30	0	0	0	1	0	65	176	1	0	45	1	43	0	527
05:15 PM	1	161	27	0	0	0	1	0	66	180	0	0	39	0	56	0	531
05:30 PM	0	154	27	0	0	0	0	1	83	173	0	0	50	0	53	0	541
05:45 PM	0	179	36	0	0	0	0	1	93	160	1	0	36	0	38	1	545
Total	2	658	120	0	0	0	2	2	307	689	2	0	170	1	190	1	2144
Grand Total	15	2204	386	0	6	3	12	3	885	2562	9	0	476	2	530	2	7095
Apprch %	0.6	84.6	14.8	0	25	12.5	50	12.5	25.6	74.1	0.3	0	47.1	0.2	52.5	0.2	
Total %	0.2	31.1	5.4	0	0.1	0	0.2	0	12.5	36.1	0.1	0	6.7	0	7.5	0	
Passenger Vehicles	15	2183	384	0	6	3	12	3	879	2539	9	0	468	2	526	2	7031
% Passenger Vehicles	100	99	99.5	0	100	100	100	100	99.3	99.1	100	0	98.3	100	99.2	100	99.1
Heavy Vehicles	0	11	2	0	0	0	0	0	6	15	0	0	7	0	4	0	45
% Heavy Vehicles	0	0.5	0.5	0	0	0	0	0	0.7	0.6	0	0	1.5	0	0.8	0	0.6
Buses	0	10	0	0	0	0	0	0	0	8	0	0	1	0	0	0	19
% Buses	0	0.5	0	0	0	0	0	0	0	0.3	0	0	0.2	0	0	0	0.3

# SHORT COUNTS

Item 9.

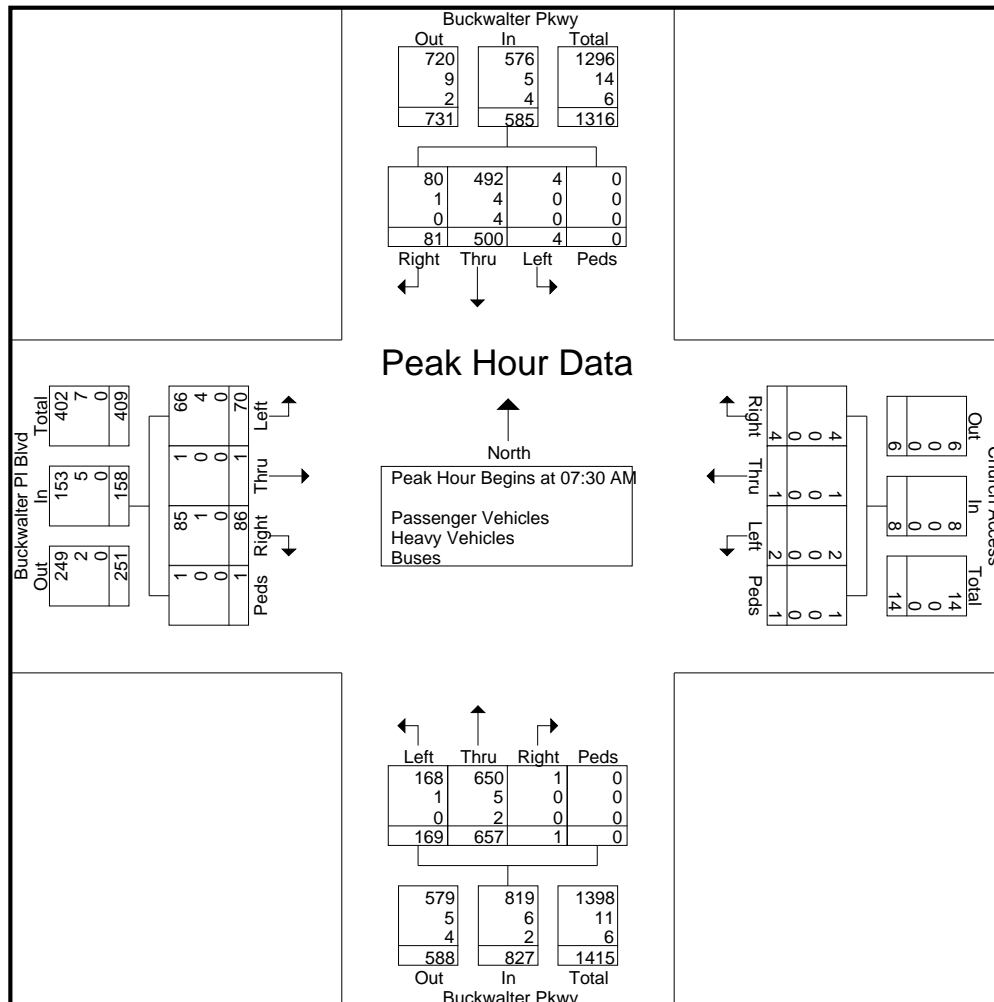
File Name : Buckwalter Pkwy @ Buckwalter PI Blvd

Site Code :

Start Date : 5/11/2021

Page No : 2

	Buckwalter Pkwy From North					Church Access From East					Buckwalter Pkwy From South					Buckwalter PI Blvd From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 11:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:30 AM																					
07:30 AM	0	93	26	0	119	0	0	0	0	0	39	171	1	0	211	19	1	29	0	49	379
07:45 AM	1	129	18	0	148	0	0	1	0	1	48	165	0	0	213	14	0	22	0	36	398
08:00 AM	2	145	15	0	162	1	0	1	1	3	34	144	0	0	178	21	0	13	0	34	377
08:15 AM	1	133	22	0	156	1	1	2	0	4	48	177	0	0	225	16	0	22	1	39	424
Total Volume	4	500	81	0	585	2	1	4	1	8	169	657	1	0	827	70	1	86	1	158	1578
% App. Total	0.7	85.5	13.8	0		25	12.5	50	12.5		20.4	79.4	0.1	0		44.3	0.6	54.4	0.6		
PHF	.500	.862	.779	.000	.903	.500	.250	.500	.250	.500	.880	.928	.250	.000	.919	.833	.250	.741	.250	.806	.930
Passenger Vehicles	4	492	80	0	576	2	1	4	1	8	168	650	1	0	819	66	1	85	1	153	1556
% Passenger Vehicles		98.4	98.8								99.4	98.9				94.3		98.8			
Heavy Vehicles	0	4	1	0	5	0	0	0	0	0	1	5	0	0	6	4	0	1	0	5	16
% Heavy Vehicles	0	0.8	1.2	0	0.9	0	0	0	0	0	0.6	0.8	0	0	0.7	5.7	0	1.2	0	3.2	1.0
Buses	0	4	0	0	4	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	6
% Buses	0	0.8	0	0	0.7	0	0	0	0	0	0	0.3	0	0	0.2	0	0	0	0	0	0.4



# SHORT COUNTS

Item 9.

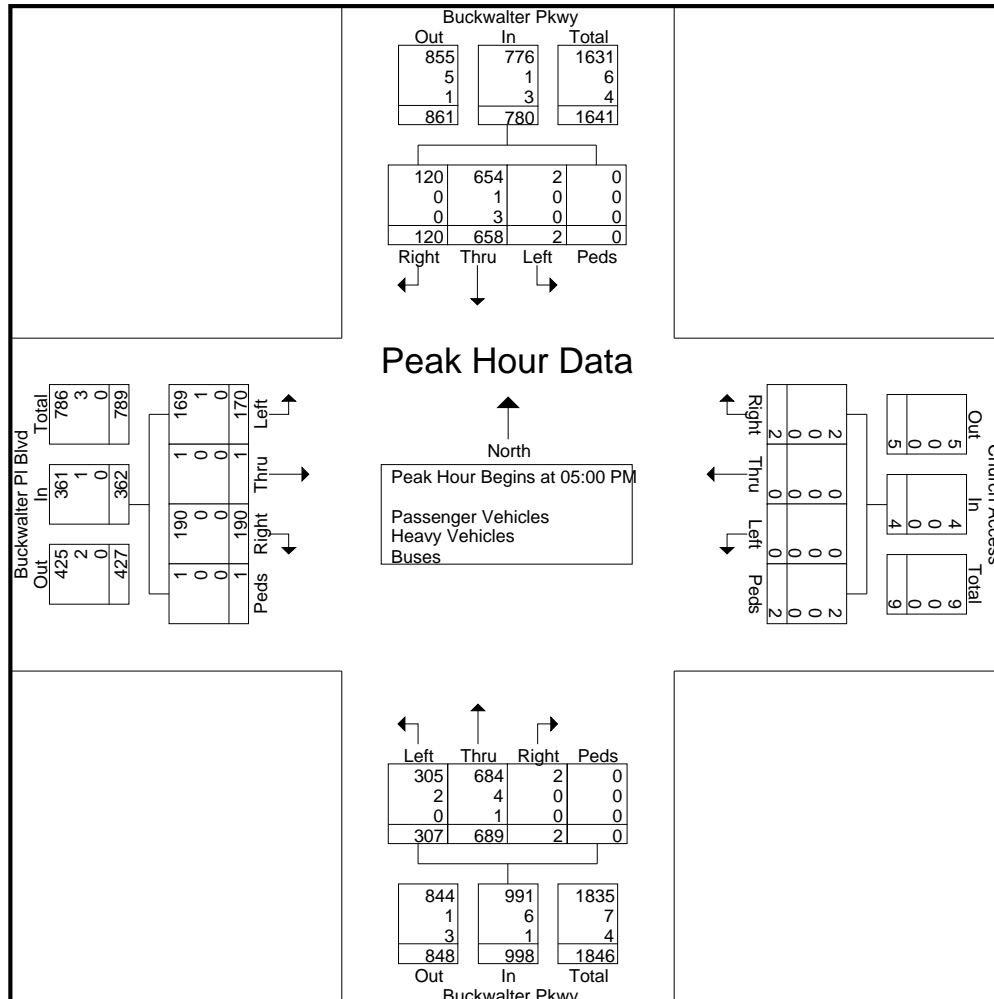
File Name : Buckwalter Pkwy @ Buckwalter Pl Blvd

Site Code :

Start Date : 5/11/2021

Page No : 3

	Buckwalter Pkwy From North					Church Access From East					Buckwalter Pkwy From South					Buckwalter Pl Blvd From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 12:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 05:00 PM																					
05:00 PM	1	164	30	0	195	0	0	1	0	1	65	176	1	0	242	45	1	43	0	89	527
05:15 PM	1	161	27	0	189	0	0	1	0	1	66	180	0	0	246	39	0	56	0	95	531
05:30 PM	0	154	27	0	181	0	0	0	1	1	83	173	0	0	256	50	0	53	0	103	541
05:45 PM	0	179	36	0	215	0	0	0	1	1	93	160	1	0	254	36	0	38	1	75	545
Total Volume	2	658	120	0	780	0	0	2	2	4	307	689	2	0	998	170	1	190	1	362	2144
% App. Total	0.3	84.4	15.4	0		0	0	50	50		30.8	69	0.2	0		47	0.3	52.5	0.3		
PHF	.500	.919	.833	.000	.907	.000	.000	.500	.500	1.00	.825	.957	.500	.000	.975	.850	.250	.848	.250	.879	.983
Passenger Vehicles	2	654	120	0	776	0	0	2	2	4	305	684	2	0	991	169	1	190	1	361	2132
% Passenger Vehicles		99.4									99.3	99.3				99.4					
Heavy Vehicles	0	1	0	0	1	0	0	0	0	0	2	4	0	0	6	1	0	0	0	1	8
% Heavy Vehicles	0	0.2	0	0	0.1	0	0	0	0	0	0.7	0.6	0	0	0.6	0.6	0	0	0	0.3	0.4
Buses	0	3	0	0	3	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	4
% Buses	0	0.5	0	0	0.4	0	0	0	0	0	0	0.1	0	0	0.1	0	0	0	0	0	0.2





# SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Buckwalter PI DW

Site Code :

Start Date : 5/11/2021

Page No : 1

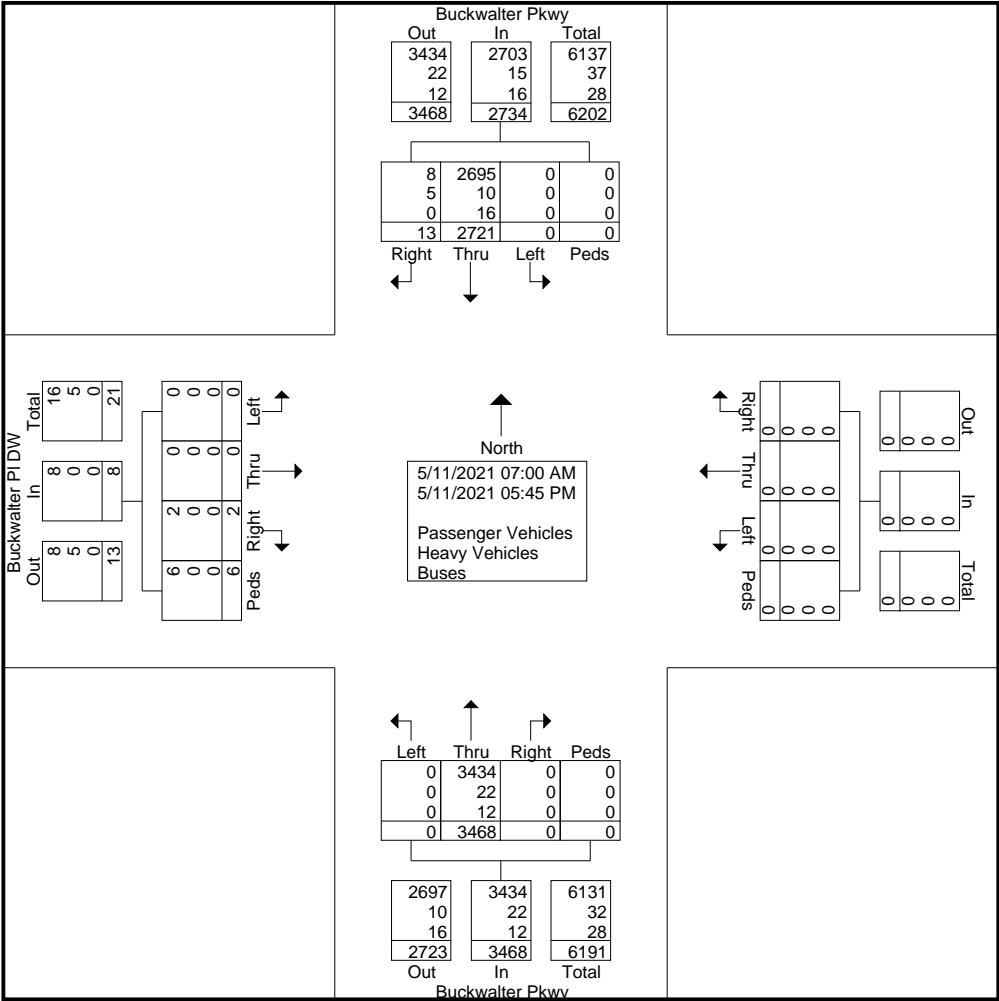
## Groups Printed- Passenger Vehicles - Heavy Vehicles - Buses

	Buckwalter Pkwy From North				From East				Buckwalter Pkwy From South				Buckwalter PI DW From West					
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Int. Total	
07:00 AM	0	73	1	0	0	0	0	0	0	132	0	0	0	0	0	0	1	207
07:15 AM	0	106	1	0	0	0	0	0	0	150	0	0	0	0	0	0	0	257
07:30 AM	0	125	1	0	0	0	0	0	0	222	0	0	0	0	0	0	0	348
07:45 AM	0	149	1	0	0	0	0	0	0	209	0	0	0	0	0	0	1	360
Total	0	453	4	0	0	0	0	0	0	713	0	0	0	0	0	0	2	1172
08:00 AM	0	169	1	0	0	0	0	0	0	185	0	0	0	0	0	0	0	355
08:15 AM	0	147	0	0	0	0	0	0	0	200	0	0	0	0	0	0	1	348
08:30 AM	0	113	1	0	0	0	0	0	0	207	0	0	0	0	0	0	1	322
08:45 AM	0	132	3	0	0	0	0	0	0	211	0	0	0	0	0	0	0	346
Total	0	561	5	0	0	0	0	0	0	803	0	0	0	0	0	0	2	1371
04:00 PM	0	209	0	0	0	0	0	0	0	252	0	0	0	0	0	0	0	461
04:15 PM	0	215	0	0	0	0	0	0	0	218	0	0	0	0	0	0	0	433
04:30 PM	0	205	1	0	0	0	0	0	0	240	0	0	0	0	0	0	0	446
04:45 PM	0	221	0	0	0	0	0	0	0	219	0	0	0	0	0	0	1	441
Total	0	850	1	0	0	0	0	0	0	929	0	0	0	0	0	0	1	1781
05:00 PM	0	212	0	0	0	0	0	0	0	256	0	0	0	0	0	2	0	470
05:15 PM	0	217	0	0	0	0	0	0	0	244	0	0	0	0	0	0	0	461
05:30 PM	0	215	0	0	0	0	0	0	0	275	0	0	0	0	0	0	0	490
05:45 PM	0	213	3	0	0	0	0	0	0	248	0	0	0	0	0	0	1	465
Total	0	857	3	0	0	0	0	0	0	1023	0	0	0	0	0	2	1	1886
Grand Total	0	2721	13	0	0	0	0	0	0	3468	0	0	0	0	0	2	6	6210
Apprch %	0	99.5	0.5	0	0	0	0	0	0	100	0	0	0	0	0	25	75	
Total %	0	43.8	0.2	0	0	0	0	0	0	55.8	0	0	0	0	0	0	0.1	
Passenger Vehicles	0	2695	8	0	0	0	0	0	0	3434	0	0	0	0	0	2	6	6145
% Passenger Vehicles	0	99	61.5	0	0	0	0	0	0	99	0	0	0	0	0	100	100	99
Heavy Vehicles	0	10	5	0	0	0	0	0	0	22	0	0	0	0	0	0	0	37
% Heavy Vehicles	0	0.4	38.5	0	0	0	0	0	0	0.6	0	0	0	0	0	0	0	0.6
Buses	0	16	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	28
% Buses	0	0.6	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0.5

SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Buckwalter PI DW  
Site Code :  
Start Date : 5/11/2021  
Page No : 2

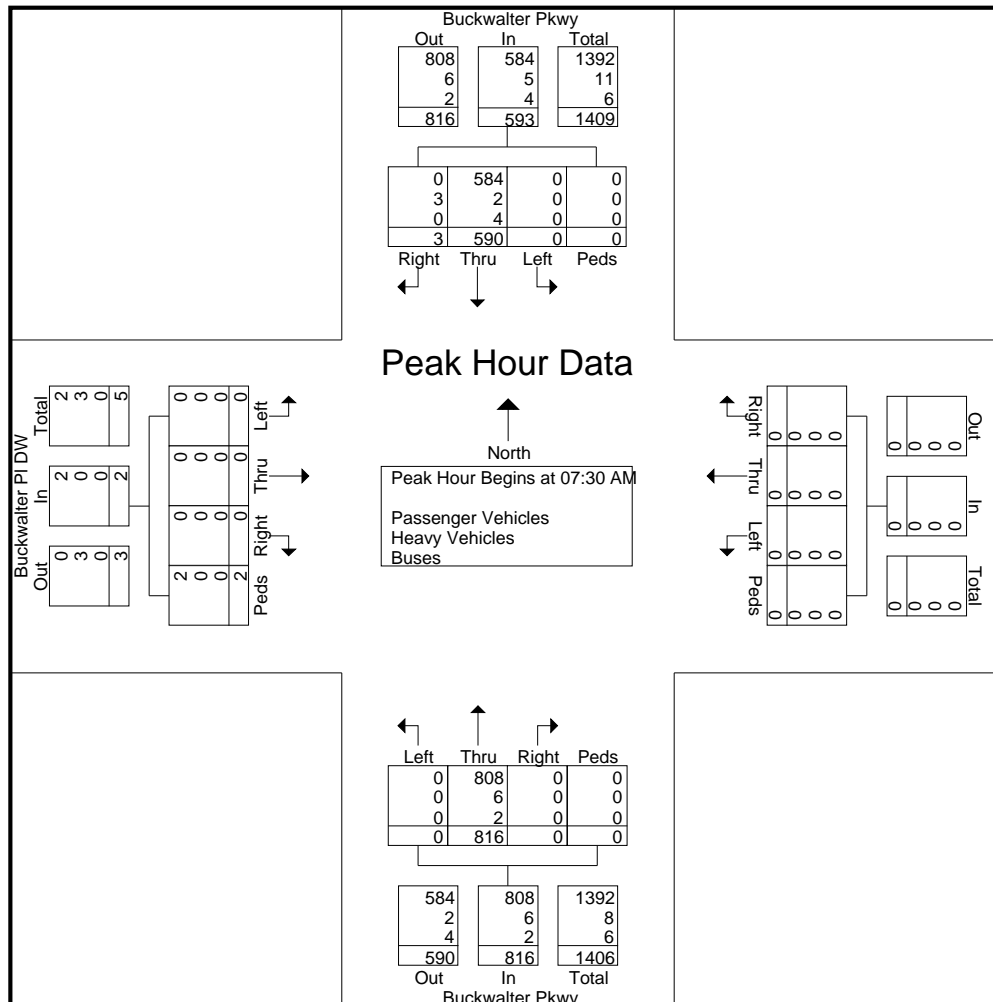


# SHORT COUNTS

Item 9.

File Name : Buckwalter Pkwy @ Buckwalter PI DW  
 Site Code :  
 Start Date : 5/11/2021  
 Page No : 3

	Buckwalter Pkwy From North					From East					Buckwalter Pkwy From South					Buckwalter PI DW From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 11:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:30 AM																					
07:30 AM	0	125	1	0	126	0	0	0	0	0	0	222	0	0	222	0	0	0	0	0	348
07:45 AM	0	149	1	0	150	0	0	0	0	0	0	209	0	0	209	0	0	0	1	1	360
08:00 AM	0	169	1	0	170	0	0	0	0	0	0	185	0	0	185	0	0	0	0	0	355
08:15 AM	0	147	0	0	147	0	0	0	0	0	0	200	0	0	200	0	0	0	1	1	348
Total Volume	0	590	3	0	593	0	0	0	0	0	0	816	0	0	816	0	0	0	2	2	1411
% App. Total	0	99.5	0.5	0		0	0	0	0	0	0	100	0	0		0	0	0	100		
PHF	.000	.873	.750	.000	.872	.000	.000	.000	.000	.000	.000	.919	.000	.000	.919	.000	.000	.000	.500	.500	.980
Passenger Vehicles	0	584	0	0	584	0	0	0	0	0	0	808	0	0	808	0	0	0	2	2	1394
% Passenger Vehicles		99.0										99.0									
Heavy Vehicles	0	2	3	0	5	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	11
% Heavy Vehicles	0	0.3	100	0	0.8	0	0	0	0	0	0	0.7	0	0	0.7	0	0	0	0	0	0.8
Buses	0	4	0	0	4	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	6
% Buses	0	0.7	0	0	0.7	0	0	0	0	0	0	0.2	0	0	0.2	0	0	0	0	0	0.4



# SHORT COUNTS

Item 9.

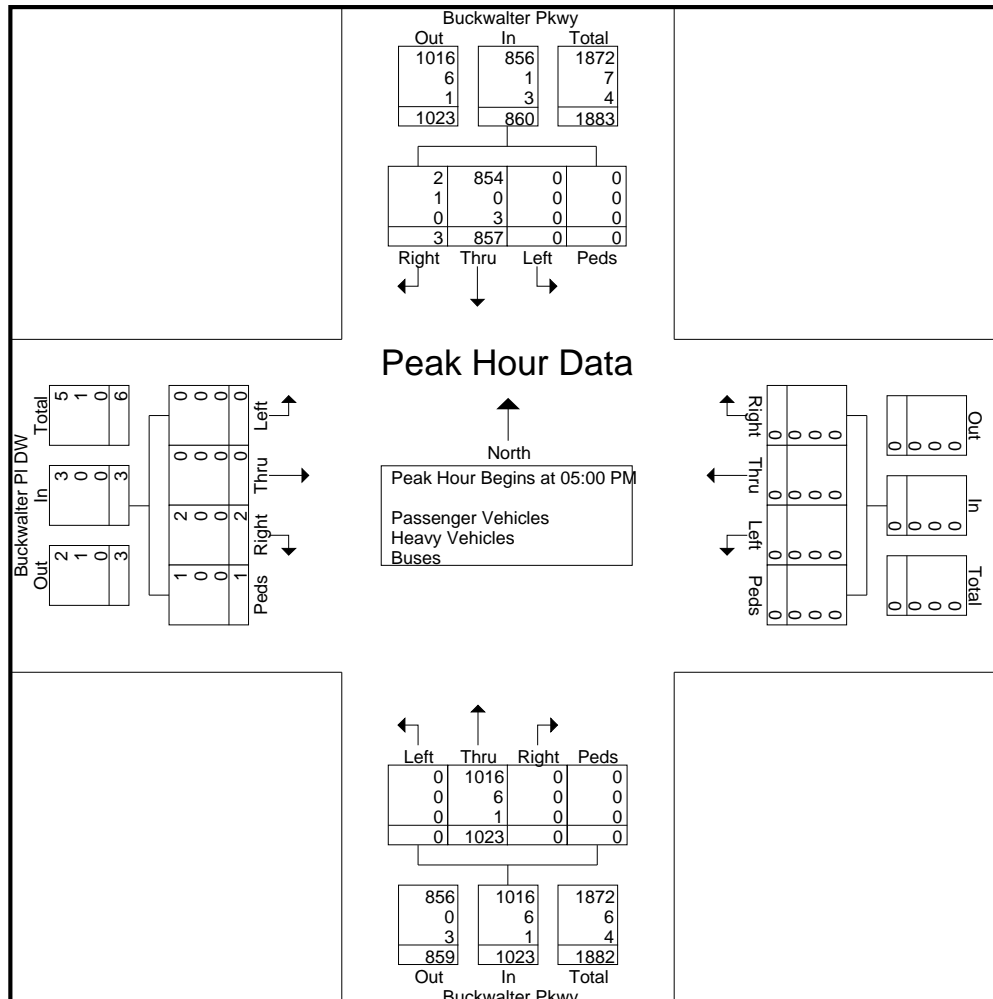
File Name : Buckwalter Pkwy @ Buckwalter PI DW

Site Code :

Start Date : 5/11/2021

Page No : 4

	Buckwalter Pkwy From North					From East					Buckwalter Pkwy From South					Buckwalter PI DW From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 12:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 05:00 PM																					
05:00 PM	0	212	0	0	212	0	0	0	0	0	0	256	0	0	256	0	0	2	0	2	470
05:15 PM	0	217	0	0	217	0	0	0	0	0	0	244	0	0	244	0	0	0	0	0	461
05:30 PM	0	215	0	0	215	0	0	0	0	0	0	275	0	0	275	0	0	0	0	0	490
05:45 PM	0	213	3	0	216	0	0	0	0	0	0	248	0	0	248	0	0	0	1	1	465
Total Volume	0	857	3	0	860	0	0	0	0	0	0	1023	0	0	1023	0	0	2	1	3	1886
% App. Total	0	99.7	0.3	0		0	0	0	0	0	0	100	0	0		0	0	66.7	33.3		
PHF	.000	.987	.250	.000	.991	.000	.000	.000	.000	.000	.000	.930	.000	.000	.930	.000	.000	.250	.250	.375	.962
Passenger Vehicles	0	854	2	0	856	0	0	0	0	0	0	1016	0	0	1016	0	0	2	1	3	1875
% Passenger Vehicles	0	99.6	66.7	0	99.5	0	0	0	0	0	0	99.3	0	0	99.3	0	0	100	100	100	99.4
Heavy Vehicles	0	0	1	0	1	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	7
% Heavy Vehicles	0	0	33.3	0	0.1	0	0	0	0	0	0	0.6	0	0	0.6	0	0	0	0	0	0.4
Buses	0	3	0	0	3	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	4
% Buses	0	0.4	0	0	0.3	0	0	0	0	0	0	0.1	0	0	0.1	0	0	0	0	0	0.2





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**Location:** 1 BUCKWALTER PKWY & PARKSIDE DR AM

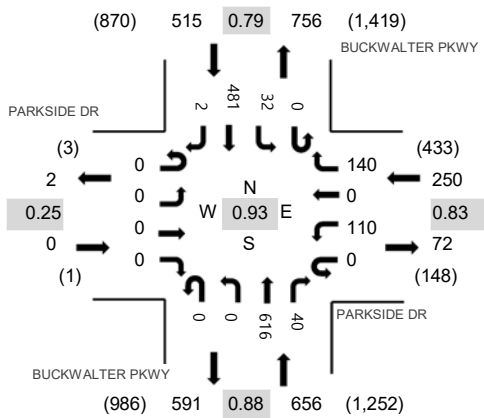
**Date:** Wednesday, January 20, 2021

**Peak Hour:** 07:30 AM - 08:30 AM

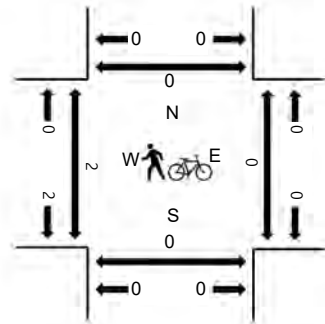
**Peak 15-Minutes:** 07:45 AM - 08:00 AM

Item 9.

### Peak Hour - Motorized Vehicles



### Peak Hour - Pedestrians/Bicycles in Crosswalk



Note: Total study counts contained in parentheses.

### Traffic Counts - Motorized Vehicles

Interval Start Time	PARKSIDE DR Eastbound				PARKSIDE DR Westbound				BUCKWALTER PKWY Northbound				BUCKWALTER PKWY Southbound				Total	Rolling Hour	Pedestrian Crossings				
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right			West	East	South	North	
7:00 AM	0	0	0	0	0	16	0	36	0	0	85	3	0	2	66	0	208	1,233	2	0	0	0	
7:15 AM	0	0	0	0	0	15	0	26	0	0	148	10	0	8	85	0	292	1,375	0	0	0	0	
7:30 AM	0	0	0	0	0	14	0	31	0	0	176	8	0	7	117	0	353	1,421	0	0	0	0	
7:45 AM	0	0	0	0	0	22	0	44	0	0	147	4	0	11	151	1	380	1,404	0	0	0	0	
8:00 AM	0	0	0	0	0	33	0	30	0	0	139	11	0	10	126	1	350	1,323	0	0	0	0	
8:15 AM	0	0	0	0	0	41	0	35	0	0	154	17	0	4	87	0	338		0	0	0	0	
8:30 AM	0	0	0	0	0	18	0	29	0	0	165	25	0	8	91	0	336		0	0	0	0	
8:45 AM	0	0	0	1	0	16	0	27	0	1	147	12	0	8	87	0	299		1	0	0	0	

### Peak Rolling Hour Flow Rates

Vehicle Type	Eastbound			Westbound			Northbound			Southbound			Total
	U-Turn	Left	Thru Right	U-Turn	Left	Thru Right	U-Turn	Left	Thru Right	U-Turn	Left	Thru Right	
Articulated Trucks	0	0	0	0	0	0	0	0	6	0	0	8	14
Lights	0	0	0	0	107	0	138	0	0	600	39	0	1,381
Mediums	0	0	0	0	3	0	2	0	0	10	1	8	26
Total	0	0	0	0	110	0	140	0	0	616	40	0	1,421



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**Location:** 2 BUCKWALTER PKWY & WASHINGTON SQUARE AM

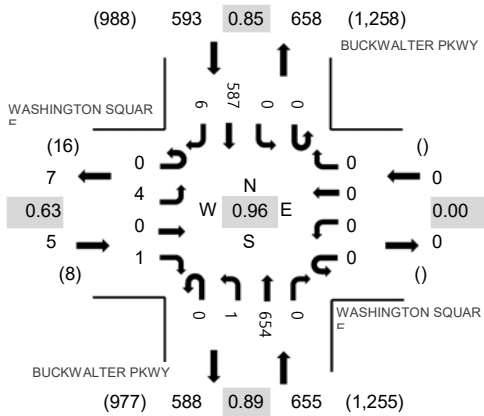
**Date:** Wednesday, January 20, 2021

**Peak Hour:** 07:30 AM - 08:30 AM

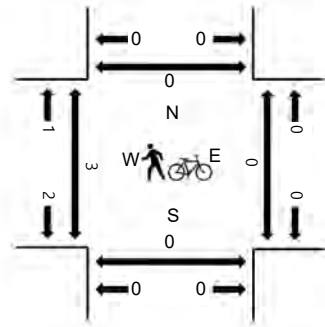
**Peak 15-Minutes:** 07:45 AM - 08:00 AM

Item 9.

### Peak Hour - Motorized Vehicles



### Peak Hour - Pedestrians/Bicycles in Crosswalk



Note: Total study counts contained in parentheses.

### Traffic Counts - Motorized Vehicles

Interval Start Time	WASHINGTON Eastbound			WASHINGTON Westbound			BUCKWALTER PKWY Northbound			BUCKWALTER PKWY Southbound			Total	Rolling Pedestrian Crossings				
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right		Hour	West	East	South	North
7:00 AM	0	0	0	1	0	0	0	0	0	1	90	0	1	171	1,074	1	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	160	0	3	262	1,211	1	0	0
7:30 AM	0	1	0	0	0	0	0	0	0	0	181	0	3	314	1,253	0	0	0
7:45 AM	0	1	0	0	0	0	0	0	0	1	151	0	3	327	1,235	0	0	0
8:00 AM	0	0	0	1	0	0	0	0	0	0	155	0	0	308	1,177	0	0	0
8:15 AM	0	2	0	0	0	0	0	0	0	0	167	0	0	304		1	0	0
8:30 AM	0	1	0	0	0	0	0	0	0	0	188	0	1	296		1	0	0
8:45 AM	0	1	0	0	0	0	0	0	0	1	160	0	2	269		1	0	0

### Peak Rolling Hour Flow Rates

Vehicle Type	Eastbound			Westbound			Northbound			Southbound			Total
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	
Articulated Trucks	0	0	0	0	0	0	0	0	0	0	8	0	16
Lights	0	4	0	1	0	0	0	0	0	1	637	0	1,217
Mediums	0	0	0	0	0	0	0	0	0	0	11	0	20
Total	0	4	0	1	0	0	0	0	0	1	654	0	1,253



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**Location:** 1 BUCKWALTER PKWY & PARKSIDE DR PM

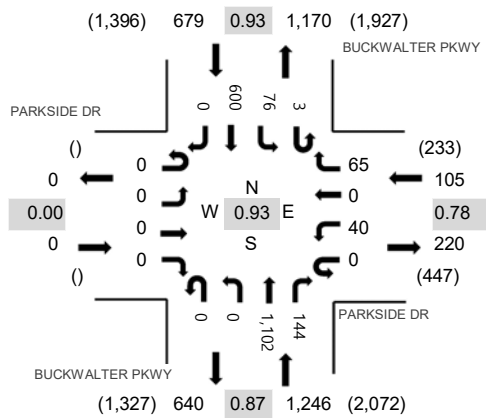
**Date:** Wednesday, January 20, 2021

**Peak Hour:** 05:00 PM - 06:00 PM

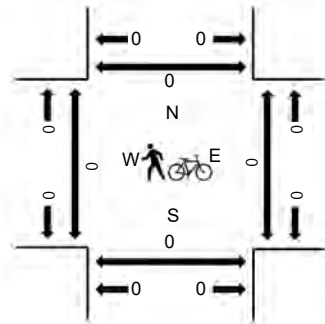
**Peak 15-Minutes:** 05:15 PM - 05:30 PM

Item 9.

### Peak Hour - Motorized Vehicles



### Peak Hour - Pedestrians/Bicycles in Crosswalk



Note: Total study counts contained in parentheses.

### Traffic Counts - Motorized Vehicles

Interval Start Time	PARKSIDE DR Eastbound				PARKSIDE DR Westbound				BUCKWALTER PKWY Northbound				BUCKWALTER PKWY Southbound				Total	Rolling Hour	Pedestrian Crossings			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right			West	East	South	North
4:00 PM	0	0	0	0	0	12	0	29	0	0	158	44	0	10	161	0	414	1,671	0	0	0	0
4:15 PM	0	0	0	0	0	14	0	16	0	0	192	41	0	32	156	0	451	1,713	0	0	0	0
4:30 PM	0	0	0	0	1	18	0	16	0	0	171	31	1	27	165	0	430	1,806	0	0	0	0
4:45 PM	0	0	0	0	0	11	0	11	0	0	162	27	1	14	150	0	376	1,882	0	0	0	0
5:00 PM	0	0	0	0	0	8	0	17	0	0	220	40	0	17	154	0	456	2,030	0	0	0	0
5:15 PM	0	0	0	0	0	11	0	16	0	0	324	35	0	23	135	0	544		0	0	0	0
5:30 PM	0	0	0	0	0	7	0	24	0	0	278	31	0	18	148	0	506		0	0	0	0
5:45 PM	0	0	0	0	0	14	0	8	0	0	280	38	3	18	163	0	524		0	0	0	0

### Peak Rolling Hour Flow Rates

Vehicle Type	Eastbound				Westbound				Northbound				Southbound				Total
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	
Articulated Trucks	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2
Lights	0	0	0	0	0	40	0	65	0	0	1,089	143	3	76	593	0	2,009
Mediums	0	0	0	0	0	0	0	0	0	0	12	1	0	0	6	0	19
Total	0	0	0	0	0	40	0	65	0	0	1,102	144	3	76	600	0	2,030



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**Location:** 2 BUCKWALTER PKWY & WASHINGTON SQUARE PM

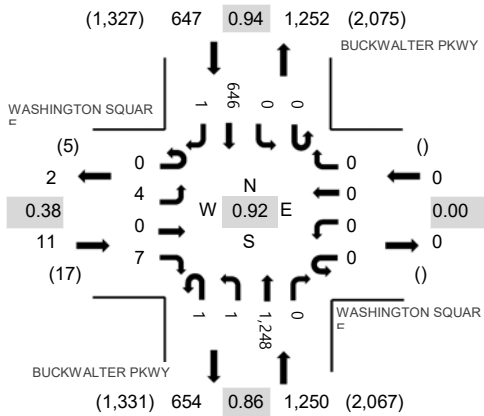
**Date:** Wednesday, January 20, 2021

**Peak Hour:** 05:00 PM - 06:00 PM

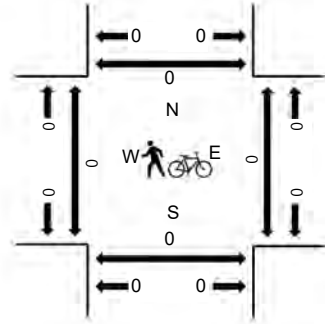
**Peak 15-Minutes:** 05:15 PM - 05:30 PM

Item 9.

### Peak Hour - Motorized Vehicles



### Peak Hour - Pedestrians/Bicycles in Crosswalk



Note: Total study counts contained in parentheses.

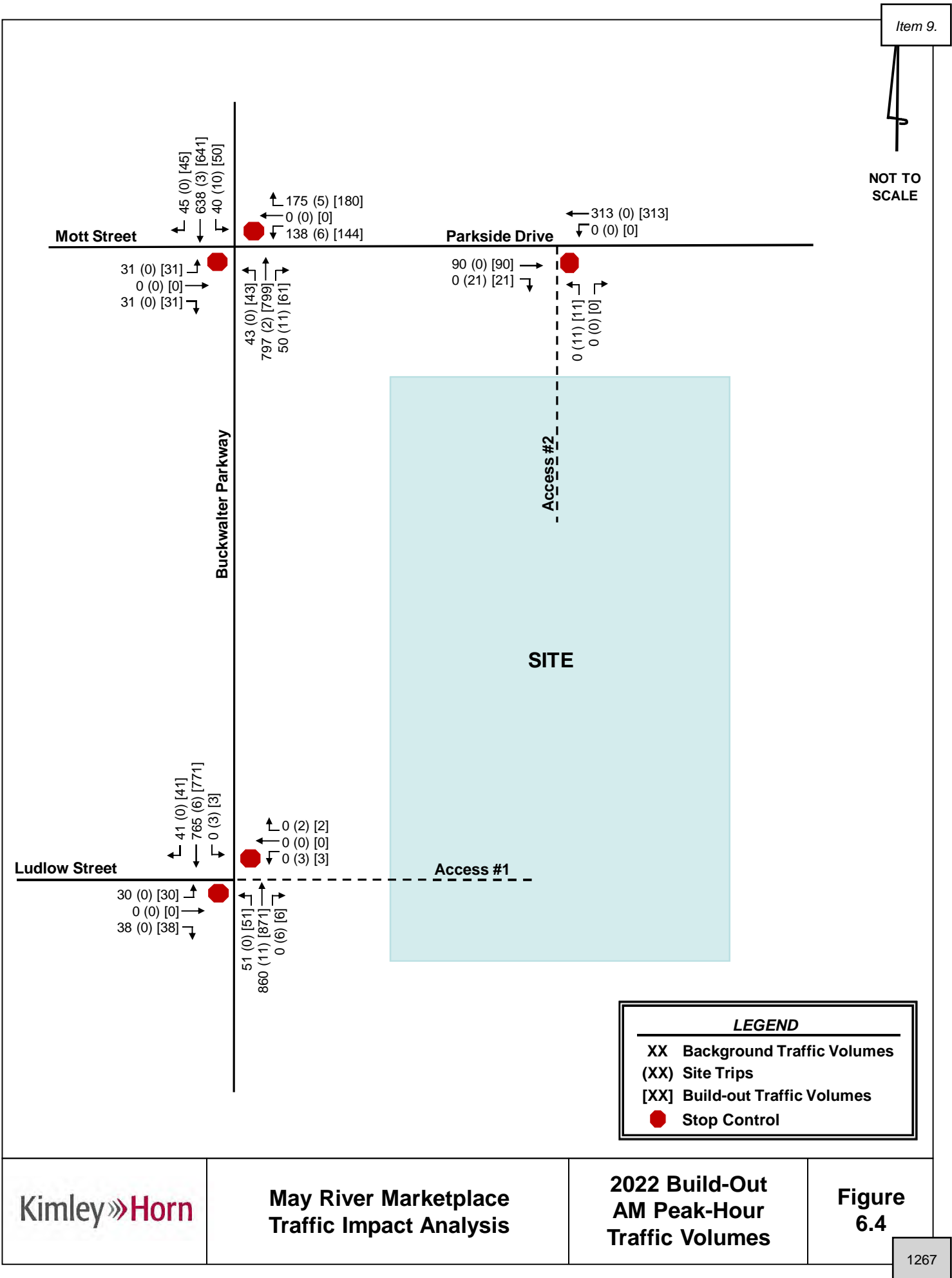
### Traffic Counts - Motorized Vehicles

Interval Start Time	WASHINGTON Eastbound				WASHINGTON Westbound				BUCKWALTER PKWY Northbound				BUCKWALTER PKWY Southbound				Total	Rolling Hour	Pedestrian Crossings				
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right			West	East	South	North	
4:00 PM	0	2	0	0	0	0	0	0	0	0	0	200	0	0	0	167	2	371	1,503	0	0	0	0
4:15 PM	0	2	0	0	0	0	0	0	0	0	0	230	0	1	0	169	0	402	1,564	0	0	0	0
4:30 PM	0	1	0	1	0	0	0	0	0	0	0	199	0	0	0	181	0	382	1,678	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	188	0	0	0	159	1	348	1,755	0	0	0	0
5:00 PM	0	3	0	5	0	0	0	0	0	0	1	260	0	0	0	162	1	432	1,908	0	0	0	0
5:15 PM	0	0	0	2	0	0	0	0	0	1	0	362	0	0	0	151	0	516		0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	305	0	0	0	154	0	459		0	0	0	0
5:45 PM	0	1	0	0	0	0	0	0	0	0	0	321	0	0	0	179	0	501		0	0	0	0

### Peak Rolling Hour Flow Rates

Vehicle Type	Eastbound			Westbound			Northbound			Southbound			Total		
	U-Turn	Left	Thru Right	U-Turn	Left	Thru Right	U-Turn	Left	Thru Right	U-Turn	Left	Thru Right			
Articulated Trucks	0	0	0	0	0	0	0	0	1	0	0	1	0	2	
Lights	0	4	0	6	0	0	0	1	1,234	0	0	0	640	1	1,887
Mediums	0	0	0	1	0	0	0	0	13	0	0	0	5	0	19
Total	0	4	0	7	0	0	0	1	1,248	0	0	0	646	1	1,908





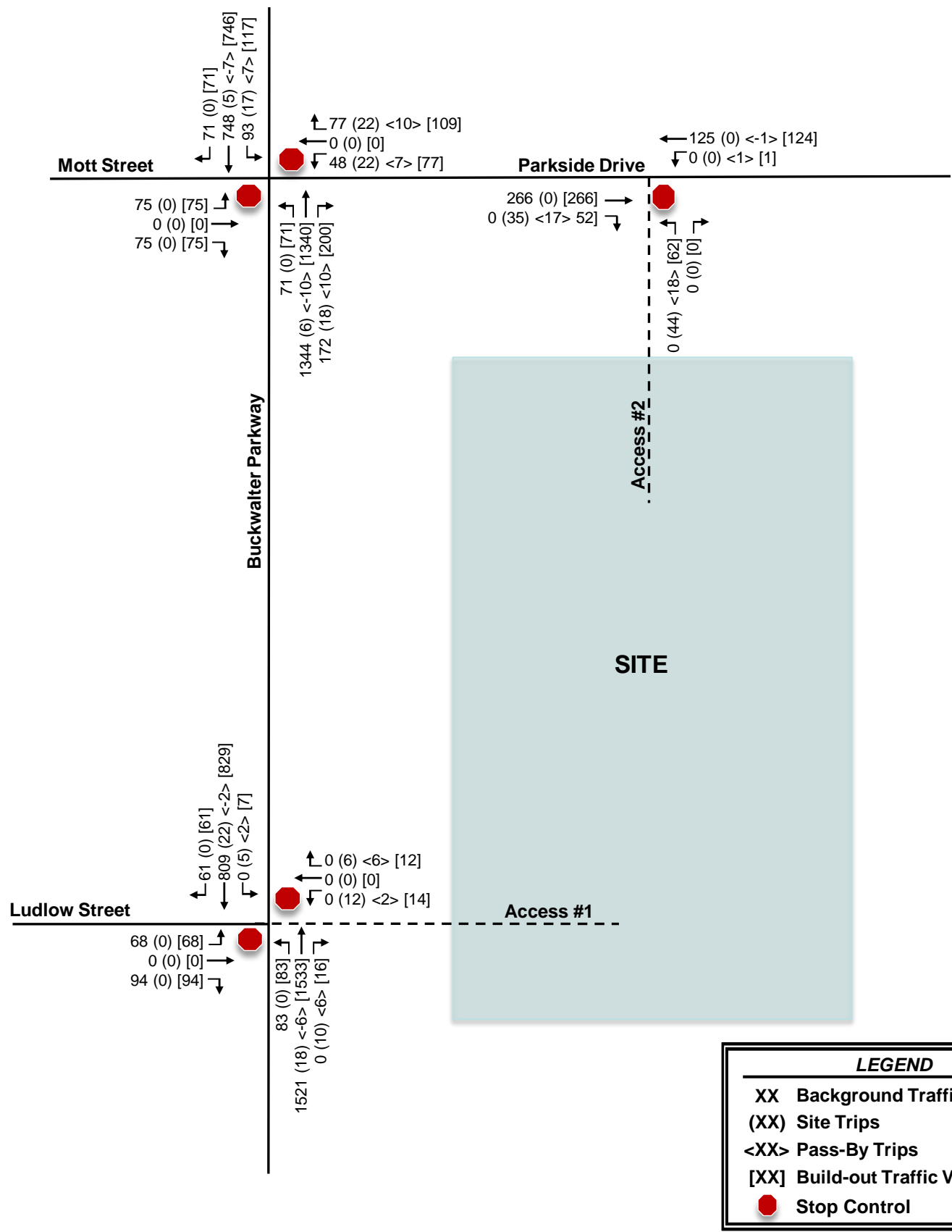
Kimley»Horn

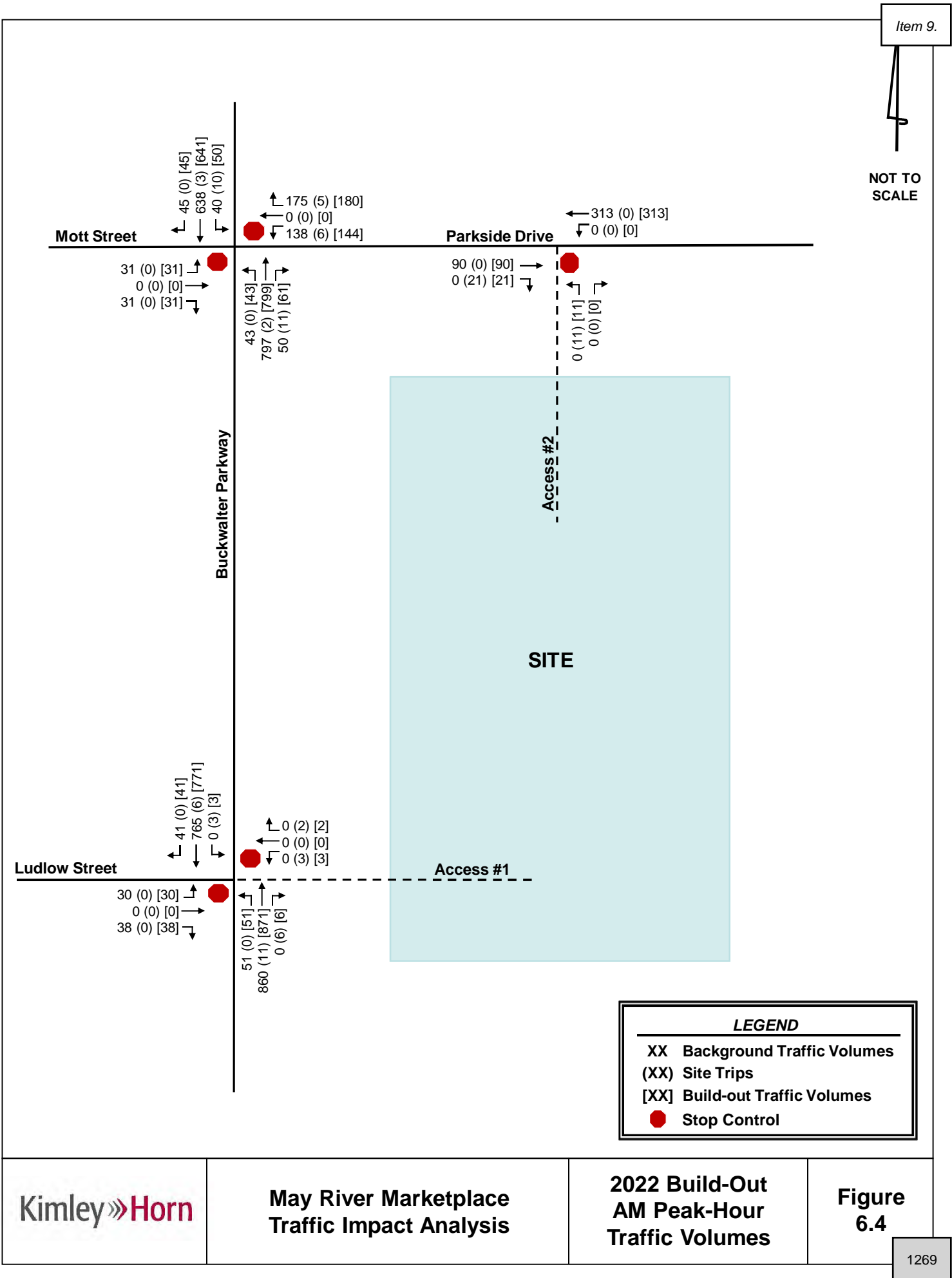
May River Marketplace  
Traffic Impact Analysis

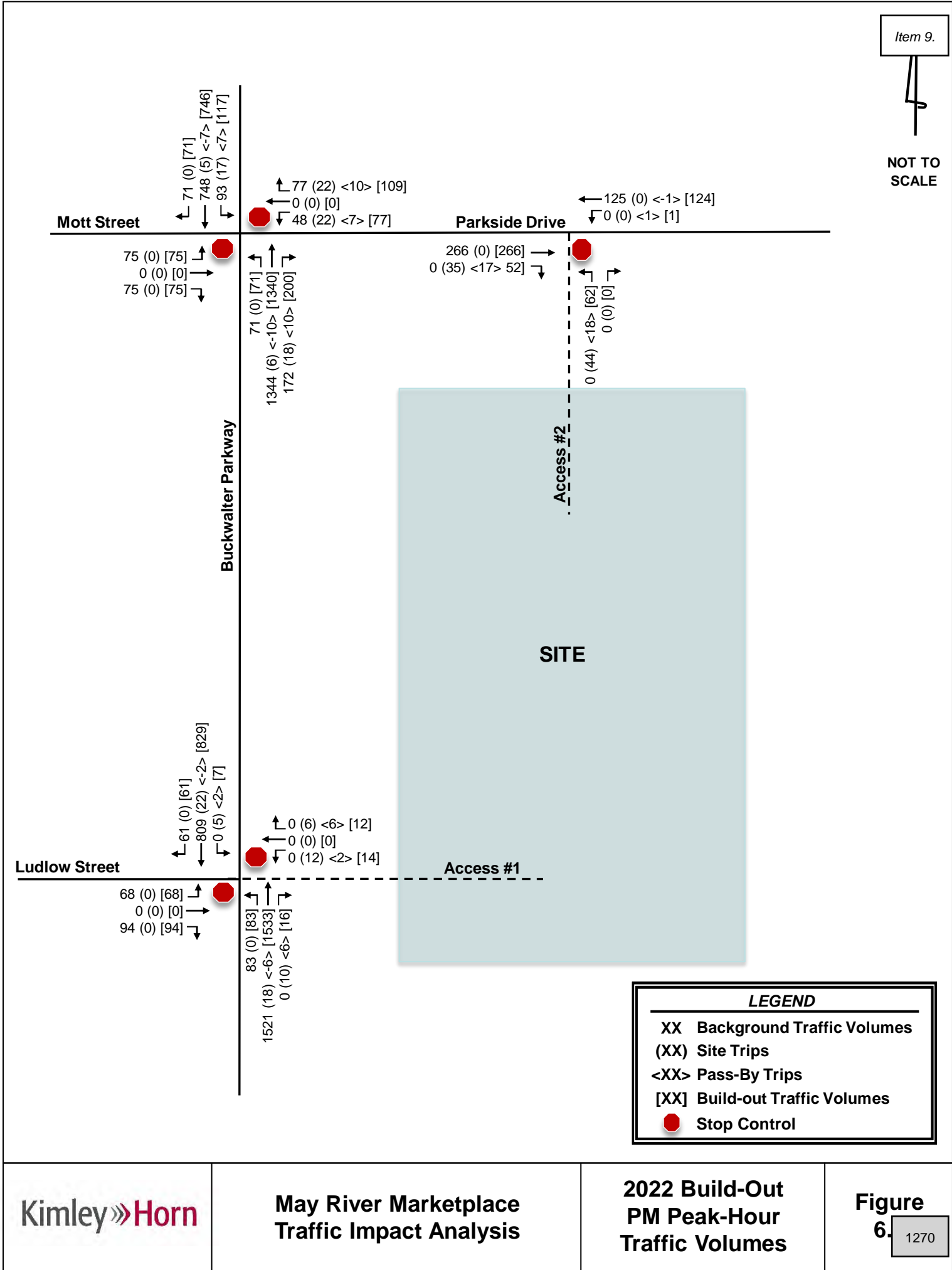
2022 Build-Out  
AM Peak-Hour  
Traffic Volumes

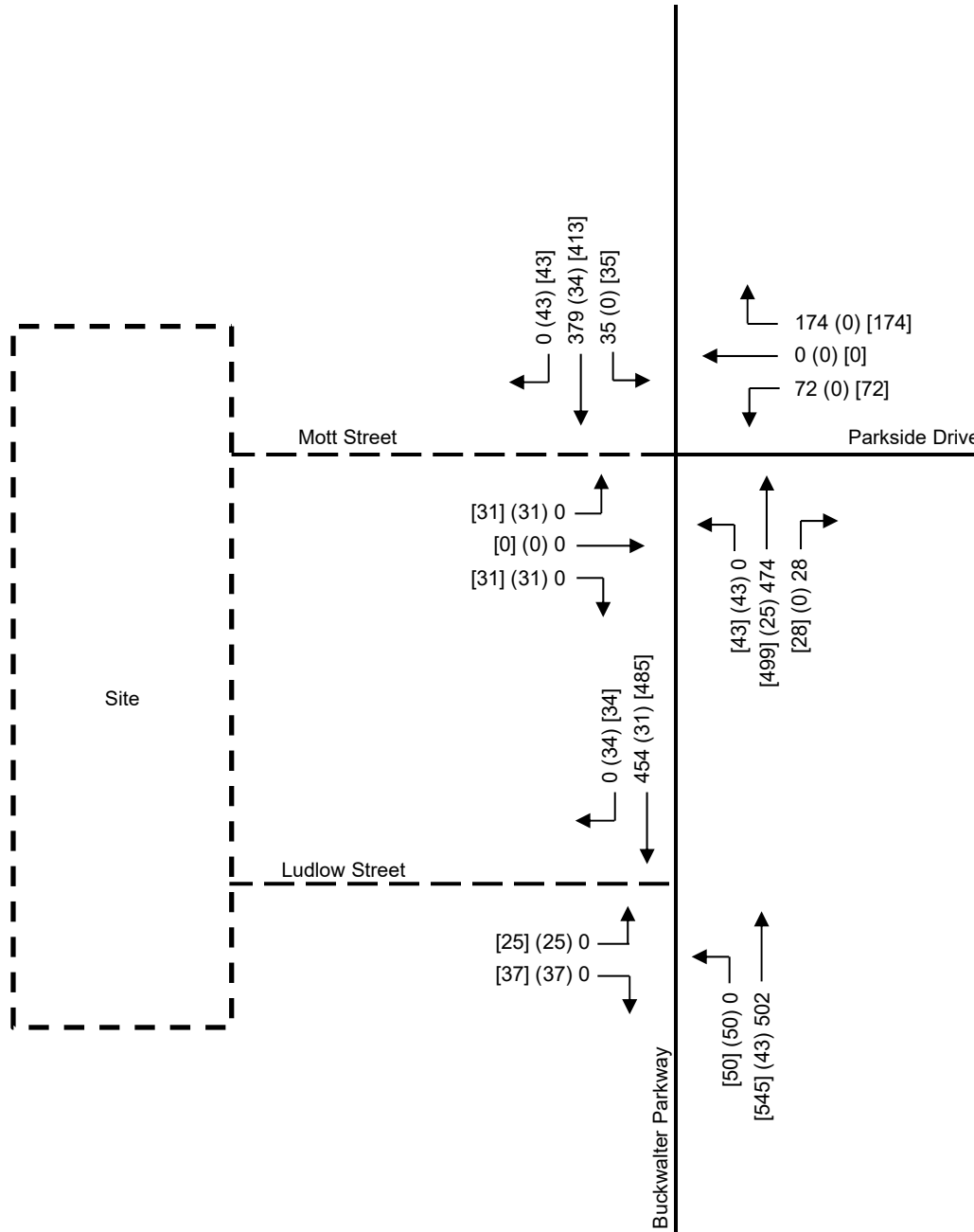
Figure  
6.4

1267



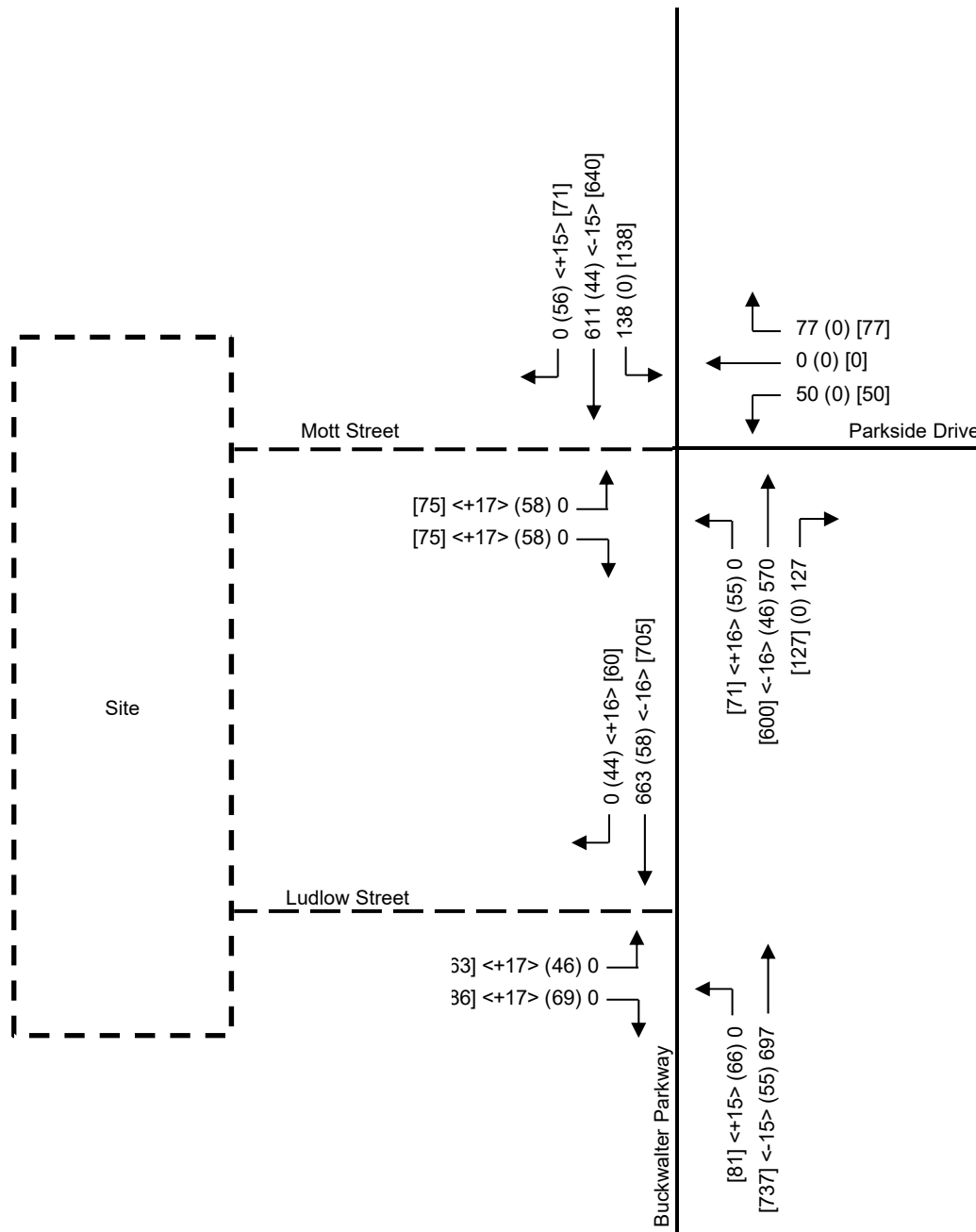






NOT TO SCALE

LEGEND	
XX	2019 Background Traffic
(XX)	Site Traffic
[XX]	2019 Buildout Traffic



NOT TO SCALE

LEGEND	
XX	2019 Background Traffic
(XX)	Site Traffic
<XX>	Pass-by Traffic
[XX]	2019 Buildout Traffic









## HCM 6th TWSC

## 3: Buckwalter Parkway &amp; Cassidy Drive

08/25/2021

## Intersection

Int Delay, s/veh 0.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	1	3	936	3	8	698
Future Vol, veh/h	1	3	936	3	8	698
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	130	-	100	130	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	50	50	95	95	95	95
Heavy Vehicles, %	25	25	2	2	2	2
Mvmt Flow	2	6	985	3	8	735

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	1369	493	0
Stage 1	985	-	-
Stage 2	384	-	-
Critical Hdwy	7.3	7.4	-
Critical Hdwy Stg 1	6.3	-	-
Critical Hdwy Stg 2	6.3	-	-
Follow-up Hdwy	3.75	3.55	-
Pot Cap-1 Maneuver	112	465	-
Stage 1	274	-	-
Stage 2	595	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	111	465	-
Mov Cap-2 Maneuver	111	-	-
Stage 1	274	-	-
Stage 2	588	-	-

Approach	WB	NB	SB
HCM Control Delay, s	19.1	0	0.1
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBRWBLn1WBLn2	SBL	SBT
Capacity (veh/h)	-	-	111	465
HCM Lane V/C Ratio	-	-	0.018	0.013
HCM Control Delay (s)	-	-	38	12.8
HCM Lane LOS	-	-	E	B
HCM 95th %tile Q(veh)	-	-	0.1	0



## HCM 6th TWSC

## 5: Buckwalter Parkway &amp; Pinellas Drive North

08/25/2021

## Intersection

Int Delay, s/veh 2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰	↱		↰		↰	↰	↰	↰	↰	↰
Traffic Vol, veh/h	21	0	9	5	1	35	12	887	22	53	597	35
Future Vol, veh/h	21	0	9	5	1	35	12	887	22	53	597	35
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	50	-	-	-	320	-	100	320	-	320
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	65	65	65	73	73	73	91	91	91	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	32	0	14	7	1	48	13	975	24	58	649	38

Major/Minor	Minor2		Minor1		Major1		Major2		Major2		Major2	
Conflicting Flow All	1279	1790	325	1442	1804	488	687	0	0	999	0	0
Stage 1	765	765	-	1001	1001	-	-	-	-	-	-	-
Stage 2	514	1025	-	441	803	-	-	-	-	-	-	-
Critical Hdwy	7.54	6.54	6.94	7.54	6.54	6.94	4.14	-	-	4.14	-	-
Critical Hdwy Stg 1	6.54	5.54	-	6.54	5.54	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.54	5.54	-	6.54	5.54	-	-	-	-	-	-	-
Follow-up Hdwy	3.52	4.02	3.32	3.52	4.02	3.32	2.22	-	-	2.22	-	-
Pot Cap-1 Maneuver	123	80	671	93	79	526	903	-	-	689	-	-
Stage 1	362	410	-	260	319	-	-	-	-	-	-	-
Stage 2	511	311	-	565	394	-	-	-	-	-	-	-
Platoon blocked, %								-	-	-	-	-
Mov Cap-1 Maneuver	102	72	671	84	71	526	903	-	-	689	-	-
Mov Cap-2 Maneuver	102	72	-	84	71	-	-	-	-	-	-	-
Stage 1	357	376	-	256	315	-	-	-	-	-	-	-
Stage 2	456	307	-	507	361	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	42.3	20.2	0.1	0.8
HCM LOS	E	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	903	-	-	102	671	293	689	-	-
HCM Lane V/C Ratio	0.015	-	-	0.317	0.021	0.192	0.084	-	-
HCM Control Delay (s)	9	-	-	55.9	10.5	20.2	10.7	-	-
HCM Lane LOS	A	-	-	F	B	C	B	-	-
HCM 95th %tile Q(veh)	0	-	-	1.2	0.1	0.7	0.3	-	-

## HCM 6th TWSC

## 8: Buckwalter Parkway &amp; Pinellas Drive South

08/25/2021

## Intersection

Int Delay, s/veh 4.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↕		↕		↕	↕	↕	↕	↕	↕
Traffic Vol, veh/h	5	2	22	40	2	70	37	834	112	26	583	7
Future Vol, veh/h	5	2	22	40	2	70	37	834	112	26	583	7
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	50	-	-	-	320	-	100	320	-	320
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	68	68	68	88	88	88	95	95	95	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	7	3	32	45	2	80	39	878	118	29	648	8

Major/Minor	Minor2		Minor1		Major1		Major2		Major2		Major2	
Conflicting Flow All	1224	1780	324	1340	1670	439	656	0	0	996	0	0
Stage 1	706	706	-	956	956	-	-	-	-	-	-	-
Stage 2	518	1074	-	384	714	-	-	-	-	-	-	-
Critical Hdwy	7.54	6.54	6.94	7.54	6.54	6.94	4.14	-	-	4.14	-	-
Critical Hdwy Stg 1	6.54	5.54	-	6.54	5.54	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.54	5.54	-	6.54	5.54	-	-	-	-	-	-	-
Follow-up Hdwy	3.52	4.02	3.32	3.52	4.02	3.32	2.22	-	-	2.22	-	-
Pot Cap-1 Maneuver	135	81	672	111	95	566	927	-	-	690	-	-
Stage 1	393	437	-	277	335	-	-	-	-	-	-	-
Stage 2	509	294	-	611	433	-	-	-	-	-	-	-
Platoon blocked, %								-	-	-	-	-
Mov Cap-1 Maneuver	107	74	672	96	87	566	927	-	-	690	-	-
Mov Cap-2 Maneuver	107	74	-	96	87	-	-	-	-	-	-	-
Stage 1	376	419	-	265	321	-	-	-	-	-	-	-
Stage 2	416	282	-	553	415	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	19.5	50.5	0.3	0.4
HCM LOS	C	F		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	927	-	-	95	672	199	690	-	-
HCM Lane V/C Ratio	0.042	-	-	0.108	0.048	0.64	0.042	-	-
HCM Control Delay (s)	9.1	-	-	47.4	10.6	50.5	10.4	-	-
HCM Lane LOS	A	-	-	E	B	F	B	-	-
HCM 95th %tile Q(veh)	0.1	-	-	0.4	0.2	3.8	0.1	-	-











## HCM 6th TWSC

## 11: Buckwalter Parkway &amp; Mott Street/Parkside Drive

08/25/2021

## Intersection

Int Delay, s/veh 27.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	0	0	131	0	167	0	733	48	38	572	2
Future Vol, veh/h	0	0	0	131	0	167	0	733	48	38	572	2
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	65	-	-	100	-	-	335	-	265	225	-	215
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	83	83	83	79	79	79	88	88	88
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	0	0	158	0	201	0	928	61	43	650	2

Major/Minor	Minor2		Minor1		Major1		Major2		Major2		Major2	
Conflicting Flow All	1200	1725	325	1339	1666	464	652	0	0	989	0	0
Stage 1	736	736	-	928	928	-	-	-	-	-	-	-
Stage 2	464	989	-	411	738	-	-	-	-	-	-	-
Critical Hdwy	7.54	6.54	6.94	7.54	6.54	6.94	4.14	-	-	4.14	-	-
Critical Hdwy Stg 1	6.54	5.54	-	6.54	5.54	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.54	5.54	-	6.54	5.54	-	-	-	-	-	-	-
Follow-up Hdwy	3.52	4.02	3.32	3.52	4.02	3.32	2.22	-	-	2.22	-	-
Pot Cap-1 Maneuver	141	88	671	~ 111	96	545	930	-	-	695	-	-
Stage 1	377	423	-	288	345	-	-	-	-	-	-	-
Stage 2	548	323	-	589	422	-	-	-	-	-	-	-
Platoon blocked, %								-	-	-	-	-
Mov Cap-1 Maneuver	85	83	671	~ 106	90	545	930	-	-	695	-	-
Mov Cap-2 Maneuver	85	83	-	~ 106	90	-	-	-	-	-	-	-
Stage 1	377	397	-	288	345	-	-	-	-	-	-	-
Stage 2	346	323	-	553	396	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	156.2	0	0.7
HCM LOS	A	F		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	WBLn2	SBL	SBT	SBR
Capacity (veh/h)	930	-	-	-	-	106	545	695	-	-
HCM Lane V/C Ratio	-	-	-	-	-	1.489	0.369	0.062	-	-
HCM Control Delay (s)	0	-	-	0	0	335.7	15.4	10.5	-	-
HCM Lane LOS	A	-	-	A	A	F	C	B	-	-
HCM 95th %tile Q(veh)	0	-	-	-	-	11.6	1.7	0.2	-	-

## Notes

~: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

HCM 6th TWSC  
13: Buckwalter Parkway & Kroger Fuel Driveway

Item 9.

08/25/2021

Intersection

Int Delay, s/veh 0.4

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↗		↗↗	↗↗	↗
Traffic Vol, veh/h	0	55	0	799	642	57
Future Vol, veh/h	0	55	0	799	642	57
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	None	-	Yield
Storage Length	-	0	-	-	-	200
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	60	0	868	698	62

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	- 349	- 0	- 0
Stage 1	- -	- -	- -
Stage 2	- -	- -	- -
Critical Hdwy	- 6.94	- -	- -
Critical Hdwy Stg 1	- -	- -	- -
Critical Hdwy Stg 2	- -	- -	- -
Follow-up Hdwy	- 3.32	- -	- -
Pot Cap-1 Maneuver	0 647	0 -	- -
Stage 1	0 -	0 -	- -
Stage 2	0 -	0 -	- -
Platoon blocked, %		- -	- -
Mov Cap-1 Maneuver	- 647	- -	- -
Mov Cap-2 Maneuver	- -	- -	- -
Stage 1	- -	- -	- -
Stage 2	- -	- -	- -

Approach	EB	NB	SB
HCM Control Delay, s	11.1	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBT EBLn1	SBT	SBR
Capacity (veh/h)	- 647	- -	- -
HCM Lane V/C Ratio	- 0.092	- -	- -
HCM Control Delay (s)	- 11.1	- -	- -
HCM Lane LOS	- B	- -	- -
HCM 95th %tile Q(veh)	- 0.3	- -	- -







## HCM 6th TWSC

## 16: Buckwalter Parkway &amp; Innovation Drive

08/25/2021

## Intersection

Int Delay, s/veh 2.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	54	38	40	765	652	45
Future Vol, veh/h	54	38	40	765	652	45
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	100	0	200	-	-	185
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	83	83	94	94	87	87
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	65	46	43	814	749	52

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	1242	375	801
Stage 1	749	-	-
Stage 2	493	-	-
Critical Hdwy	6.84	6.94	4.14
Critical Hdwy Stg 1	5.84	-	-
Critical Hdwy Stg 2	5.84	-	-
Follow-up Hdwy	3.52	3.32	2.22
Pot Cap-1 Maneuver	167	623	818
Stage 1	428	-	-
Stage 2	579	-	-
Platoon blocked, %			
Mov Cap-1 Maneuver	158	623	818
Mov Cap-2 Maneuver	158	-	-
Stage 1	405	-	-
Stage 2	579	-	-

Approach	EB	NB	SB
HCM Control Delay, s	29.8	0.5	0
HCM LOS	D		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	818	-	158	623	-	-
HCM Lane V/C Ratio	0.052	-	0.412	0.073	-	-
HCM Control Delay (s)	9.6	-	42.9	11.2	-	-
HCM Lane LOS	A	-	E	B	-	-
HCM 95th %tile Q(veh)	0.2	-	1.8	0.2	-	-

## HCM 6th TWSC

## 20: Buckwalter Parkway &amp; Progressive Street

08/25/2021

## Intersection

Int Delay, s/veh 0.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↗		↗↗	↗↗	↗
Traffic Vol, veh/h	0	62	0	840	628	72
Future Vol, veh/h	0	62	0	840	628	72
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	None	-	Yield
Storage Length	-	0	-	-	-	120
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	79	79	95	95	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	78	0	884	698	80

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	- 349	- 0	- 0
Stage 1	- -	- -	- -
Stage 2	- -	- -	- -
Critical Hdwy	- 6.94	- -	- -
Critical Hdwy Stg 1	- -	- -	- -
Critical Hdwy Stg 2	- -	- -	- -
Follow-up Hdwy	- 3.32	- -	- -
Pot Cap-1 Maneuver	0 647	0 -	- -
Stage 1	0 -	0 -	- -
Stage 2	0 -	0 -	- -
Platoon blocked, %		- -	- -
Mov Cap-1 Maneuver	- 647	- -	- -
Mov Cap-2 Maneuver	- -	- -	- -
Stage 1	- -	- -	- -
Stage 2	- -	- -	- -

Approach	EB	NB	SB
HCM Control Delay, s	11.3	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBT EBLn1	SBT	SBR
Capacity (veh/h)	- 647	- -	- -
HCM Lane V/C Ratio	- 0.121	- -	- -
HCM Control Delay (s)	- 11.3	- -	- -
HCM Lane LOS	- B	- -	- -
HCM 95th %tile Q(veh)	- 0.4	- -	- -

## HCM 6th TWSC

## 25: Buckwalter Parkway &amp; Ludlow Street

08/25/2021

## Intersection

Int Delay, s/veh 0.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔	↔				↔	↔		↔	↔	↔
Traffic Vol, veh/h	5	0	1	0	0	0	1	778	0	0	699	7
Future Vol, veh/h	5	0	1	0	0	0	1	778	0	0	699	7
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	90	-	-	-	210	-	-	215	-	200
Veh in Median Storage, #	-	0	-	-	16979	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	63	63	63	92	92	92	89	89	89	85	85	85
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	8	0	2	0	0	0	1	874	0	0	822	8

Major/Minor	Minor2			Major1			Major2		
Conflicting Flow All	1261	1698	411	830	0	0	874	0	0
Stage 1	822	822	-	-	-	-	-	-	-
Stage 2	439	876	-	-	-	-	-	-	-
Critical Hdwy	6.84	6.54	6.94	4.14	-	-	4.14	-	-
Critical Hdwy Stg 1	5.84	5.54	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.84	5.54	-	-	-	-	-	-	-
Follow-up Hdwy	3.52	4.02	3.32	2.22	-	-	2.22	-	-
Pot Cap-1 Maneuver	162	91	590	798	-	-	768	-	-
Stage 1	392	386	-	-	-	-	-	-	-
Stage 2	617	365	-	-	-	-	-	-	-
Platoon blocked, %					-	-		-	-
Mov Cap-1 Maneuver	162	0	590	798	-	-	768	-	-
Mov Cap-2 Maneuver	162	0	-	-	-	-	-	-	-
Stage 1	392	0	-	-	-	-	-	-	-
Stage 2	617	0	-	-	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	25.5	0	0
HCM LOS	D		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	SBL	SBT	SBR
Capacity (veh/h)	798	-	-	162	590	768	-	-
HCM Lane V/C Ratio	0.001	-	-	0.049	0.003	-	-	-
HCM Control Delay (s)	9.5	-	-	28.4	11.1	0	-	-
HCM Lane LOS	A	-	-	D	B	A	-	-
HCM 95th %tile Q(veh)	0	-	-	0.2	0	0	-	-





# HCM 6th TWSC







## 3: Buckwalter Parkway & Cassidy Drive

Item 9.

08/25/2021

### Intersection

Int Delay, s/veh 0.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	2	7	815	2	1	827
Future Vol, veh/h	2	7	815	2	1	827
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	130	-	100	130	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	56	56	86	86	88	88
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	4	13	948	2	1	940

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	1420	474	0
Stage 1	948	-	-
Stage 2	472	-	-
Critical Hdwy	6.84	6.94	-
Critical Hdwy Stg 1	5.84	-	-
Critical Hdwy Stg 2	5.84	-	-
Follow-up Hdwy	3.52	3.32	-
Pot Cap-1 Maneuver	127	537	-
Stage 1	337	-	-
Stage 2	594	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	127	537	-
Mov Cap-2 Maneuver	127	-	-
Stage 1	337	-	-
Stage 2	593	-	-

Approach	WB	NB	SB
HCM Control Delay, s	16.9	0	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBRWBLn1WBLn2	SBL	SBT
Capacity (veh/h)	-	-	127	537
HCM Lane V/C Ratio	-	-	0.028	0.023
HCM Control Delay (s)	-	-	34.2	11.9
HCM Lane LOS	-	-	D	B
HCM 95th %tile Q(veh)	-	-	0.1	0.1

## HCM 6th TWSC

## 5: Buckwalter Parkway &amp; Pinellas Drive North

08/25/2021

Intersection												
Int Delay, s/veh	4.2											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔	↔		↔		↔	↔	↔	↔	↔	↔
Traffic Vol, veh/h	38	0	35	11	1	37	30	738	10	15	768	55
Future Vol, veh/h	38	0	35	11	1	37	30	738	10	15	768	55
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	50	-	-	-	320	-	100	320	-	320
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	75	75	75	63	63	63	88	88	88	86	86	86
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	51	0	47	17	2	59	34	839	11	17	893	64
Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	1416	1845	447	1388	1898	420	957	0	0	850	0	0
Stage 1	927	927	-	907	907	-	-	-	-	-	-	-
Stage 2	489	918	-	481	991	-	-	-	-	-	-	-
Critical Hdwy	7.54	6.54	6.94	7.54	6.54	6.94	4.14	-	-	4.14	-	-
Critical Hdwy Stg 1	6.54	5.54	-	6.54	5.54	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.54	5.54	-	6.54	5.54	-	-	-	-	-	-	-
Follow-up Hdwy	3.52	4.02	3.32	3.52	4.02	3.32	2.22	-	-	2.22	-	-
Pot Cap-1 Maneuver	97	74	559	102	69	582	714	-	-	784	-	-
Stage 1	289	345	-	297	353	-	-	-	-	-	-	-
Stage 2	529	349	-	535	322	-	-	-	-	-	-	-
Platoon blocked, %								-	-	-	-	-
Mov Cap-1 Maneuver	81	69	559	89	64	582	714	-	-	784	-	-
Mov Cap-2 Maneuver	81	69	-	89	64	-	-	-	-	-	-	-
Stage 1	275	337	-	283	336	-	-	-	-	-	-	-
Stage 2	451	332	-	480	315	-	-	-	-	-	-	-
Approach	EB		WB		NB		SB					
HCM Control Delay, s	60.5		26.8		0.4		0.2					
HCM LOS	F		D									
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	SBL	SBT	SBR			
Capacity (veh/h)	714	-	-	81	559	242	784	-	-			
HCM Lane V/C Ratio	0.048	-	-	0.626	0.083	0.321	0.022	-	-			
HCM Control Delay (s)	10.3	-	-	105.2	12	26.8	9.7	-	-			
HCM Lane LOS	B	-	-	F	B	D	A	-	-			
HCM 95th %tile Q(veh)	0.1	-	-	2.9	0.3	1.3	0.1	-	-			

## HCM 6th TWSC

## 8: Buckwalter Parkway &amp; Pinellas Drive South

08/25/2021

Intersection												
Int Delay, s/veh	58.7											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↖	↗		↖		↗	↖	↗	↖	↗	↗
Traffic Vol, veh/h	23	3	62	110	0	81	69	680	130	68	697	22
Future Vol, veh/h	23	3	62	110	0	81	69	680	130	68	697	22
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	50	-	-	-	320	-	100	320	-	320
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	80	80	80	82	82	82	95	95	95	95	95	95
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	29	4	78	134	0	99	73	716	137	72	734	23

Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	1382	1877	367	1375	1763	358	757	0	0	853	0	0
Stage 1	878	878	-	862	862	-	-	-	-	-	-	-
Stage 2	504	999	-	513	901	-	-	-	-	-	-	-
Critical Hdwy	7.54	6.54	6.94	7.54	6.54	6.94	4.14	-	-	4.14	-	-
Critical Hdwy Stg 1	6.54	5.54	-	6.54	5.54	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.54	5.54	-	6.54	5.54	-	-	-	-	-	-	-
Follow-up Hdwy	3.52	4.02	3.32	3.52	4.02	3.32	2.22	-	-	2.22	-	-
Pot Cap-1 Maneuver	103	71	630	~ 104	83	638	850	-	-	782	-	-
Stage 1	309	364	-	316	370	-	-	-	-	-	-	-
Stage 2	518	319	-	512	355	-	-	-	-	-	-	-
Platoon blocked, %								-	-	-	-	-
Mov Cap-1 Maneuver	76	59	630	~ 76	69	638	850	-	-	782	-	-
Mov Cap-2 Maneuver	76	59	-	~ 76	69	-	-	-	-	-	-	-
Stage 1	282	331	-	289	338	-	-	-	-	-	-	-
Stage 2	400	292	-	403	322	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	33.9	\$ 505.7	0.8	0.9
HCM LOS	D	F		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	850	-	-	74	630	121	782	-	-
HCM Lane V/C Ratio	0.085	-	-	0.439	0.123	1.925	0.092	-	-
HCM Control Delay (s)	9.6	-	-	87.3	11.5	\$ 505.7	10.1	-	-
HCM Lane LOS	A	-	-	F	B	F	B	-	-
HCM 95th %tile Q(veh)	0.3	-	-	1.8	0.4	18.7	0.3	-	-

Notes												
~: Volume exceeds capacity		\$: Delay exceeds 300s		+: Computation Not Defined		*: All major volume in platoon						











## HCM 6th TWSC

## 11: Buckwalter Parkway &amp; Mott Street/Parkside Drive

08/25/2021

## Intersection

Int Delay, s/veh 18

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	0	0	45	0	73	0	1245	163	89	678	0
Future Vol, veh/h	0	0	0	45	0	73	0	1245	163	89	678	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	65	-	-	100	-	-	335	-	265	225	-	215
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	78	78	78	87	87	87	93	93	93
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	0	0	58	0	94	0	1431	187	96	729	0

Major/Minor	Minor2		Minor1		Major1		Major2		Major2		Major2	
Conflicting Flow All	1637	2539	365	1988	2352	716	729	0	0	1618	0	0
Stage 1	921	921	-	1431	1431	-	-	-	-	-	-	-
Stage 2	716	1618	-	557	921	-	-	-	-	-	-	-
Critical Hdwy	7.54	6.54	6.94	7.54	6.54	6.94	4.14	-	-	4.14	-	-
Critical Hdwy Stg 1	6.54	5.54	-	6.54	5.54	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.54	5.54	-	6.54	5.54	-	-	-	-	-	-	-
Follow-up Hdwy	3.52	4.02	3.32	3.52	4.02	3.32	2.22	-	-	2.22	-	-
Pot Cap-1 Maneuver	67	27	632	~ 36	35	373	871	-	-	399	-	-
Stage 1	291	347	-	141	198	-	-	-	-	-	-	-
Stage 2	387	161	-	482	347	-	-	-	-	-	-	-
Platoon blocked, %								-	-	-	-	-
Mov Cap-1 Maneuver	41	20	632	~ 29	27	373	871	-	-	399	-	-
Mov Cap-2 Maneuver	41	20	-	~ 29	27	-	-	-	-	-	-	-
Stage 1	291	263	-	141	198	-	-	-	-	-	-	-
Stage 2	290	161	-	366	263	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	298.1	0	2
HCM LOS	A	F		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	WBLn2	SBL	SBT	SBR
Capacity (veh/h)	871	-	-	-	-	29	373	399	-	-
HCM Lane V/C Ratio	-	-	-	-	-	1.989	0.251	0.24	-	-
HCM Control Delay (s)	0	-	-	0	0	752.6	17.9	16.8	-	-
HCM Lane LOS	A	-	-	A	A	F	C	C	-	-
HCM 95th %tile Q(veh)	0	-	-	-	-	6.8	1	0.9	-	-

## Notes

~: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

## HCM 6th TWSC

## 13: Buckwalter Parkway &amp; Kroger Fuel Driveway

08/25/2021

## Intersection

Int Delay, s/veh 0.4

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↗		↑↑	↑↑	↗
Traffic Vol, veh/h	0	62	0	1164	671	64
Future Vol, veh/h	0	62	0	1164	671	64
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	None	-	Yield
Storage Length	-	0	-	-	-	200
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	67	0	1265	729	70

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	-	365	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	6.94	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	3.32	-
Pot Cap-1 Maneuver	0	632	0
Stage 1	0	-	0
Stage 2	0	-	0
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	632	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	11.4	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBT EBLn1	SBT	SBR
Capacity (veh/h)	- 632	-	-
HCM Lane V/C Ratio	- 0.107	-	-
HCM Control Delay (s)	- 11.4	-	-
HCM Lane LOS	- B	-	-
HCM 95th %tile Q(veh)	- 0.4	-	-







## HCM 6th TWSC

## 16: Buckwalter Parkway &amp; Innovation Drive

08/25/2021

## Intersection

Int Delay, s/veh 18.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	132	121	114	784	632	99
Future Vol, veh/h	132	121	114	784	632	99
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	100	0	200	-	-	185
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	84	84	95	95	95	95
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	157	144	120	825	665	104

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	1318	333	769
Stage 1	665	-	-
Stage 2	653	-	-
Critical Hdwy	6.84	6.94	4.14
Critical Hdwy Stg 1	5.84	-	-
Critical Hdwy Stg 2	5.84	-	-
Follow-up Hdwy	3.52	3.32	2.22
Pot Cap-1 Maneuver	~ 149	663	841
Stage 1	473	-	-
Stage 2	480	-	-
Platoon blocked, %			
Mov Cap-1 Maneuver	~ 128	663	841
Mov Cap-2 Maneuver	~ 128	-	-
Stage 1	405	-	-
Stage 2	480	-	-

Approach	EB	NB	SB
HCM Control Delay, s	120	1.3	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	841	-	128	663	-	-
HCM Lane V/C Ratio	0.143	-	1.228	0.217	-	-
HCM Control Delay (s)	10	-	219.1	11.9	-	-
HCM Lane LOS	A	-	F	B	-	-
HCM 95th %tile Q(veh)	0.5	-	9.7	0.8	-	-

## Notes

~: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

HCM 6th TWSC  
20: Buckwalter Parkway & Progressive Street

Item 9.

08/25/2021

Intersection

Int Delay, s/veh 1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↗		↗↗	↗↗	↗
Traffic Vol, veh/h	0	135	0	924	689	58
Future Vol, veh/h	0	135	0	924	689	58
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	None	-	Yield
Storage Length	-	0	-	-	-	120
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	85	85	94	94	95	95
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	159	0	983	725	61

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	- 363	- 0	- 0
Stage 1	- -	- -	- -
Stage 2	- -	- -	- -
Critical Hdwy	- 6.94	- -	- -
Critical Hdwy Stg 1	- -	- -	- -
Critical Hdwy Stg 2	- -	- -	- -
Follow-up Hdwy	- 3.32	- -	- -
Pot Cap-1 Maneuver	0 634	0 -	- -
Stage 1	0 -	0 -	- -
Stage 2	0 -	0 -	- -
Platoon blocked, %		- -	- -
Mov Cap-1 Maneuver	- 634	- -	- -
Mov Cap-2 Maneuver	- -	- -	- -
Stage 1	- -	- -	- -
Stage 2	- -	- -	- -

Approach	EB	NB	SB
HCM Control Delay, s	12.6	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBT EBLn1	SBT	SBR
Capacity (veh/h)	- 634	- -	- -
HCM Lane V/C Ratio	- 0.251	- -	- -
HCM Control Delay (s)	- 12.6	- -	- -
HCM Lane LOS	- B	- -	- -
HCM 95th %tile Q(veh)	- 1	- -	- -

## HCM 6th TWSC

## 25: Buckwalter Parkway &amp; Ludlow Street

08/25/2021

## Intersection

Int Delay, s/veh 0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔	↔				↔	↔		↔	↔	↔
Traffic Vol, veh/h	5	0	8	0	0	0	2	1410	0	0	730	1
Future Vol, veh/h	5	0	8	0	0	0	2	1410	0	0	730	1
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	90	-	-	-	210	-	-	215	-	200
Veh in Median Storage, #	-	0	-	-	16979	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	50	50	50	92	92	92	86	86	86	94	94	94
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	10	0	16	0	0	0	2	1640	0	0	777	1

Major/Minor	Minor2			Major1			Major2		
Conflicting Flow All	1601	2421	389	778	0	0	1640	0	0
Stage 1	777	777	-	-	-	-	-	-	-
Stage 2	824	1644	-	-	-	-	-	-	-
Critical Hdwy	6.84	6.54	6.94	4.14	-	-	4.14	-	-
Critical Hdwy Stg 1	5.84	5.54	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.84	5.54	-	-	-	-	-	-	-
Follow-up Hdwy	3.52	4.02	3.32	2.22	-	-	2.22	-	-
Pot Cap-1 Maneuver	97	32	610	834	-	-	391	-	-
Stage 1	414	405	-	-	-	-	-	-	-
Stage 2	391	156	-	-	-	-	-	-	-
Platoon blocked, %					-	-		-	-
Mov Cap-1 Maneuver	97	0	610	834	-	-	391	-	-
Mov Cap-2 Maneuver	97	0	-	-	-	-	-	-	-
Stage 1	413	0	-	-	-	-	-	-	-
Stage 2	391	0	-	-	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	24.6	0	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	SBL	SBT	SBR
Capacity (veh/h)	834	-	-	97	610	391	-	-
HCM Lane V/C Ratio	0.003	-	-	0.103	0.026	-	-	-
HCM Control Delay (s)	9.3	-	-	46.3	11.1	0	-	-
HCM Lane LOS	A	-	-	E	B	A	-	-
HCM 95th %tile Q(veh)	0	-	-	0.3	0.1	0	-	-











# HCM 6th TWSC

## 3: Buckwalter Parkway & Cassidy Drive






















2030 A Item 9.

Intersection						
Int Delay, s/veh	0.1					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	1	3	1182	4	10	924
Future Vol, veh/h	1	3	1182	4	10	924
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	130	-	100	130	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	25	25	2	2	2	2
Mvmt Flow	1	3	1313	4	11	1027
Major/Minor	Minor1	Major1		Major2		
Conflicting Flow All	1849	657	0	0	1317	0
Stage 1	1313	-	-	-	-	-
Stage 2	536	-	-	-	-	-
Critical Hdwy	7.3	7.4	-	-	4.14	-
Critical Hdwy Stg 1	6.3	-	-	-	-	-
Critical Hdwy Stg 2	6.3	-	-	-	-	-
Follow-up Hdwy	3.75	3.55	-	-	2.22	-
Pot Cap-1 Maneuver	51	357	-	-	521	-
Stage 1	177	-	-	-	-	-
Stage 2	490	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	50	357	-	-	521	-
Mov Cap-2 Maneuver	50	-	-	-	-	-
Stage 1	177	-	-	-	-	-
Stage 2	480	-	-	-	-	-
Approach	WB	NB		SB		
HCM Control Delay, s	31.1	0		0.1		
HCM LOS	D					
Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	50	357	521	-
HCM Lane V/C Ratio	-	-	0.022	0.009	0.021	-
HCM Control Delay (s)	-	-	78.6	15.2	12.1	-
HCM Lane LOS	-	-	F	C	B	-
HCM 95th %tile Q(veh)	-	-	0.1	0	0.1	-

# HCM 6th Signalized Intersection Summary

## 5: Buckwalter Parkway & Pinellas Drive North

2030 A Item 9.

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	28	2	10	49	3	38	94	772	42	58	1118	26
Future Volume (veh/h)	28	2	10	49	3	38	94	772	42	58	1118	26
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	31	2	11	54	3	42	104	858	47	64	1242	29
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	168	9	152	104	14	53	365	2858	1275	555	2858	1275
Arrive On Green	0.10	0.10	0.10	0.10	0.10	0.10	1.00	1.00	1.00	0.80	0.80	0.80
Sat Flow, veh/h	1151	95	1585	600	147	551	436	3554	1585	616	3554	1585
Grp Volume(v), veh/h	33	0	11	99	0	0	104	858	47	64	1242	29
Grp Sat Flow(s),veh/h/ln	1247	0	1585	1298	0	0	436	1777	1585	616	1777	1585
Q Serve(g_s), s	0.0	0.0	0.8	6.3	0.0	0.0	5.3	0.0	0.0	2.7	12.6	0.4
Cycle Q Clear(g_c), s	3.0	0.0	0.8	9.3	0.0	0.0	17.9	0.0	0.0	2.7	12.6	0.4
Prop In Lane	0.94		1.00	0.55		0.42	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	177	0	152	171	0	0	365	2858	1275	555	2858	1275
V/C Ratio(X)	0.19	0.00	0.07	0.58	0.00	0.00	0.29	0.30	0.04	0.12	0.43	0.02
Avail Cap(c_a), veh/h	287	0	277	288	0	0	365	2858	1275	555	2858	1275
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	50.4	0.0	49.4	53.7	0.0	0.0	1.2	0.0	0.0	2.6	3.5	2.3
Incr Delay (d2), s/veh	0.5	0.0	0.2	3.1	0.0	0.0	2.0	0.3	0.1	0.4	0.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	0.0	0.3	3.1	0.0	0.0	0.2	0.1	0.0	0.3	3.0	0.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	50.9	0.0	49.6	56.8	0.0	0.0	3.1	0.3	0.1	3.0	4.0	2.4
LnGrp LOS	D	A	D	E	A	A	A	A	A	A	A	A
Approach Vol, veh/h	44		99			1009			1335			
Approach Delay, s/veh	50.6		56.8			0.6			3.9			
Approach LOS	D		E			A			A			
Timer - Assigned Phs	2		4			6			8			
Phs Duration (G+Y+Rc), s	102.5		17.5			102.5			17.5			
Change Period (Y+Rc), s	6.0		6.0			6.0			6.0			
Max Green Setting (Gmax), s	87.0		21.0			87.0			21.0			
Max Q Clear Time (g_c+I1), s	19.9		5.0			14.6			11.3			
Green Ext Time (p_c), s	9.3		0.1			13.1			0.3			
Intersection Summary												
HCM 6th Ctrl Delay			5.5									
HCM 6th LOS			A									

HCM 6th TWSC  
8: Buckwalter Parkway & Pinellas Drive South

2030 A Item 9.

Intersection												
Int Delay, s/veh	0.7											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations			↗			↗		↗↗	↗		↗↗	↗
Traffic Vol, veh/h	0	0	24	0	0	77	0	1104	134	0	831	8
Future Vol, veh/h	0	0	24	0	0	77	0	1104	134	0	831	8
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	0	-	-	100	-	-	320
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	0	27	0	0	86	0	1227	149	0	923	9

Major/Minor	Minor2		Minor1		Major1		Major2	
Conflicting Flow All	-	-	462	-	-	614	-	0
Stage 1	-	-	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-	-	-
Critical Hdwy	-	-	6.94	-	-	6.94	-	-
Critical Hdwy Stg 1	-	-	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-	-	-
Follow-up Hdwy	-	-	3.32	-	-	3.32	-	-
Pot Cap-1 Maneuver	0	0	547	0	0	435	0	-
Stage 1	0	0	-	0	0	-	0	-
Stage 2	0	0	-	0	0	-	0	-
Platoon blocked, %	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	547	-	-	435	-	-
Mov Cap-2 Maneuver	-	-	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-	-	-























Approach	EB	WB	NB	SB
HCM Control Delay, s	11.9	15.3	0	0
HCM LOS	B	C		

Minor Lane/Major Mvmt	NBT	NBR	EBLn1WBLn1	SBT	SBR
Capacity (veh/h)	-	-	547	435	-
HCM Lane V/C Ratio	-	-	0.049	0.197	-
HCM Control Delay (s)	-	-	11.9	15.3	-
HCM Lane LOS	-	-	B	C	-
HCM 95th %tile Q(veh)	-	-	0.2	0.7	-

# HCM 6th Signalized Intersection Summary













## 11: Buckwalter Parkway & Mott Street/Parkside Drive

2030 A Item 9.

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	61	0	31	151	0	189	94	873	68	58	718	45
Future Volume (veh/h)	61	0	31	151	0	189	94	873	68	58	718	45
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No			No			No		
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	68	0	34	168	0	210	104	970	76	64	798	50
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	149	0	315	309	0	315	516	2493	1112	438	2493	1112
Arrive On Green	0.20	0.00	0.20	0.20	0.00	0.20	1.00	1.00	1.00	1.00	1.00	1.00
Sat Flow, veh/h	1172	0	1585	1375	0	1585	650	3554	1585	539	3554	1585
Grp Volume(v), veh/h	68	0	34	168	0	210	104	970	76	64	798	50
Grp Sat Flow(s),veh/h/ln	1172	0	1585	1375	0	1585	650	1777	1585	539	1777	1585
Q Serve(g_s), s	6.8	0.0	2.1	13.7	0.0	14.7	0.0	0.0	0.0	0.0	0.0	0.0
Cycle Q Clear(g_c), s	21.5	0.0	2.1	15.8	0.0	14.7	0.0	0.0	0.0	0.0	0.0	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	149	0	315	309	0	315	516	2493	1112	438	2493	1112
V/C Ratio(X)	0.46	0.00	0.11	0.54	0.00	0.67	0.20	0.39	0.07	0.15	0.32	0.04
Avail Cap(c_a), veh/h	288	0	502	471	0	502	516	2493	1112	438	2493	1112
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	54.4	0.0	39.4	45.9	0.0	44.4	0.0	0.0	0.0	0.0	0.0	0.0
Incr Delay (d2), s/veh	2.2	0.0	0.1	1.5	0.0	2.4	0.9	0.5	0.1	0.7	0.3	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.1	0.0	0.8	4.8	0.0	6.0	0.1	0.2	0.0	0.1	0.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	56.6	0.0	39.5	47.4	0.0	46.9	0.9	0.5	0.1	0.7	0.3	0.1
LnGrp LOS	E	A	D	D	A	D	A	A	A	A	A	A
Approach Vol, veh/h	102				378				1150			
Approach Delay, s/veh	50.9				47.1				0.5			
Approach LOS	D				D				A			
Timer - Assigned Phs	2			4			6			8		
Phs Duration (G+Y+Rc), s	90.2			29.8			90.2			29.8		
Change Period (Y+Rc), s	6.0			6.0			6.0			6.0		
Max Green Setting (Gmax), s	70.0			38.0			70.0			38.0		
Max Q Clear Time (g_c+I1), s	2.0			23.5			2.0			17.8		
Green Ext Time (p_c), s	9.8			0.3			7.2			1.8		
Intersection Summary												
HCM 6th Ctrl Delay	9.4											
HCM 6th LOS	A											

HCM 6th Signalized Intersection Summary

13: Buckwalter Parkway & Kroger Fuel Driveway

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	59	60	48	1011	844	68
Future Volume (veh/h)	59	60	48	1011	844	68
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No		No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	66	0	53	1123	938	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	86		569	3027	3027	
Arrive On Green	0.05	0.00	0.85	0.85	1.00	0.00
Sat Flow, veh/h	1781	1585	597	3647	3647	1585
Grp Volume(v), veh/h	66	0	53	1123	938	0
Grp Sat Flow(s),veh/h/ln	1781	1585	597	1777	1777	1585
Q Serve(g_s), s	4.4	0.0	1.7	8.2	0.0	0.0
Cycle Q Clear(g_c), s	4.4	0.0	1.7	8.2	0.0	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	86		569	3027	3027	
V/C Ratio(X)	0.77		0.09	0.37	0.31	
Avail Cap(c_a), veh/h	341		569	3027	3027	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	2.00	2.00
Upstream Filter(l)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	56.4	0.0	1.4	1.9	0.0	0.0
Incr Delay (d2), s/veh	13.3	0.0	0.3	0.4	0.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.3	0.0	0.1	1.3	0.1	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	69.8	0.0	1.8	2.3	0.3	0.0
LnGrp LOS	E		A	A	A	
Approach Vol, veh/h	66	A		1176	938	A
Approach Delay, s/veh	69.8			2.3	0.3	
Approach LOS	E			A	A	
Timer - Assigned Phs	2		4		6	
Phs Duration (G+Y+Rc), s	108.2		11.8		108.2	
Change Period (Y+Rc), s	6.0		6.0		6.0	
Max Green Setting (Gmax), s	85.0		23.0		85.0	
Max Q Clear Time (g_c+I1), s	10.2		6.4		2.0	
Green Ext Time (p_c), s	10.8		0.1		7.5	
Intersection Summary						
HCM 6th Ctrl Delay			3.4			
HCM 6th LOS			A			





HCM 6th TWSC  
16: Buckwalter Parkway & Innovation Drive

2030 A Item 9.

Intersection						
Int Delay, s/veh	0.3					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↗		↕	↕	↗
Traffic Vol, veh/h	0	42	0	1072	856	54
Future Vol, veh/h	0	42	0	1072	856	54
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	185
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	47	0	1191	951	60
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	-	476	-	0	-	0
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	6.94	-	-	-	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	3.32	-	-	-	-
Pot Cap-1 Maneuver	0	535	0	-	-	-
Stage 1	0	-	0	-	-	-
Stage 2	0	-	0	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	-	535	-	-	-	-
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	12.4	0		0		
HCM LOS	B					
Minor Lane/Major Mvmt	NBT EBLn1		SBT	SBR		
Capacity (veh/h)	- 535		-	-		
HCM Lane V/C Ratio	- 0.087		-	-		
HCM Control Delay (s)	- 12.4		-	-		
HCM Lane LOS	- B		-	-		
HCM 95th %tile Q(veh)	- 0.3		-	-		

HCM 6th TWSC  
20: Buckwalter Parkway & Progressive Street

2030 A Item 9.

Intersection						
Int Delay, s/veh	0.4					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	0	62	0	840	628	72
Future Vol, veh/h	0	62	0	840	628	72
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	None	-	Yield
Storage Length	-	0	-	-	-	120
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	69	0	933	698	80

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	- 349	- 0	- 0
Stage 1	- -	- -	- -
Stage 2	- -	- -	- -
Critical Hdwy	- 6.94	- -	- -
Critical Hdwy Stg 1	- -	- -	- -
Critical Hdwy Stg 2	- -	- -	- -
Follow-up Hdwy	- 3.32	- -	- -
Pot Cap-1 Maneuver	0 647	0 -	- -
Stage 1	0 -	0 -	- -
Stage 2	0 -	0 -	- -
Platoon blocked, %		- -	- -
Mov Cap-1 Maneuver	- 647	- -	- -
Mov Cap-2 Maneuver	- -	- -	- -
Stage 1	- -	- -	- -
Stage 2	- -	- -	- -






Approach	EB	NB	SB
HCM Control Delay, s	11.2	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBT EBLn1	SBT	SBR
Capacity (veh/h)	- 647	- -	- -
HCM Lane V/C Ratio	- 0.106	- -	- -
HCM Control Delay (s)	- 11.2	- -	- -
HCM Lane LOS	- B	- -	- -
HCM 95th %tile Q(veh)	- 0.4	- -	- -



HCM 6th TWSC  
25: Buckwalter Parkway & Ludlow Street

2030 A Item 9.

Intersection												
Int Delay, s/veh	0.2											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	0	38	0	0	2	0	1035	6	0	875	42
Future Vol, veh/h	0	0	38	0	0	2	0	1035	6	0	875	42
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	0	-	-	-	-	-	200
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	0	42	0	0	2	0	1150	7	0	972	47

Major/Minor	Minor2		Minor1		Major1		Major2	
Conflicting Flow All	-	-	486	-	-	579	-	0
Stage 1	-	-	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-	-	-
Critical Hdwy	-	-	6.94	-	-	6.94	-	-
Critical Hdwy Stg 1	-	-	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-	-	-
Follow-up Hdwy	-	-	3.32	-	-	3.32	-	-
Pot Cap-1 Maneuver	0	0	527	0	0	458	0	-
Stage 1	0	0	-	0	0	-	0	-
Stage 2	0	0	-	0	0	-	0	-
Platoon blocked, %	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	527	-	-	458	-	-
Mov Cap-2 Maneuver	-	-	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	12.4	12.9	0	0
HCM LOS	B	B		







Minor Lane/Major Mvmt	NBT	NBR	EBLn1WBLn1	SBT	SBR
Capacity (veh/h)	-	-	527	458	-
HCM Lane V/C Ratio	-	-	0.08	0.005	-
HCM Control Delay (s)	-	-	12.4	12.9	-
HCM Lane LOS	-	-	B	B	-
HCM 95th %tile Q(veh)	-	-	0.3	0	-



# HCM 6th TWSC

## 3: Buckwalter Parkway & Cassidy Drive






















2030 p Item 9.

Intersection						
Int Delay, s/veh	0.1					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	2	8	1100	2	1	1116
Future Vol, veh/h	2	8	1100	2	1	1116
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	130	-	100	130	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	25	25	2	2	2	2
Mvmt Flow	2	9	1222	2	1	1240
Major/Minor	Minor1	Major1	Major2			
Conflicting Flow All	1844	611	0	0	1224	0
Stage 1	1222	-	-	-	-	-
Stage 2	622	-	-	-	-	-
Critical Hdwy	7.3	7.4	-	-	4.14	-
Critical Hdwy Stg 1	6.3	-	-	-	-	-
Critical Hdwy Stg 2	6.3	-	-	-	-	-
Follow-up Hdwy	3.75	3.55	-	-	2.22	-
Pot Cap-1 Maneuver	51	385	-	-	565	-
Stage 1	200	-	-	-	-	-
Stage 2	439	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	51	385	-	-	565	-
Mov Cap-2 Maneuver	51	-	-	-	-	-
Stage 1	200	-	-	-	-	-
Stage 2	438	-	-	-	-	-
Approach	WB	NB	SB			
HCM Control Delay, s	27.4	0	0			
HCM LOS	D					
Minor Lane/Major Mvmt	NBT	NBRWBLn1WBLn2	SBL	SBT		
Capacity (veh/h)	-	- 51 385	565	-		
HCM Lane V/C Ratio	-	- 0.044 0.023	0.002	-		
HCM Control Delay (s)	-	- 78.8 14.6	11.4	-		
HCM Lane LOS	-	- F B	B	-		
HCM 95th %tile Q(veh)	-	- 0.1 0.1	0	-		

# HCM 6th Signalized Intersection Summary

## 5: Buckwalter Parkway & Pinellas Drive North

2030 p Item 9.

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	67	3	38	132	1	40	99	965	66	118	983	12
Future Volume (veh/h)	67	3	38	132	1	40	99	965	66	118	983	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	74	3	42	147	1	44	110	1072	73	131	1092	13
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	330	12	312	217	4	50	351	2498	1114	405	2498	1114
Arrive On Green	0.20	0.20	0.20	0.20	0.20	0.20	1.00	1.00	1.00	0.70	0.70	0.70
Sat Flow, veh/h	1377	62	1585	832	22	254	510	3554	1585	491	3554	1585
Grp Volume(v), veh/h	77	0	42	192	0	0	110	1072	73	131	1092	13
Grp Sat Flow(s),veh/h/ln	1439	0	1585	1109	0	0	510	1777	1585	491	1777	1585
Q Serve(g_s), s	0.0	0.0	2.6	15.6	0.0	0.0	7.0	0.0	0.0	13.0	15.8	0.3
Cycle Q Clear(g_c), s	5.4	0.0	2.6	21.0	0.0	0.0	22.8	0.0	0.0	13.0	15.8	0.3
Prop In Lane	0.96		1.00	0.77		0.23	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	342	0	312	271	0	0	351	2498	1114	405	2498	1114
V/C Ratio(X)	0.22	0.00	0.13	0.71	0.00	0.00	0.31	0.43	0.07	0.32	0.44	0.01
Avail Cap(c_a), veh/h	427	0	409	358	0	0	351	2498	1114	405	2498	1114
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	40.8	0.0	39.7	49.5	0.0	0.0	2.1	0.0	0.0	7.2	7.6	5.3
Incr Delay (d2), s/veh	0.3	0.0	0.2	4.3	0.0	0.0	2.3	0.5	0.1	2.1	0.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.0	0.0	1.0	5.9	0.0	0.0	0.4	0.2	0.0	1.4	5.2	0.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	41.2	0.0	39.9	53.7	0.0	0.0	4.5	0.5	0.1	9.3	8.2	5.4
LnGrp LOS	D	A	D	D	A	A	A	A	A	A	A	A
Approach Vol, veh/h	119		192				1255				1236	
Approach Delay, s/veh	40.7		53.7				0.9				8.3	
Approach LOS	D		D				A				A	
Timer - Assigned Phs	2		4				6				8	
Phs Duration (G+Y+Rc), s	90.4		29.6				90.4				29.6	
Change Period (Y+Rc), s	6.0		6.0				6.0				6.0	
Max Green Setting (Gmax), s	77.0		31.0				77.0				31.0	
Max Q Clear Time (g_c+I1), s	24.8		7.4				17.8				23.0	
Green Ext Time (p_c), s	11.8		0.5				12.6				0.6	
Intersection Summary												
HCM 6th Ctrl Delay			9.5									
HCM 6th LOS			A									

HCM 6th TWSC  
8: Buckwalter Parkway & Pinellas Drive South

2030 p Item 9.

Intersection												
Int Delay, s/veh	1											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations			↗			↗		↗↗	↗		↗↗	↗
Traffic Vol, veh/h	0	0	68	0	0	89	0	1021	155	0	1081	26
Future Vol, veh/h	0	0	68	0	0	89	0	1021	155	0	1081	26
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	0	-	-	100	-	-	320
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	0	76	0	0	99	0	1134	172	0	1201	29

Major/Minor	Minor2		Minor1		Major1		Major2	
Conflicting Flow All	-	-	601	-	-	567	-	0
Stage 1	-	-	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-	-	-
Critical Hdwy	-	-	6.94	-	-	6.94	-	-
Critical Hdwy Stg 1	-	-	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-	-	-
Follow-up Hdwy	-	-	3.32	-	-	3.32	-	-
Pot Cap-1 Maneuver	0	0	443	0	0	467	0	-
Stage 1	0	0	-	0	0	-	0	-
Stage 2	0	0	-	0	0	-	0	-
Platoon blocked, %	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	443	-	-	467	-	-
Mov Cap-2 Maneuver	-	-	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-	-	-























Approach	EB	WB	NB	SB
HCM Control Delay, s	14.8	14.8	0	0
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBT	NBR	EBLn1WBLn1	SBT	SBR
Capacity (veh/h)	-	-	443	467	-
HCM Lane V/C Ratio	-	-	0.171	0.212	-
HCM Control Delay (s)	-	-	14.8	14.8	-
HCM Lane LOS	-	-	B	B	-
HCM 95th %tile Q(veh)	-	-	0.6	0.8	-

# HCM 6th Signalized Intersection Summary

## 11: Buckwalter Parkway & Mott Street/Parkside Drive







2030 p Item 9.

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	143	0	75	92	0	109	152	1445	223	139	828	71
Future Volume (veh/h)	143	0	75	92	0	109	152	1445	223	139	828	71
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	159	0	83	102	0	121	169	1606	248	154	920	79
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	161	0	238	195	0	238	483	2665	1189	246	2665	1189
Arrive On Green	0.15	0.00	0.15	0.15	0.00	0.15	1.00	1.00	1.00	1.00	1.00	1.00
Sat Flow, veh/h	1270	0	1585	1315	0	1585	564	3554	1585	248	3554	1585
Grp Volume(v), veh/h	159	0	83	102	0	121	169	1606	248	154	920	79
Grp Sat Flow(s),veh/h/ln	1270	0	1585	1315	0	1585	564	1777	1585	248	1777	1585
Q Serve(g_s), s	9.6	0.0	5.6	9.1	0.0	8.4	0.0	0.0	0.0	0.0	0.0	0.0
Cycle Q Clear(g_c), s	18.0	0.0	5.6	14.7	0.0	8.4	0.0	0.0	0.0	0.0	0.0	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	161	0	238	195	0	238	483	2665	1189	246	2665	1189
V/C Ratio(X)	0.99	0.00	0.35	0.52	0.00	0.51	0.35	0.60	0.21	0.63	0.35	0.07
Avail Cap(c_a), veh/h	161	0	238	195	0	238	483	2665	1189	246	2665	1189
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	57.0	0.0	45.7	52.3	0.0	46.9	0.0	0.0	0.0	0.0	0.0	0.0
Incr Delay (d2), s/veh	66.4	0.0	0.9	2.5	0.0	1.8	2.0	1.0	0.4	11.4	0.4	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	7.8	0.0	2.3	3.1	0.0	3.5	0.3	0.4	0.1	0.8	0.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	123.3	0.0	46.6	54.8	0.0	48.7	2.0	1.0	0.4	11.4	0.4	0.1
LnGrp LOS	F	A	D	D	A	D	A	A	A	B	A	A
Approach Vol, veh/h		242			223			2023			1153	
Approach Delay, s/veh		97.0			51.5			1.0			1.8	
Approach LOS		F			D			A			A	
Timer - Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		96.0		24.0		96.0		24.0				
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0				
Max Green Setting (Gmax), s		90.0		18.0		90.0		18.0				
Max Q Clear Time (g_c+I1), s		2.0		20.0		2.0		16.7				
Green Ext Time (p_c), s		28.2		0.0		17.1		0.1				
<b>Intersection Summary</b>												
HCM 6th Ctrl Delay				10.7								
HCM 6th LOS				B								

# HCM 6th Signalized Intersection Summary

## 13: Buckwalter Parkway & Kroger Fuel Driveway



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	144	68	136	1408	963	76
Future Volume (veh/h)	144	68	136	1408	963	76
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	160	0	151	1564	1070	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	190		478	2819	2819	
Arrive On Green	0.11	0.00	0.79	0.79	1.00	0.00
Sat Flow, veh/h	1781	1585	527	3647	3647	1585
Grp Volume(v), veh/h	160	0	151	1564	1070	0
Grp Sat Flow(s),veh/h/ln	1781	1585	527	1777	1777	1585
Q Serve(g_s), s	10.6	0.0	10.0	19.5	0.0	0.0
Cycle Q Clear(g_c), s	10.6	0.0	10.0	19.5	0.0	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	190		478	2819	2819	
V/C Ratio(X)	0.84		0.32	0.55	0.38	
Avail Cap(c_a), veh/h	341		478	2819	2819	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	52.6	0.0	3.6	4.6	0.0	0.0
Incr Delay (d2), s/veh	9.6	0.0	1.7	0.8	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.2	0.0	0.9	5.0	0.2	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	62.2	0.0	5.3	5.4	0.4	0.0
LnGrp LOS	E		A	A	A	
Approach Vol, veh/h	160	A		1715	1070	A
Approach Delay, s/veh	62.2			5.4	0.4	
Approach LOS	E			A	A	
Timer - Assigned Phs	2		4		6	
Phs Duration (G+Y+Rc), s	101.2		18.8		101.2	
Change Period (Y+Rc), s	6.0		6.0		6.0	
Max Green Setting (Gmax), s	85.0		23.0		85.0	
Max Q Clear Time (g_c+I1), s	21.5		12.6		2.0	
Green Ext Time (p_c), s	22.2		0.3		9.1	
Intersection Summary						
HCM 6th Ctrl Delay			6.6			
HCM 6th LOS			A			

### Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th TWSC  
16: Buckwalter Parkway & Innovation Drive

2030 p Item 9.

Intersection						
Int Delay, s/veh	0.8					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↗		↗↗	↗↗	↗
Traffic Vol, veh/h	0	132	0	1222	916	118
Future Vol, veh/h	0	132	0	1222	916	118
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	185
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	147	0	1358	1018	131

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	- 509	- 0	- 0
Stage 1	- -	- -	- -
Stage 2	- -	- -	- -
Critical Hdwy	- 6.94	- -	- -
Critical Hdwy Stg 1	- -	- -	- -
Critical Hdwy Stg 2	- -	- -	- -
Follow-up Hdwy	- 3.32	- -	- -
Pot Cap-1 Maneuver	0 509	0 -	- -
Stage 1	0 -	0 -	- -
Stage 2	0 -	0 -	- -
Platoon blocked, %		- -	- -
Mov Cap-1 Maneuver	- 509	- -	- -
Mov Cap-2 Maneuver	- -	- -	- -
Stage 1	- -	- -	- -
Stage 2	- -	- -	- -

Approach	EB	NB	SB
HCM Control Delay, s	14.9	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBT EBLn1	SBT	SBR
Capacity (veh/h)	- 509	- -	- -
HCM Lane V/C Ratio	- 0.288	- -	- -
HCM Control Delay (s)	- 14.9	- -	- -
HCM Lane LOS	- B	- -	- -
HCM 95th %tile Q(veh)	- 1.2	- -	- -



HCM 6th TWSC  
20: Buckwalter Parkway & Progressive Street

2030 p Item 9.

Intersection						
Int Delay, s/veh	1					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↗		↗↗	↗↗	↗
Traffic Vol, veh/h	0	148	0	1253	984	69
Future Vol, veh/h	0	148	0	1253	984	69
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	None	-	Yield
Storage Length	-	0	-	-	-	120
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	164	0	1392	1093	77

Major/Minor	Minor2	Major1	Major2			
Conflicting Flow All	-	547	-	0	-	0
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	6.94	-	-	-	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	3.32	-	-	-	-
Pot Cap-1 Maneuver	0	481	0	-	-	-
Stage 1	0	-	0	-	-	-
Stage 2	0	-	0	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	-	481	-	-	-	-
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	16.3	0	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBT EBLn1	SBT	SBR
Capacity (veh/h)	- 481	-	-
HCM Lane V/C Ratio	- 0.342	-	-
HCM Control Delay (s)	- 16.3	-	-
HCM Lane LOS	- C	-	-
HCM 95th %tile Q(veh)	- 1.5	-	-

HCM 6th TWSC  
25: Buckwalter Parkway & Ludlow Street

2030 p Item 9.

Intersection												
Int Delay, s/veh	1											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations			↗			↗		↕			↕	↗
Traffic Vol, veh/h	0	0	95	0	0	12	0	1005	17	0	1761	60
Future Vol, veh/h	0	0	95	0	0	12	0	1005	17	0	1761	60
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	0	-	-	-	-	-	200
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	0	106	0	0	13	0	1117	19	0	1957	67

Major/Minor	Minor2		Minor1		Major1		Major2	
Conflicting Flow All	-	-	979	-	-	568	-	0
Stage 1	-	-	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-	-	-
Critical Hdwy	-	-	6.94	-	-	6.94	-	-
Critical Hdwy Stg 1	-	-	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-	-	-
Follow-up Hdwy	-	-	3.32	-	-	3.32	-	-
Pot Cap-1 Maneuver	0	0	249	0	0	466	0	-
Stage 1	0	0	-	0	0	-	0	-
Stage 2	0	0	-	0	0	-	0	-
Platoon blocked, %	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	249	-	-	466	-	-
Mov Cap-2 Maneuver	-	-	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	29.7	13	0	0
HCM LOS	D	B		

Minor Lane/Major Mvmt	NBT	NBR	EBLn1WBLn1	SBT	SBR
Capacity (veh/h)	-	-	249	466	-
HCM Lane V/C Ratio	-	-	0.424	0.029	-
HCM Control Delay (s)	-	-	29.7	13	-
HCM Lane LOS	-	-	D	B	-
HCM 95th %tile Q(veh)	-	-	2	0.1	-



## Division C.4: - Buckwalter Parkway

### C.4.10 - Application

The following access management standards apply to all properties within Beaufort County's jurisdiction on Buckwalter Parkway between the intersection of US 278 and SC 46 (May River Road).

### C.4.20 - Signal Spacing

The recommended spacing between full-signalized accesses is 2,000 feet.

### C.4.30 - Future Signal Locations

The specific signalized access locations shall correspond to the planned signal locations provided in *Buckwalter Access Management Study Update (2021)* Figure 5 in Appendix 10-D: Buckwalter Parkway Access Management Plan of the Beaufort County Comprehensive Plan and the existing traffic signal locations. Existing and planned intersection locations are subject to change to better meet the spacing guidelines. If a modification of the defined signal locations is desired to meet the demands of a specific development or to better meet prescribed spacing goals noted above, the following conditions shall be satisfied:

- A. The modified location must meet the warrants for signalization with the proposed development as defined in the Manual on Uniform Traffic Control Devices (MUTCD) by the Federal Highway Administration (FHWA) with the analysis and specific application of traffic signal warrants to be approved by the Beaufort County traffic engineer.
- B. The modified location must provide adequate spacing (as defined in the spacing standards indicated above) from existing traffic signals and planned traffic signals, including: (note that distances shown should be considered approximate)
  1. Buckwalter Parkway at US 278
  2. Planned location - Buckwalter Parkway at Cinema North (2,026 feet south of US 278)
  3. Planned location - Buckwalter Parkway at Mott Street/Parkside Drive (1,788 feet south of Cinema North)
  4. Planned location - Buckwalter Parkway at Kroger Fuel Drive (2,176 feet south of Mott Street/Parkside Drive)
  5. Buckwalter Parkway at Buckwalter Town Center South (1,496 feet south of Kroger Fuel Drive)
  6. Buckwalter Parkway at Bluffton Parkway (1,077 feet south of Buckwalter Town Center South) \*Intersection location is subject to change to better reflect the access management goals stated above for the corridor as the current location is less than desired spacing of 1,500 feet from location 5.

~~(this signal will be relocated once Phase 5b of the Bluffton Parkway is completed)~~

7. Buckwalter Parkway at Lake Point Drive (1,585 feet south of Bluffton Parkway) \*Intersection location is subject to change to better reflect the access management goals stated above for the corridor as the current location would be less than desired spacing of 1,500 feet from a relocated location 6.
8. Buckwalter Parkway at Bluffton Parkway and Hampton Hall (3,958 feet south of Lake Point Drive/Parker's driveway)
9. Buckwalter Parkway at H.E. McCracken Circle and Old Bridge Drive (4,500 feet south of Hampton Hall)
10. Buckwalter Parkway at SC 46 (May River Road)

- C. The future signalized intersection location shall not have an adverse impact on existing or future LOS based on comparative analysis of conditions with the recommended signal locations indicated in *Buckwalter Access Management Study Update (2021)*. The developer shall be required to conduct LOS and signal system progression analysis to demonstrate compatibility of the proposed signal location with operation of the remainder of the signal system.

#### C.4.40 - Driveways

- A. **Spacing:** Additional access points above the full accesses indicated in subsection C.4.30.B may be granted for right-in/right-out or other controlled movement access with a minimum spacing of 500 feet. Single parcel access is strongly discouraged and connectivity to adjacent parcels should be provided. Joint access driveways are encouraged for small parcels to adhere to the 500-foot spacing. Driveways should be limited to the number needed to provide adequate access to a development. Factors such as alignment with opposing driveways and minimum spacing requirements will have a bearing on the location and number of driveways approved. For parcels/developments that have frontage on Buckwalter Parkway and have access to a signalized intersection location recommended in the Buckwalter Parkway Access Management Plan, minimum spacing shall be 800 feet unless specified in Figure 5 of the Buckwalter Parkway Access Management Plan.
- B. **Driveway design:** Driveway width and turning radii shall conform to SCDOT's Access and Roadside Management Standards.
- C. **Driveway linkages:** See Article VI, Section 6.3.10.D for driveway linkage requirements for non-residential development.
- D. **Retrofitting existing driveways:** As changes are made to previously developed property or to the roadway, driveways will be evaluated for the need to be relocated, consolidated, or eliminated if they do not meet the access management standards.

#### C.4.10 - Deceleration Lanes

Deceleration lanes shall be required when the volume of traffic turning at a site is high enough in relation to the through traffic to constitute the potential for disruption as indicated in the traffic impact analysis.

**ORDINANCE 2021 / \_\_**

**TEXT AMENDMENT TO THE COMMUNITY DEVELOPMENT CODE (CDC):  
APPENDIX C, DIVISION C.4 (BUCKWALTER PARKWAY ACCESS MANAGEMENT  
STANDARDS).**

**WHEREAS**, deleted text is strikethrough; and

**WHEREAS**, added text is highlighted in yellow and underlined.

Adopted this \_\_\_\_ day of \_\_\_\_\_ 2021.

COUNTY COUNCIL OF BEAUFORT COUNTY

By: \_\_\_\_\_  
Joseph Passiment, Chairman

ATTEST:

\_\_\_\_\_  
Sarah W. Brock, JD, Clerk to Council

## Application for Federal Assistance SF-424

\*1. Type of Submission:

☐ Preapplication

☒ Application

☐ Changed/Corrected Application

\*2. Type of Application

☒ New

☐ Continuation

☐ Revision

\* If Revision, select appropriate letter(s):

\*Other (Specify)

\*3. Date Received:

NA

4. Applicant Identifier:

HXD (Hilton Head) Hilton Head Island, SC

\*5b. Federal Entity Identifier:

45-0030

\*5b. Federal Award Identifier:

### State Use Only:

6. Date Received by State:

7. State Application Identifier:

### 8. APPLICANT INFORMATION:

\*a. Legal Name: County of Beaufort

\*b. Employer/Taxpayer Identification Number (EIN/TIN):

57-6000311

\*c. Organizational DUNS:

14-160-8690

### d. Address:

\*Street 1:

Street 2:

\*City:

HILTON HEAD ISLAND

County/Parish:

\*State:

SC

Province:

\*Country:

USA: United States

\*Zip / Postal Code

### e. Organizational Unit:

Department Name:

Division Name:

### f. Name and contact information of person to be contacted on matters involving this application:

Prefix:

Mr.

\*First Name:

Jon

Middle Name:

\*Last Name:

Rembold

Suffix:

Title:

Director/Manager

Organizational Affiliation:

\*Telephone Number: 843-255-2952

Fax Number:

\*Email: jrembold@bcgov.net



**Application for Federal Assistance SF-424**

**\*9. Type of Applicant 1: Select Applicant Type:**

X. Airport Sponsor

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

\*Other (Specify)

**\*10. Name of Federal Agency:**

**Federal Aviation Administration**

**11. Catalog of Federal Domestic Assistance Number:**

20.106

CFDA Title:

Airport Improvement Program

**\*12. Funding Opportunity Number:**

NA

\*Title:

NA

**13. Competition Identification Number:**

NA

Title:

NA

**14. Areas Affected by Project (Cities, Counties, States, etc.):**

**\*15. Descriptive Title of Applicant's Project:**

\$75,806 to provide relief from rent and minimum annual guarantees to eligible small airport concessions located at primary airports.

\$18,951 to provide relief from rent and minimum annual guarantees to eligible large airport concessions located at primary airports.

## Application for Federal Assistance SF-424

### 16. Congressional Districts Of:

\*a. Applicant: 1

\*b. Program/Project: 1

Attach an additional list of Program/Project Congressional Districts if needed.

### 17. Proposed Project:

\*a. Start Date: NA

\*b. End Date: NA

### 18. Estimated Funding (\$):

*a. Federal	\$94,757
*b. Applicant	\$0
*c. State	\$0
*d. Local	\$0
*e. Other	\$0
*f. Program Income	\$0
*g. TOTAL	\$94,757

### \*19. Is Application Subject to Review By State Under Executive Order 12372 Process?

- ☐ a. This application was made available to the State under the Executive Order 12372 Process for review on \_\_\_\_.
- ☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.
- ☒ c. Program is not covered by E. O. 12372

### \*20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes", provide explanation in attachment.)

☐ Yes ☒ No

If "Yes", provide explanation and attach

21. \*By signing this application, I certify (1) to the statements contained in the list of certifications\*\* and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances\*\* and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U. S. Code, Title 218, Section 1001)

☒ \*\* I AGREE

\*\* The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

### Authorized Representative:

Prefix: Mr. \*First Name: Jon

Middle Name:

\*Last Name: Rembold

Suffix:

\*Title: Director/Manager

\*Telephone Number: 843-255-2952

Fax Number:

\* Email: jrembold@bcgov.net

\*Signature of Authorized Representative:

\*Date Signed:



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 10.

### ITEM TITLE:

Hilton Head Island Airport – Recommendation of approval to apply for the American Rescue Plan Act 2021 (ARPA) Grant Funds  
(Fiscal impact: Incoming Grant Funds - \$1,995,069)

### MEETING NAME AND DATE:

County Council – December 13, 2021

### PRESENTER INFORMATION:

Jared Fralix, Assistant County Administrator – Engineering  
Jon Rembold, Airports Director - Alternate  
(2 minutes)

### ITEM BACKGROUND:

On June 22, 2021, Hilton Head Island Airport became eligible for funds under the American Rescue Plan Act 2021 (Public Law 117-2) (ARPA). The purpose of these funds is to provide economic relief to airports in response to the COVID-19 pandemic. Hilton Head Island Airport has two grant opportunities:

- Airport Operations -\$1,900,312
- Concessionaire Relief -\$94,757

Beaufort County Airport Board (BCAB) Date: 11/18/2021  
Public Facilities Committee (PFC) Date: 11/15/2021

### PROJECT / ITEM NARRATIVE:

These funds are to be used for costs related to operations, personnel, cleaning, sanitization, janitorial services, combating the spread of pathogens at the airport, and other similar costs. These projects mentioned above will be 100% funded by these grants.

*The grant offer cover letter requires the governing body to approve the permission to apply for the ARPA grant to the individual signing the application.*

### FISCAL IMPACT:

*The airport will receive grant funds in the amount of \$1,995,069 which will fund efforts as outlined in the ARPA documents (including relief to concessionaires).*

### STAFF RECOMMENDATIONS TO COUNTY COUNCIL:

*Staff is requesting permission to apply for the American Rescue Plan Act 2021 (ARPA) grant funds.*

### OPTIONS FOR COUNTY COUNCIL MOTION:

*Motion to approve /deny the permission to apply for the American Rescue Plan Act 2021 (ARPA) grant funds.*

## Application for Federal Assistance SF-424

\*1. Type of Submission:

- ☐ Preapplication  
☒ Application  
☐ Changed/Corrected Application

\*2. Type of Application

- ☒ New  
☐ Continuation  
☐ Revision

\* If Revision, select appropriate letter(s):

\*Other (Specify)

\*3. Date Received:

NA

4. Applicant Identifier:

HXD (Hilton Head) Hilton Head Island, SC

\*5b. Federal Entity Identifier:

45-0030

\*5b. Federal Award Identifier:

### State Use Only:

6. Date Received by State:

7. State Application Identifier:

### 8. APPLICANT INFORMATION:

\*a. Legal Name: County of Beaufort

\*b. Employer/Taxpayer Identification Number (EIN/TIN):

57-6000311

\*c. Organizational DUNS:

14-160-8690

### d. Address:

\*Street 1:

Street 2:

\*City:

HILTON HEAD ISLAND

County/Parish:

\*State:

SC

Province:

\*Country:

USA: United States

\*Zip / Postal Code

### e. Organizational Unit:

Department Name:

Division Name:

### f. Name and contact information of person to be contacted on matters involving this application:

Prefix: Mr.

\*First Name: Jon

Middle Name:

\*Last Name: Rembold

Suffix:

Title:

Director/Manager

Organizational Affiliation:

\*Telephone Number: 843-255-2952

Fax Number:

\*Email: jrembold@bcgov.net

**Application for Federal Assistance SF-424**

**\*9. Type of Applicant 1: Select Applicant Type:**

X. Airport Sponsor

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

\*Other (Specify)

**\*10. Name of Federal Agency:**

**Federal Aviation Administration**

**11. Catalog of Federal Domestic Assistance Number:**

20.106

CFDA Title:

Airport Improvement Program

**\*12. Funding Opportunity Number:**

NA

\*Title:

NA

**13. Competition Identification Number:**

NA

Title:

NA

**14. Areas Affected by Project (Cities, Counties, States, etc.):**

**\*15. Descriptive Title of Applicant's Project:**

\$1,900,312 for costs related to operations, personnel, cleaning, sanitization, janitorial services, combating the spread of pathogens at the airport, and debt service payments.

## Application for Federal Assistance SF-424

### 16. Congressional Districts Of:

\*a. Applicant: 1

\*b. Program/Project: 1

Attach an additional list of Program/Project Congressional Districts if needed.

### 17. Proposed Project:

\*a. Start Date: NA

\*b. End Date: NA

### 18. Estimated Funding (\$):

*a. Federal	\$1,900,312
*b. Applicant	\$0
*c. State	\$0
*d. Local	\$0
*e. Other	\$0
*f. Program Income	\$0
*g. TOTAL	\$1,900,312

### \*19. Is Application Subject to Review By State Under Executive Order 12372 Process?

- ☐ a. This application was made available to the State under the Executive Order 12372 Process for review on \_\_\_\_.
- ☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.
- ☒ c. Program is not covered by E. O. 12372

### \*20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes", provide explanation in attachment.)

☐ Yes ☒ No

If "Yes", provide explanation and attach

21. \*By signing this application, I certify (1) to the statements contained in the list of certifications\*\* and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances\*\* and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U. S. Code, Title 218, Section 1001)

☒ \*\* I AGREE

\*\* The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

### Authorized Representative:

Prefix: Mr. \*First Name: Jon

Middle Name:

\*Last Name: Rembold

Suffix:

\*Title: Director/Manager

\*Telephone Number: 843-255-2952

Fax Number:

\* Email: jrembold@bcgov.net

\*Signature of Authorized Representative:

\*Date Signed:

**Application for Federal Assistance SF-424**

\*1. Type of Submission:

☐ Preapplication☒ Application☐ Changed/Corrected Application

\*2. Type of Application

☒ New☐ Continuation☐ Revision

\* If Revision, select appropriate letter(s):

\*Other (Specify)  
\_\_\_\_\_

\*3. Date Received:

NA

4. Applicant Identifier:

ARW (Beaufort Exec) Hilton Head Island, SC

\*5b. Federal Entity Identifier:

45-0008

\*5b. Federal Award Identifier:

**State Use Only:**

6. Date Received by State:

7. State Application Identifier:

**8. APPLICANT INFORMATION:**

\*a. Legal Name: County of Beaufort

\*b. Employer/Taxpayer Identification Number (EIN/TIN):

57-6000311

\*c. Organizational DUNS:

14-160-8690

**d. Address:**

\*Street 1: 39 Airport Circle

Street 2: \_\_\_\_\_

\*City: BEAUFORT

County/Parish: \_\_\_\_\_

\*State: SC

Province: \_\_\_\_\_

\*Country: USA: United States

\*Zip / Postal Code 29907

**e. Organizational Unit:**

Department Name:

Division Name:

**f. Name and contact information of person to be contacted on matters involving this application:**

Prefix: Mr. \*First Name: Jon

Middle Name: \_\_\_\_\_

\*Last Name: Rembold

Suffix: \_\_\_\_\_

Title: Airport Director

Organizational Affiliation:

\*Telephone Number: 843-255-2972

Fax Number:

\*Email: jrembold@bcgov.net

**Application for Federal Assistance SF-424**

**\*9. Type of Applicant 1: Select Applicant Type:**

X. Airport Sponsor

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

\*Other (Specify)

**\*10. Name of Federal Agency:**

**Federal Aviation Administration**

**11. Catalog of Federal Domestic Assistance Number:**

20.106

CFDA Title:

Airport Improvement Program

**\*12. Funding Opportunity Number:**

NA

\*Title:

NA

**13. Competition Identification Number:**

NA

Title:

NA

**14. Areas Affected by Project (Cities, Counties, States, etc.):**

**\*15. Descriptive Title of Applicant's Project:**

\$32,000 for costs related to operations, personnel, cleaning, sanitization, janitorial services, combating the spread of pathogens at the airport, and debt service payments.



## Application for Federal Assistance SF-424

### 16. Congressional Districts Of:

\*a. Applicant: 1

\*b. Program/Project: 1

Attach an additional list of Program/Project Congressional Districts if needed.

### 17. Proposed Project:

\*a. Start Date: NA

\*b. End Date: NA

### 18. Estimated Funding (\$):

*a. Federal	\$32,000
*b. Applicant	\$0
*c. State	\$0
*d. Local	\$0
*e. Other	\$0
*f. Program Income	\$0
*g. TOTAL	\$32,000

### \*19. Is Application Subject to Review By State Under Executive Order 12372 Process?

- ☐ a. This application was made available to the State under the Executive Order 12372 Process for review on \_\_\_\_.
- ☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.
- ☒ c. Program is not covered by E. O. 12372

### \*20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes", provide explanation in attachment.)

☐ Yes ☒ No

If "Yes", provide explanation and attach

21. \*By signing this application, I certify (1) to the statements contained in the list of certifications\*\* and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances\*\* and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U. S. Code, Title 218, Section 1001)

☒ \*\* I AGREE

\*\* The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

### Authorized Representative:

Prefix: Mr. \*First Name: Jon

Middle Name:

\*Last Name: Rembold

Suffix:

\*Title: Airport Director

\*Telephone Number: 843-255-2972

Fax Number:

\* Email: jrembold@bcgov.net

\*Signature of Authorized Representative:

\*Date Signed:



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 11.

### ITEM TITLE:

Beaufort Executive Airport – Recommendation of approval to apply for the American Rescue Plan Act 2021 (ARPA)

*(Fiscal impact: Incoming Grant Funds - \$32,000)*

### MEETING NAME AND DATE:

County Council – December 13, 2021

### PRESENTER INFORMATION:

Jared Fralix, Assistant County Administrator – Engineering

Jon Rembold, Airports Director - Alternate

*(2 minutes)*

### ITEM BACKGROUND:

On June 22, 2021, Beaufort Executive Airport (ARW) became eligible for funds under the American Rescue Plan Act 2021 (Public Law 117-2) (ARPA). The purpose of these funds is to provide economic relief to airports in response to the COVID-19 pandemic. Beaufort Executive Airport has one grant opportunity:

- Airport Operations -\$32,000

Beaufort County Airport Board (BCAB) Date: 11/18/2021

Public Facilities Committee (PFC) Date: 11/15/2021

### PROJECT / ITEM NARRATIVE:

These funds are to be used for costs related to operations, personnel, cleaning, sanitization, janitorial services, combating the spread of pathogens at the airport, and other similar costs. This project mentioned above will be 100% funded by this grant.

*The grant offer cover letter requires the governing body to approve the permission to apply for the ARPA grant to the individual signing the application.*

### FISCAL IMPACT:

*The airport will receive grant funds in the amount of \$32,000 which fully funds this project.*

### STAFF RECOMMENDATIONS TO COUNTY COUNCIL:

*Staff is requesting permission to apply for the American Rescue Plan Act 2021 (ARPA) grant funds.*

### OPTIONS FOR COUNTY COUNCIL MOTION:

*Motion to approve /deny the permission to apply for the American Rescue Plan Act 2021 (ARPA) grant funds.*



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 12.

### ITEM TITLE:

Recommendation of Hilton Head Island Airport (HXD) and Beaufort Executive Airport (ARW) Hangar rent increase approval.

### MEETING NAME AND DATE:

Public Facilities Committee – November 15, 2021

### PRESENTER INFORMATION:

Jared Fralix, P.E. ACA – Engineering

Jon Rembold, C.M. Airports Director (Alternate)

(2 minutes)

### ITEM BACKGROUND:

The last increase for All County hangar use agreements at Hilton Head Island Airport (HXD) and Beaufort Executive Airport (ARW) was on August 1, 2019.

The proposed increases effective January 01, 2022 will be:

- HXD
  - T-Hangar from current rate \$439.80 to \$462.00
  - Corporate Hangar (60'x52') from current rate \$1,307.35 to \$1,373.00
  - Box Hangar (80'x80') from current rate \$2,680.19 to \$2,815.00
- ARW
  - T-Hangar from current rate \$326.55 to \$345.00

### PROJECT / ITEM NARRATIVE:

This increase helps cover the costs of building insurance, operations, and maintenance. Hangar use fees also help to pay for the airport's portion of the cost of the airfield improvements that are ongoing at HXD & ARW.

The current waiting lists for Hangar space:

HXD: (24) ARW: (54)

### FISCAL IMPACT:

54000001-47220 (Hangar rent for HXD) total annual amount:

- HXD
  - T-Hangar annual rate - \$5,545.00
  - Corporate Hangar (60'x52') annual rate - \$16,476.00
  - Box Hangar (80'x80') annual rate - \$33,780.00

51000001-47210 (Hangar rent for ARW) total annual amount:

- ARW
  - T-Hangar annual rate - \$4,140.00

### STAFF RECOMMENDATIONS TO COMMITTEE:

*Staff recommends approval of Hangar Rent Increase for both Hilton Head Island Airport (HXD) and Beaufort Executive Airport (ARW).*

**OPTIONS FOR COMMITTEE MOTION:**

*Motion to approve /deny the recommendation of Hangar Rent Increase for both Hilton Head Island Airport (HXD) and Beaufort Executive Airport (ARW).*

***(Next Steps -N/A – This is a revenue generating item.)***

# MINUTES

## Beaufort County Airports Board

*October 21, 2021 | 1:30 pm | WebEx Meeting called to order by Chairman Howard Ackerman*

### In Attendance

Howard Ackerman, Anne Esposito, Leslie Adlam Flory, Brian Turrisi, Nicholas Mesenburg, Thomas Sheahan and James Buckley, Chris Butler, Mark Bailey, Ian Scott.

Absent: Trey Ambrose.

County Staff: Jon Rembold, Airports Director; Stephen Parry, Assistant Airports Director; Paul Dolin, Beaufort Executive Airport Supervisor; Elena Milbrandt, Airports Administrative Assistant.

Stewart Rodman - Beaufort County Council member.

Public: Ben Klimko – Signature Flight Support.

### Approval of Agenda

Motion: Mr. Howard Ackerman made a motion to accept the agenda. The vote was FOR–Howard Ackerman, Anne Esposito, Leslie Adlam Flory, Brian Turrisi, Nicholas Mesenburg, James Buckley, and Thomas Sheahan.

The amended agenda was approved as distributed.

AGAINST –None. ABSENT Trey Ambrose.

### Approval of Minutes

Motion: Mr. Brian Turrisi made a motion to accept the September 16, 2021 meeting minutes. The vote was FOR –Howard Ackerman, Anne Esposito, Leslie Adlam Flory, Brian Turrisi, Nicholas Mesenburg, James Buckley, Chris Butler, Mark Bailey, Ian Scott and Thomas Sheahan.

The minutes were approved as distributed.

AGAINST – None. ABSENT – Trey Ambrose.

### Public Comments

There were no public comments offered.

### Director's Report - Beaufort Executive Airport Update

#### ❖ BEAUFORT EXECUTIVE AIRPORT EVENT:

- Mr. Dolin discussed the success and positive feedback of the Runway 5K Race (October 9<sup>th</sup>) to the board members.

#### ❖ BEAUFORT EXECUTIVE AIRPORT TERMINAL:

- Mr. Dolin briefed the board members on the terminal remodel taking place on (November 8<sup>th</sup>) at the airport.

- ❖ BEAUFORT EXECUTIVE AIRPORT HIRES:
  - Mr. Dolin briefed the board members on new part-time hires at the airport.
- ❖ BEAUFORT EXECUTIVE AIRPORT JANITORIAL SERVICES:
  - Mr. Rembold briefed the board members on janitorial services with On Point Commercial & Residential Cleaning for Beaufort Executive Airport.

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## Director's Report – Hilton Head Island Airport Update

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- ❖ ANNUAL ATAX & HTAX APPLICATION:
  - Mr. Rembold briefed the board members on annual ATAX & HTAX and submitting applications.
- ❖ REBRANDING OF AIRPORT LOGO:
  - Mr. Rembold briefed the board members on new logo in the works and retiring old brand.
- ❖ CONCESSIONS OPENS:
  - Mr. Rembold briefed the board members on the opening of new concession area.
- ❖ CONCOURS D'ELEGANCE & MOTORING FESTIVAL – NOVEMBER 5-7, 2021:
  - Mr. Rembold briefed the board members on the Concours d'Elegance & Motoring Festival automotive exhibition being held at the Hilton Head Airport.
- ❖ PROJECTS:
  - Mr. Rembold gave the latest information on the progress of current projects at the terminal. No major changes currently.
- ❖ HILTON HEAD AIRPORT JANITORIAL SERVICES:
  - Mr. Rembold briefed the board members on janitorial services with Low Country Commercial Service for Hilton Head Airport.

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## Unfinished Business

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N/A

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## New Business

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### 1. MOTION TO APPROVE HANGAR RATE INCREASE AT BOTH AIRPORTS

A Motion was made by Chris Butler to move forward the Hangar Rate Increase proposal to the Public Facilities Committee meeting on November 15th, 2021, seconded by Leslie Adlam Flory. The vote was FOR – Howard Ackerman, Anne Esposito, Leslie Adlam Flory, Brian Turrisi, Nicholas Mesenburg, James Buckley, Thomas Sheahan, Chris Butler, Mark Bailey, and Ian Scott.

AGAINST – None. ABSENT- Trey Ambrose.

**THE MOTION FOR APPROVAL PASSES.**

### 2. MOTION TO APPROVE JANITORIAL AGREEMENTS AT BOTH AIRPORTS

A Motion was made by Chris Butler to approve the janitorial service agreements for both Beaufort Executive Airport (ARW) and Hilton Head Airport (HXD), seconded by Brian Turrisi. The vote was

FOR – Chris Butler, Mark Bailey, Ian Scott, Howard Ackerman, Anne Esposito, Leslie Adlam Flory, Brian Turrisi, Nicholas Mesenburg, James Buckley, and Thomas Sheahan.

AGAINST – None. ABSENT- Trey Ambrose.

**THE MOTION FOR APPROVAL PASSES.**

---

## Chairman Update

---

### 1. **Finance Committee**

Members: Howard Ackerman (Chair), Anne Esposito, Chris Butler and Brian Turrisi.

- ◆ The Finance Committee has nothing new to report this month. They will keep the board informed of any new developments.

### 2. **Communications and Marketing**

Members: Jim Buckley (Chair), Brian Turrisi and Leslie Adlam Flory.

- ◆ The Communications and Marketing Committee has nothing new to report this month. They will keep the board informed of any new developments.

### 3. **Passenger Service Committee**

Members: Leslie Adlam Flory (Chair) and Anne Esposito.

- ◆ The Passenger Service Committee has nothing new to report this month. They will keep the board informed of any further developments.

### 4. **ARW Facilities Use and Improvement**

Members: Chris Butler (Chair), Mark Bailey and Trey Ambrose

The ARW Facilities Use and Improvement Committee Chair has nothing new to report this month. They will keep the board informed of any new developments.

### 5. **The Hilton Head Island Airport General Aviation Improvement Committee**

Members: Howard Ackerman and Brian Turrisi.

This Committee will focus on improvements to the General Aviation side of HXD.

- ◆ The Hilton Head Island General Aviation Improvement Committee has nothing new to report this month. They will keep the board informed of any new developments.

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## Public Comments

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Public comment were given by James Buckley and Chris Butler.

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## Next Meeting

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November 18, 2021 | 1:30 pm | WebEx Meeting | For more information, please click here:

[www.beaufortcountysc.gov/events/2021/11/Airports%20Board%202021-11-18.html](http://www.beaufortcountysc.gov/events/2021/11/Airports%20Board%202021-11-18.html)

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## Contact us –Social Media

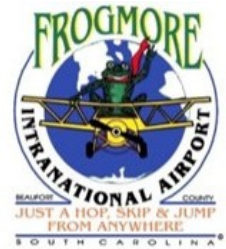
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Please like and share our [Facebook page](#) & [Instagram page](#). Check out our [Website](#) page as well.

Motion to adjourn was made at 2:07 pm and was passed unanimously.



County Council of Beaufort County  
 Robert Smalls Government Complex  
 100 Ribaut Road, Beaufort, South Carolina 29902  
 Phone 843-255-2942 • Fax 843-255-9424



**TO:** Beaufort County Airports (HXD, ARW) - Hangar Tenants

**FROM:** Jon Rembold, Airports Director

**SUBJ:** Airport Hangar Use Rate

**DATE:** November 17, 2021

Dear Airport Hangar Tenant,

All County hangar use agreements at Hilton Head Island Airport (HXD) and Beaufort County Airport (ARW) are being changed effective January 01, 2022 to reflect a 5% rate increase. This increase helps cover the costs of building insurance, operations, and maintenance. Hangar use fees also help to pay for the airport's portion of the cost of the airfield improvements that are ongoing at HXD & ARW.

Revised hangar agreements will be sent to each hangar tenant reflecting the new rate. Each tenant must return the signed agreement and a certificate of insurance by January 01, 2022 in order to maintain their agreement.

Please contact me at 843-255-2952 or [jrembold@bcgov.net](mailto:jrembold@bcgov.net) if you have any questions.

cc: Eric Greenway, County Administrator  
 Dale Butts, Assistant County Administrator – Finance  
 Trey Ambrose Chairman Beaufort County Airports Board



**RESOLUTION 2021/\_\_\_****A RESOLUTION TO ADOPT THE BEAUFORT COUNTY AIRPORTS HANGAR USE AGREEMENT**

**WHEREAS**, the County owns and is responsible for the management, control and operation of the Airports at Hilton Head Island and at Beaufort Executive; and

**WHEREAS**, the County has Aircraft Hangars available for use at the Airports; and,

**WHEREAS**, Lessor is willing to rent such space, to the Lessee upon the terms and conditions set forth herein; and

**WHEREAS**, the parties hereto agree to be bound by all of the terms and conditions set forth herein;

**WHEREAS**, Beaufort County recognizes that the Airports are Enterprise Funds needing to generate revenue, and;

**WHEREAS**, the Executive Committee considered the attached Airports Hangar Use Rates at the November 15, 2021 meeting and unanimously recommends that County Council adopt the rates as presented; and

**NOW THEREFORE, BE IT RESOLVED, THAT THE COUNTY COUNCIL OF BEAUFORT COUNTY, SOUTH** adopts the Airports Hangar Use Rates that is attached hereto and incorporated herein as fully as if repeated verbatim:

Adopted this \_\_\_\_ day of December 2021.

COUNTY COUNCIL OF BEAUFORT COUNTY

BY: \_\_\_\_\_  
Joseph Passiment, Chairman

ATTEST:

\_\_\_\_\_  
Sarah W. Brock, Clerk to Council

Hangar Type	Current Monthly Rate	5% Increase	New Monthly Rate
HXD T-Hangar	\$439.80	\$22.20	\$462.00
HXD Corporate Hangar 60' x 52'	\$1,307.35	\$65.65	\$1,373.00
HXD Box Hangar 80'x 80'	\$2,680.19	\$134.81	\$2,815.00
ARW T-Hangar	\$326.55	\$18.45	\$345.00



## BEAUFORT COUNTY COUNCIL AGENDA ITEM SUMMARY

Item 13.

### ITEM TITLE:

Contract Award: Recommendation to Award IFB #101121E, Sun City EMS/Fire Renovations

### MEETING NAME AND DATE:

County Council – December 13, 2021

### PRESENTER INFORMATION:

Jared Fralix, Assistant County Administrator – Engineering

(5 mins)

### ITEM BACKGROUND:

Sun City EMS/Fire Station 34 at 25 William Pope Drive, Bluffton, is more than 20 years old and is in need of renovation and expansion to continue to meet the first responders needs for Sun City and Unincorporated Beaufort County. Additionally, current personnel quarters are limited to a large bay room with bunks, providing no privacy or virus protection/spread. Extra space is limited and does not allow for sufficient storage space for expendables, supplies, materials, etc. An MOA, executed May 14, 2021, between Beaufort County and the Bluffton Township Fire District makes the parties mutually financially responsible for this Work.

### PROJECT / ITEM NARRATIVE:

The work would be in two phases. Phase I would be new construction of an East Wing to include individual bunk rooms, bathrooms, workout room, storage and decontamination rooms. Once completed and occupied, Phase II would be a renovation of the existing living area to increase storage, office space, community room, and add a walk-in clinic. IFB#101121 had three bidders, and Brantley Construction Services, LLC out of Charleston SC was the lowest, most responsive bidder at \$1,234,000.00.

### FISCAL IMPACT:

Beaufort County would encumber the entire estimated amount of \$1,234,000.00; however, BTFD would reimburse 50% of all costs. With a 10% contingency, the total budget is \$1,357,400 to be funded from 2017 GO Bond:

BTFD Contribution Red Barn	40100001-47040	\$248,896.50
BTFD Contribution Sun City Phase I Design	40100001-47040	\$15,077.33
BTFD Contribution Sun City Phase II Design	40100001-47040	\$15,500.00
BTFD 50% Construction Match	40100001-47040	\$678,700.00
Beaufort County Available	40100011-54410	\$314,804.74
Transfer from Contingency	40100011-56000	\$95,000.00

Note: the numbers above are all project related activities which include engineering design, construction, third party inspections, and miscellaneous items that are included purchased at internal approval levels.

### STAFF RECOMMENDATIONS TO COUNCIL:

Staff recommends approval of contract award to Brantley Construction Services, LLC for IFB#101121E.

**OPTIONS FOR COUNCIL MOTION:**

Motion to approve/deny award of Contract to Brantley Construction Services, LLC for IFB#101121E.

*Next Step: Move forward to County Council for award of contract to Brantley Construction Services, LLC.*

Bid Date and Time: Friday, October 15, 2021 at 3:00 PM  
 Bid Location: Beaufort County Purchasing Department  
 106 Industrial Village Rd. Building 2 Beaufort, SC, 29906  
 IFB 101321E



## Sun City EMS and Fire Station Addition and Renovation

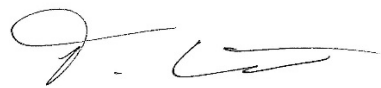
25 William Pope Drive, Okatie SC, 29909

## Bid Tabulation

Item or Description	Paul S Akins Company, Inc.	Brantley Construction Company, LLC.	Collins Construction Services, Inc.
SC License Number	G10501	G111944	G14790
Addendum #1 Received	Yes	Yes	Yes
Addendum #2 Received	Yes	Yes	Yes
Addendum #3 Received	Yes	Yes	Yes
Addendum #4 Received	Yes	Yes	Yes
Invitation to Bid Form	Yes	Yes	Yes
Bid Form	Yes	Yes	Yes
Consent of Surety	Yes	Yes	Yes
Bid Bond	Yes	Yes	Yes
Certificate of Non-Segregated Facilities	Yes	Yes	Yes
Certification of Non-Collusion	Yes	Yes	Yes
Contractors Qualifications Statement	Yes	Yes	Yes
Certification Regarding Debarment, Suspension, Ineligibility, and Voluntary Exclusion	Yes	Yes	Yes
Local Vendor Preference – Participation Affidavit	Yes	Yes	Yes
Good Faith Efforts Checklist	Yes	Yes	Yes
Non-Discrimination Checklist	Yes	Yes	Yes
A. Base Bid	\$1,310.200	\$ 1,144,000.00	\$ 1,480,000.00
B. Allowance	\$90,000.00	\$ 90,000.00	\$ 90,000.00

C. Total Bid (A+B)	\$ 1,400,200.00	\$ 1,234,000.00	\$ 1,575,000.00


Certification:  
Bids tabulated herein were opened on Friday, October 15, 2021 at 3:00 PM, in the office of Beaufort County Purchasing Department, 106 Industrial Village Road, Building 2 Beaufort, SC, 29906. The above Tabulation is true and accurate.



Certified by: \_\_\_\_\_ on 10-15-2021  
Tripp Armstrong, Associate AIA

**THIS IS NOT AN ORDER**

Dates Advertised: September 13, 2021

	<b>INVITATION FOR BID (IFB)</b>		FORMAL SEALED BID (X)      REQUEST FOR QUOTE ( )
We require bids to be electronically submitted through our Vendor Registry Program. Please go to <a href="http://www.BeaufortCountySC.gov">www.BeaufortCountySC.gov</a> and sign up to submit your bid.			Purchasing Department Beaufort Industrial Village 106 Industrial Village Rd. Bldg. 2 Beaufort, SC 29906-4291
*BIDS WILL BE RECEIVED UNTIL 3:00 P.M. LOCAL TIME ON: <b>October 13, 2021</b>		Bid No. <b>IFB#101121E</b>	
<b>BID TITLE: Sun City EMS/FIRE Renovations</b>			
<b>PREBID CONFERENCE: A Pre-Bid</b> conference will be held on September 22, 2021 at 1:00 p.m. virtually through WebEx. This is a Non-Mandatory meeting; all interested bidders and subcontractors are encouraged to attend. Please send your email address to Victoria Moyer at <a href="mailto:victoria.moyer@bcgov.net">victoria.moyer@bcgov.net</a> for the WebEx invitation.			
David L. Thomas, CPPO Purchasing Director	Mailing Date	<b>SUBMIT QUESTIONS TO:</b> Vendor Registry at least 10 calendar days before bid opening.	
<b>VENDOR NAME</b> Brantley Construction Services, LLC DBA Brantley Construction Company, LLC		<b>REASON FOR NO BID</b>	
<b>VENDOR MAILING ADDRESS</b> 8300 Dorchester Rd		<b>Amend Number(s) Received:</b> 1, 2, 3, 4	
<b>CITY-STATE-ZIP-CODE</b> Charleston, SC 29418		<b>S.C. TAX NO.</b>	
Telephone Number (843) 552-0150 Toll-Free Number ( ) Fax Number (843) 552-9072		<b>FEDERAL I.D. OR SOCIAL SECURITY NO.</b> 20-3509558	
I certify that this bid is made without prior understanding, agreement, or connection with any corporation, firm or any corporation, firm, or person submitting a bid for the same materials, supplies, or equipment, and is in all respects fair and without collusion or fraud. I agree to abide by all conditions of this bid and certify that I am authorized to sign this bid for the bidder.		<b>AUTHORIZED SIGNATURE (MANUAL)</b>	
		<b>AUTHORIZED SIGNATURE (TYPE/TITLE)</b> Gary D. Brantley, President	
Bid Security is attached (if required) in the amount of: 5% of Bid if over \$30,000.00.			

**BID ACCEPTANCE AND DELIVERY** (Prices bid must be firm for a minimum of 90 days). In compliance with the Invitation, and subject to all conditions thereof, the above signed offers and agrees, if this bid is accepted within (90) days from date of opening, to furnish any or all items quoted on at prices as set forth after the item and to make delivery within (120) days after receipt of order with transportation cost included and prepaid. Unless otherwise stated and accepted herein, I agree to complete this proposed contract in less than sixty (30) calendar days after issue date of purchase order.

**IMPORTANT**  
 IF YOU CONSIDER THESE SPECIFICATIONS AS RESTRICTIVE,  
 SEE GENERAL PROVISIONS, PARAGRAPH #20, DISCREPANCIES

IFB #101321E

## BID FORM

THIS BID SUBMITTED TO: Beaufort County Capital Projects DepartmentTITLE OF WORK: Sun City EMS/Fire RenovationsLOCATION OF WORK: 25 William Pope Drive, Bluffton SC

1. **BIDDER** has examined all Contract Documents including Addenda.
2. **BIDDER** understands and accepts the terms and conditions of the Invitation to Bid, Instructions to Bidders, and all other Contract Documents.
3. **BIDDER** having examined the plans and specifications with related documents and the site of the proposed work, and being familiar with all of the conditions surrounding the construction of the proposed project including the availability of materials and supplies to construct the project in accordance with the contract documents, within the time set forth herein, and at the process stated below, proposed to enter into a contract with the County to provide the necessary machinery, tools, apparatus, all materials and labor, and other means of construction necessary to complete the Work. The undersigned proposes to furnish and construct the items listed in the attached Schedule of Items for the unit prices stated.
4. **BIDDER** agrees that the cost of any work performed, materials furnished, services provided or expenses incurred, which are not specifically delineated in the Contract Documents, but which are incidental to the scope, intent, and completion of the Contract, shall be deemed to have been included in the prices bid for the various items scheduled.

**Start and Completion of Work**

The Bidder further proposes and agrees hereby to promptly commence the Work **with adequate force and equipment within ten (10) calendar days** from receipt of Notice to Proceed, or as may be specified by Special Provision. **Contractor shall complete all work not later than 365 calendar days following the date of the Notice to Proceed or IAW any Special Provision by the Owner.**

Bidder acknowledges receipt of the following addenda:

No. 1, 2, 3, 4  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

5. **BIDDER** acknowledges that, in accordance with the Agreement, Liquidated Damages are set at \$800 per calendar day.
6. In accordance with Paragraph 5.1 of the Agreement, progress payments will be made less retainage in an amount equal to ten percent (10%). If the Contractor is **50% complete** with the project

and **on schedule**, the retainage may be reduced to five percent **(5%)**.

7. The Work shall be completed in accordance with the Schedule of Prices set forth by **BIDDERS** in Bid Form - Schedule of Prices which is attached hereto and made a part hereof.

8. **BIDDER** will, if this Bid is accepted by Owner, enter into the Agreement included in the Contract Documents to perform and furnish all Work as specified or indicated in the Contract Documents.

9. **BIDDER** has completed the following additional documents, which are attached hereto and made a part hereof:

- (a) **NON-COLLUSION AFFIDAVIT**
- (b) **CONSENT OF SURETY**
- (c) **BID BOND**
- (d) **CERTIFICATION BY CONTRACTOR**

10. **BIDDER** has included with this Bid Form a Bid security in an amount and under the terms and conditions indicated in the Instructions to Bidders.

11. **BIDDER** is organized under the laws of the State of South Carolina as

a LLC, S-Corp (indicate proprietorship, partnership, or corporation) as follows:

Name (of business): Brantley Construction Services, LLC DBA Brantley Construction Company, LLC

Address: 8300 Dorchester Rd, Charleston, SC 29418

Telephone: 843-552-0150 FAX: 843-552-9072

South Carolina Bidder's License No.: G111944

Licensing Authority: South Carolina Contractor's Licensing Board


12. Communications concerning this Bid should be addressed to the **BIDDER's** company, to the attention of:

Name: Brantley Construction Services, LLC DBA Brantley Construction Company, LLC

Address: 8300 Dorchester Rd, Charleston, SC 29418

Telephone: 843-552-0150 FAX: 843-552-9072



**SIGNED BY:**  
SignatureGary D. Brantley

Name Printed

Title: President Date: October 13, 2021

I, the above signed, certify that this Bid does not violate any Federal or State Antitrust Laws.

 (Initial)

IFB #101321E

## BID PAGE

## SUN CITY EMS/FIRE RENOVATIONS

**NOTE: An itemized Schedule of Values along with a Time Schedule of Performance will be required to be supplied to the ENGINEER by the CONTRACTOR within 15 days after Notice to Proceed. SCHEDULE OF PRICES**

The **BIDDER** having examined the plans and specifications with related documents and the site of the proposed work, and being familiar with all of the conditions surrounding the construction of the proposed project including the availability of materials and supplies to construct the project in accordance with the contract documents, within the time set forth herein, and at the process stated below, proposed to enter into a contract with the County to provide the necessary machinery, tools, apparatus, all materials and labor, and other means of construction necessary to complete the Work. The undersigned proposes to complete the Work for the bid listed and broken down as follows for the Sun City EMS/Fire Renovations, both Phase I (New Construction of 2534 sq ft East Wing) and Phase II (Renovation of the existing 1910 sq ft West Wing) with all Work as designed in Exhibit 1, attached.

**Turn Key Base Price for Phase I and Phase II:**

- a. Base Bid: \$ 1,144,000.00
- b. Allowance \$ 90,000.00
- c. Total Bid Numerically: \$ 1,234,000.00
- d. Same amount, spelled out in words for confirmation: One million two hundred thirty-four thousand dollars and 00/100

**SIGNED BY:**  
SignatureGary D. Brantley

Name Printed

Title: President Date: October 15, 2021

**IFB #101321E**

**BID BOND**

(Five Percent [5%] of Bid)

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned:

Brantley Construction Services, LLC DBA Brantley Construction Company, LLC, as Principal, and  
Fidelity and Deposit Company of Maryland

\_\_\_\_\_, as Surety, are hereby held and firmly bound unto Beaufort County, South Carolina as County in the penal sum of Five Percent of the Amount Bid.....

Dollars

(\$ 5%) for the payment of which, well and truly to be made, we hereby jointly and severally bid ourselves, our heirs, executors, administrators, successors, and assigns. Signed this 13<sup>th</sup> day of October, 2021.

The condition of the above obligation is such that whereas the Principal has submitted to Beaufort County, South Carolina a certain bid attached hereto and hereby made a part hereof to enter into a contract in writing for the construction of: Sun City Ems/Fire Renovations IFB #101321E

**NOW, THEREFORE,**

- a) If said bid shall be rejected or in the alternate.
- b) If said bid shall be accepted and the Principal shall execute and deliver a Contract in the Form of Contract attached hereto (properly complete in accordance with said bid) and shall furnish a bond for his faithful performance of said Contract and for the payment of all persons performing labor and furnishing material in connection therewith, and shall in all other respects perform the agreement created by the acceptance of said bid, then this obligation shall be void, otherwise the same shall remain in force and effect, it being expressly understood and agreed that the liability of the surety for any and all claims hereunder shall, in no event, exceed the penal amount of this obligation as herein stated.

The Surety, for value received, hereby stipulates and agrees that the obligations of said Surety and its bond shall be in no way impaired or affected by any extension of the time within which the County may accept such bids, and said Surety does hereby waive notice of any such extension.

IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year first set forth above.

Brantley Construction Services, LLC DBA  
Brantley Construction Company, LLC

(SEAL)

Principal

By:

Gary D. Brantley, President

(SEAL)

Surety: Fidelity and Deposit Company of Maryland

By:

### South Carolina Representative

Duainette H. Cullum, Attorney in Fact & SC Resident Agent

## EXTRACT FROM BY-LAWS OF THE COMPANIES

"Article V, Section 8, Attorneys-in-Fact. The Chief Executive Officer, the President, or any Executive Vice President or Vice President may, by written instrument under the attested corporate seal, appoint attorneys-in-fact with authority to execute bonds, policies, recognizances, stipulations, undertakings, or other like instruments on behalf of the Company, and may authorize any officer or any such attorney-in-fact to affix the corporate seal thereto; and may with or without cause modify or revoke any such appointment or authority at any time."

## CERTIFICATE

I, the undersigned, Secretary of the ZURICH AMERICAN INSURANCE COMPANY, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND, do hereby certify that the foregoing Power of Attorney is still in full force and effect on the date of this certificate; and I do further certify that Article V, Section 8, of the By-Laws of the Companies is still in force.

This Power of Attorney and Certificate may be signed by facsimile under and by authority of the following resolution of the Board of Directors of the ZURICH AMERICAN INSURANCE COMPANY at a meeting duly called and held on the 15th day of December 1998.

RESOLVED: "That the signature of the President or a Vice President and the attesting signature of a Secretary or an Assistant Secretary and the Seal of the Company may be affixed by facsimile on any Power of Attorney...Any such Power or any certificate thereof bearing such facsimile signature and seal shall be valid and binding on the Company."

This Power of Attorney and Certificate may be signed by facsimile under and by authority of the following resolution of the Board of Directors of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at a meeting duly called and held on the 5th day of May, 1994, and the following resolution of the Board of Directors of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at a meeting duly called and held on the 10th day of May, 1990.

RESOLVED: "That the facsimile or mechanically reproduced seal of the company and facsimile or mechanically reproduced signature of any Vice-President, Secretary, or Assistant Secretary of the Company, whether made heretofore or hereafter, wherever appearing upon a certified copy of any power of attorney issued by the Company, shall be valid and binding upon the Company with the same force and effect as though manually affixed.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed the corporate seals of the said Companies, this 13th day of October, 2021



*Brian M. Hodges*

By: Brian M. Hodges  
Vice President

**TO REPORT A CLAIM WITH REGARD TO A SURETY BOND, PLEASE SUBMIT A COMPLETE DESCRIPTION OF THE CLAIM INCLUDING THE PRINCIPAL ON THE BOND, THE BOND NUMBER, AND YOUR CONTACT INFORMATION TO:**

Zurich Surety Claims  
1299 Zurich Way  
Schaumburg, IL 60196-1056  
[www.reportsfclaims@zurichna.com](mailto:www.reportsfclaims@zurichna.com)  
800-626-4577

**ZURICH AMERICAN INSURANCE COMPANY  
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY  
FIDELITY AND DEPOSIT COMPANY OF MARYLAND  
POWER OF ATTORNEY**


KNOW ALL MEN BY THESE PRESENTS: That the ZURICH AMERICAN INSURANCE COMPANY, a corporation of the State of New York, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, a corporation of the State of Illinois, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND a corporation of the State of Illinois (herein collectively called the "Companies"), by **Robert D. Murray, Vice President**, in pursuance of authority granted by Article V, Section 8, of the By-Laws of said Companies, which are set forth on the reverse side hereof and are hereby certified to be in full force and effect on the date hereof, do hereby nominate, constitute, and appoint **A. T. JOHNSON, Adrian C. BURCHETT, Robert J. LAVISKY, Marcus L. STEVENS, Duainette H. CULLUM, Marian C. NEWMAN, Wesley V. DASHER, JR. and Lori J. KELLY**, all of Columbia, South Carolina, EACH, its true and lawful agent and Attorney-in-Fact, to make, execute, seal and deliver, for, and on its behalf as surety, and as its act and deed: any and all bonds and undertakings, and the execution of such bonds or undertakings in pursuance of these presents, shall be as binding upon said Companies, as fully and amply, to all intents and purposes, as if they had been duly executed and acknowledged by the regularly elected officers of the ZURICH AMERICAN INSURANCE COMPANY at its office in New York, New York., the regularly elected officers of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at its office in Owings Mills, Maryland., and the regularly elected officers of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at its office in Owings Mills, Maryland., in their own proper persons.

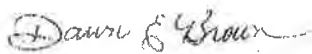
The said Vice President does hereby certify that the extract set forth on the reverse side hereof is a true copy of Article V, Section 8, of the By-Laws of said Companies and is now in force.

IN WITNESS WHEREOF, the said Vice-President has hereunto subscribed his/her names and affixed the Corporate Seals of the said ZURICH AMERICAN INSURANCE COMPANY, COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and FIDELITY AND DEPOSIT COMPANY OF MARYLAND, this 24<sup>th</sup> day of January, A.D. 2020.



ATTEST:  
ZURICH AMERICAN INSURANCE COMPANY  
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY  
FIDELITY AND DEPOSIT COMPANY OF MARYLAND

  
By: Robert D. Murray  
Vice President


  
By: Dawn E. Brown  
Secretary

State of Maryland  
County of Baltimore

On this 24th day of January, A.D. 2020, before the subscriber, a Notary Public of the State of Maryland, duly commissioned and qualified, **Robert D. Murray, Vice President and Dawn E. Brown, Secretary** of the Companies, to me personally known to be the individuals and officers described in and who executed the preceding instrument, and acknowledged the execution of same, and being by me duly sworn, depose and saith, that he/she is the said officer of the Company aforesaid, and that the seals affixed to the preceding instrument are the Corporate Seals of said Companies, and that the said Corporate Seals and the signature as such officer were duly affixed and subscribed to the said instrument by the authority and direction of the said Corporations.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my Official Seal the day and year first above written.



  
Constance A. Dunn, Notary Public  
My Commission Expires: July 9, 2023



IFB #101321E

**CONSENT OF SURETY****OWNER:** Beaufort County**TITLE OF WORK:** Sun City Ems/Fire Renovations IFB #101321E

(Complete above exactly as given in Invitation to Bid)

In consideration of the premises and of One Dollar (\$1.00), lawful money of the United States, it is in hand paid by the Contractor, the receipt whereof, is hereby acknowledged, the undersigned surety consents and agrees that if the contract, for which the preceding Bid is made, be awarded to the person or persons submitting the same as contracted, it will become bound as surety and guarantor for its faithful performance in an amount equal to one hundred percent (100%) of the Contract Price, and will execute as surety thereto when required to do so by the Owner, and if the said Contractor shall omit or refuse to execute such contract, if so awarded, it will pay without proof of notice and on demand to the Owner any increase between the sum of which the said Contractor would have been entitled upon the completion of the said Contract and the sum which the said Owner may be obligated to pay to another contractor to whom the contract may be afterwards awarded, the amount in such case to be determined by the bids plus the cost, if any, of re-advertising for bids for this work, less the amount of any certified check or bid bond payable and received.

In witness whereof, said surety has caused these presents to be signed and attested by a duly authorized officer and its corporate seal to be hereto affixed this 13th day of October, 2021.

(A corporate acknowledgment and statement of authority to be here attached by the surety company)

Fidelity and Deposit Company of Maryland

(Surety Company)

BY Duainette H. Cullum

(Surety Company, Attorney-In-Fact)  
Duainette H. Cullum, Attorney-in-Fact

Attest: [Signature]

IFB #101321E

**CERTIFICATION BY CONTRACTOR**

Regarding

**NON-SEGREGATED FACILITIES**

The Bidder certifies that he does not, and will not, provide and maintain segregated facilities for his employees at his establishments and, further that he does not, and will not, permit his employees to perform their services at those locations, under his control, where segregated facilities are provided and maintained. Segregated fountains, transportation, parking, entertainment, recreation, ad housing facilities; waiting, rest, wash, dressing, and locker room, and time clock, work, storage, restaurant, and other eating areas which are set apart in fact, or by explicit directive, habit, local custom, or otherwise, on the basis of color, creed, national origin, and race. The Bidder agrees that, except where he has obtained identical certifications from proposed subcontractors for specific time periods, he will obtain identical certifications from proposed subcontractors prior to the award of subcontractors exceeding **\$10,000.00** which are not exempt from the provisions of the Equal Opportunity clause, and that he will retain such certifications in his files.

The Bidder agrees that a breach of this certification is a violation of the Equal Opportunity clause in this Contract. The penalty for making false statements is prescribed in 18 U.S.C. 1001.

Brantley Construction Services, LLC  
DBA Brantley Construction Company, LLC

Contractor

  
(Signature)

Gary D. Brantley, President  
Name and Title of Signer

October 13, 2021

Date

IFB #101321E

**NON-COLLUSION AFFIDAVIT OF PRIME BIDDER**

State of South Carolina )  
 ) ss.  
 County of Dorchester )

Brantley Construction Services, LLC  
DBA Brantley Construction Company, LLC being first duly sworn, deposes and  
 says that:

He is Gary D. Brantley, President (Owner, Partner, Officer,  
 Representative, or Agent) of the Bidder that has submitted the attached Bid;

(1) He is fully informed respecting the preparation and contents of the attached Bid and of all  
 pertinent circumstances respecting such Bid;

(2) Such Bid is genuine and is not a collusive or sham Bid;

(3) Neither the said Bidder nor any of its officers, partners, owners, agents, representatives,  
 employees, or parties in interest, including this affiant, has in any way colluded, conspired, connived, or  
 agreed, directly or indirectly, with any other Bidder, firm or person to submit a collusive or sham Bid in  
 connection with the Contract for which the attached Bid has been submitted to or refrain from bidding in  
 connection with such Contract, or has in any collusion or communication or conference with any other  
 Bidder, firm or person to fix the price or prices in the attached Bid or of another Bidder, or to fix any  
 overhead, profit or cost element of the bid price or the Bid of any other Bidder, or to secure through any  
 collusion, conspiracy, connivance or unlawful agreement any advantage against Beaufort County or any  
 person interested in the proposed Contract; and,

(4) The price or prices quoted in the attached Bid are fair and proper and are not tainted by  
 any collusion, conspiracy, connivance, or unlawful agreement on the part of the Bidder or any of its agents,  
 representative, owners, employees, or parties in interest, including this affiant.

Name 

Title Gary D. Brantley, President

Subscribed and Sworn to before me this

13 day of October, 2021.

 (SEAL)

Notary Title


My commission expires: 7-20-2022





IFB #101321E

**CONTRACTOR'S QUALIFICATION STATEMENT****CERTIFICATION:** The following is a statement of fact.


 Gary D. Brantley, President
 October 13, 2021

Signature
 Typed Name and Title
Date

**A. GENERAL**

- A.1 Submit to: Beaufort County
- A.2 Name of Project (if applicable): [Project Title] Sun City EMS/FIRE Renovations  
 [Project Location] William Pope, Sun City, SC
- A.3 Contractor:
- A.4 Name: Brantley Construction Services, LLC DBA Brantley Construction Company, LLC  
 Mailing Address: 8300 Dorchester Rd, Charleston, SC 29418  
 Street Address: 8300 Dorchester Rd, Charleston, SC 29418  
 Telephone Number (including area code): 843-552-0150  
 Facsimile Number (including area code): 843-552-9072  
 Contact Person: Christina McAlhaney, Estimator  
 Contact Person's E-mail Address: Christina@brantleyconstruction.com  
 South Carolina Contractor's License Number: G111944

**B. BUSINESS ORGANIZATION**

- B.1 Check type of business organization:  
 Corporation \_\_\_\_\_ Individual \_\_\_\_\_ Partnership \_\_\_\_\_  
 (Name of Partners) \_\_\_\_\_  
 Joint Venture \_\_\_\_\_ Other LLC, S-Corp
- B.2 If a corporation: \_\_\_\_\_  
 State of Incorporation: South Carolina  
 If not incorporated in South Carolina, State Corporation Commission Registration Number: \_\_\_\_\_  
 Date of Incorporation: 2005  
 Federal I.D. Number: 20-3509558

Officers:

Name	Address	Phone No.	Position	Yrs in
Gary D. Brantley	Charleston, SC	843-552-0150 x7	President	16

President: Gary D. Brantley

Vice President(s): \_\_\_\_\_

Secretary: Not Applicable

Treasurer: Not Applicable

Are you a Subchapter S Corporation: Yes \_\_\_\_\_ No \_\_\_\_\_

Name \_\_\_\_\_ Address \_\_\_\_\_ Phone No. \_\_\_\_\_

Subchapter S Shareholders: \_\_\_\_\_

**B.3 If a partnership:**

Date of Organization: \_\_\_\_\_

Type of partnership: \_\_\_\_\_

List of General Partners:

Name \_\_\_\_\_ Address & Phone No. \_\_\_\_\_ Years as GP \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**B.4 If individually owned:**

Name, address, and phone number of sole-proprietor: \_\_\_\_\_

Years in business: 16

B.5 Have you ever operated under another name? Yes X No \_\_\_\_\_

If yes,

All other business names and addresses of principal placed of business for each business.

Brantley Construction Services of Florida, LLC, 8300 Dorchester Rd, Charleston, SC 29418

Number of years in business under each name:

Company - 16 years, FL- 1 year

Contractor's license number in each state in which a business was operated.

SC G111944, NC 63208, GA GCCO 003848, FL CGC1530259

### C. BONDING

C.1 Bonding Agent: McGriff Insurance Services, Inc.

Name: McGriff Insurance Services, Inc.

Address: 200 Center Point Drive, Suite 2400, Columbia, SC 29210

Telephone Number (including area code): 803-748-0100

Contact Person: Robert Lavisky

C.2 Bonding Company: Fidelity and Deposit Company of Maryland

Name: Fidelity and Deposit Company of Maryland

Address: 1299 Zurich Way, 5th Floor, Schaumburg, IL 60196

Telephone Number (including area code): 803-748-0100

Contact Person: Robert Lavisky, McGriff Insurance Services, Inc.

Best's Key Rating of bonding company: A+

C.3 Number of years this bonding company has acted as surety for you: 7 years

C.4 Bonding Capacity: Maximum single job size: \$30,000,000

Total bonding limit: \$90,000,000

C.5 Do you intend to use any alternative form of security? No

If so, indicate the form of security you intend to use and the name, address, point of contact, and telephone number of the banks, savings and loan, or surety you intend to use. (NOTE: Prequalification will not assure acceptance of any form of security.)

Form of Security: Surety, McGriff Insurance Services, Inc.

Bank or Savings & Loan: Not Applicable

Contact: Robert Lavisky, McGriff Insurance Services, Inc.

Address & Phone No.: 200 Center Point Drive, Suite 2400, Columbia, SC 29210, 803-748-0100

C.6 Have any Performance or Payment Bond claims ever been paid by any surety on behalf of your organization?

Yes \_\_\_\_\_ No X

If yes, state the name of the project(s); the date; the name, address, telephone number, and contact person for the claimant; the surety satisfying the claim; the size of the claim; and the circumstances giving rise to the claim. (Provide attachments if necessary.)

C.7 Have you ever arbitrated or litigated a claim with an Owner, Architect, or Engineer in the last five years?

Yes X No \_\_\_\_\_

If yes, state the name of the project(s); the date; the name, address, telephone number, and contact person for the claimant; the surety satisfying the claim; the size of the claim; and the circumstances giving rise to the claim. (Provide attachments if necessary.)

**See Attachment**

C.8 If you answer yes to the following, provide the name, address, telephone number, contact person, and circumstances relating to the question on a separate attachment.

Have you or any officer, partner, or owner of your organization, in any state or territory of the United States, or with respect to any agency of the Federal government:

- a) In the last in the last five years, received any fines or citations for building code violations which were unrelated to design? Y\_\_\_N **X**
- b) Ever been found to be guilty of charges relating to conflicts of interest: Y\_\_\_N **X**
- c) Ever been convicted on charges related to any criminal activity relating to construction means, methods, or techniques; bidding or bid rigging; or bribery? Y\_\_\_N **X**
- d) In the last five years, been found guilty of any minority contracting law violations? Y\_\_\_N **X**
- e) In the last five years, pleaded no contest in any criminal proceeding related to contracting? Y\_\_\_N **X**
- f) Ever been disbarred from doing Federal, state, or local government work for any reason? Y\_\_\_N **X**
- g) Ever been terminated on a contract due to your default? Y\_\_\_N **X**
- h) In the last five years, paid liquidated damages for being late on a project? Y **X** N\_\_\_
- i) In the last five years, been subject to tax collection proceedings? Y\_\_\_N **X**
- j) In the last seven years, filed for bankruptcy? Y\_\_\_N **X**

If the answer to j) was yes, under what chapter of bankruptcy did you file?

**Not Applicable**

If you filed under Chapter 11 Reorganization, how long did you operate under this status? **N/A**

Are you operating under Chapter 11 status now? Y\_\_\_N **X**

#### **D. SAFETY**

- D.1 Have you, in the last three years, been cited for willful violations for failure to abate, or for repeated violations, by the United States Occupational Safety and Health Administration or by

the South Carolina Occupational Safety and Health Administration or by any other governmental body? Y\_\_\_\_N **X**

If yes, state date, name, address, telephone number, and contact person for agency issuing citation and the nature of the violation. Also, advise the amount of fines paid, if any. Provide attachments if necessary.

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D.2 List your worker's compensation experience modifier for the last three years.

2021 - 1.04, 2020 - 1.01, 2019 - 0.81 See Attached EMR letter.

## E. References

E.1 Provide at least two references from each industry group listed. Provide other references as requested. Provide current names, addresses, telephone numbers, and contacts.

Architects/Engineers: James P. Verkaik Architect, LLC, Mount Pleasant, SC  
843-200-3509

Architects/Engineers: SGA | Namour Wright Design, 804 Meeting St, Charleston, SC 29403  
Don Baus  
843-530-3764

Major Subcontractors: New South construction Supply 4987 Banco Road, North Charleston, SC 29418  
Bailey Williams  
843-760-0780, bailey.williams@newsouthsupply.com

Major Subcontractors: HR Allen, Inc, 2675 Rourk St, Charleston, SC 29405  
Matt Epstein  
843-747-4100

Financial Institutions: Synovus, 158 Meeting Street, Charleston, SC 29401  
Jerry Tekac, Vice President  
843-529-2010, jerrytekac@synovus.com

**§ C.7 Have you ever arbitrated or litigated a claim with an Owner, Architect, or Engineer in the last five years?**

Claimant: Brantley Construction Company, LLC

Claimant Address: 8300 Dorchester Rd, Charleston, SC 29418

Claimant Contact: Gary D. Brantley, President 843-552-0150

Surety: Not Applicable

2017 *Appeal of Brantley Construction Services, LLC* under Contract No. W912HN-10-D-0056, ABSCA No. 61118

This matter involves a claim for additional compensation for changes to the contract involving paving at Camp Mackall Army Air Field and Pope Army Air Field. The company successfully completed the work. Brantley Construction successfully negotiated a settlement of this matter, which resulted in no materially adverse effect upon the company's financial position.

**§ C.8.h. In the last five years, paid liquidated damages for being late on a project?**

In 2019, Brantley Construction Company, LLC was assessed 18 days liquidated damages on a Company Operations Facility on Hunter Army Airfield, GA for an overhead plumbing line leak repair, as well as repairs to the drywall, paint, and flooring. The leak was found just days prior to an already scheduled substantial completion inspection. In the previous 42 years, Brantley Construction Company, LLC had not been assessed liquidated damages on any other projects.



July 26, 2021

RE: Brantley Construction Company, LLC  
Experience Modification Rate

To Whom It May Concern,

The purpose of this letter is to confirm Brantley Construction Company, LLC's experience modification rate (EMR) history and to provide an explanation of the current EMR. In no way is the current EMR a reflection of Brantley's dedication to safety or indicative of their performance.

7/1/2021	1.04	7/1/2018	.80
7/1/2020	1.01	7/1/2017	.79
7/1/2019	.81	7/1/2016	.79

**Brantley has not had a lost time workers' compensation claim nor a jobsite incident since February 2008.** We feel the EMR is unjustly calculated based on one small claim for the three years of data and their safety record is the best indicator for evaluation. Please see the description and details of the claim below.

**Date of Hire:** 10/15/2018

**Date of Injury:** 10/16/2018

**Description of Claim:** Claimant was on his first day of employment and fell off the toilet in his hotel room injury his right knee. No lost time.

**Cost Incurred:** \$12,500.00

**Status:** Closed

**Please Note:**

- The employee was employed for one (1) day
- There was no lost time
- There were underlining pre-existing conditions with his knee
- It was not a job site injury

This one claim is having a .19 impact on Brantley's current EMR. Without this claim, their EMR would be .85

Brantley is in excellent standings with their insurance company, Amerisure. Their management team is dedicated to providing the safest working environment for their employees and others on the job site. We believe Brantley is an organization of the highest quality and has the experience and capabilities to build any project safely. Please do not hesitate to call me with any questions at (404) 433-0786.

Many thanks,

Jim Clarke

Senior Vice President

3400 Overton Park Drive, Suite 300

Atlanta, Georgia 30339



**Certification regarding Debarment, Suspension, Ineligibility,  
and Voluntary Exclusion:**

**Company Name:** Brantley Construction Services, LLC DBA Brantley Construction Company, LLC

The contractor certifies, by submission of this qualification statement or acceptance of a contract, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any State, Federal department, or agency. It further agrees by submitting this qualification statement that it will include this clause without modification in all lower tier transactions, solicitations, proposals, contracts, and subcontracts. Where the bidder/contractor or any lower tier participant is unable to certify to this statement, it shall attach an explanation to this solicitation/bid. State whether or not your company has been involved in any litigation within the past five (5) years arising out of your performance.

**Circle Yes or ☒ No**

If you answer yes, explain fully if it has been involved in any litigation involving performance.

Signature

  
Gary D. Brantley, President

## LOCAL VENDOR PREFERENCE – PARTICIPATION AFFIDAVIT

### SECTION 2.537.1

A competitive procurement made by Beaufort County shall be made from responsive and responsible resident vendors in the County for procurement, if such bid does not exceed the lowest qualified bid from a non-county vendor by more than five (5%) percent or Ten Thousand (\$10,000.00) Dollars, whichever is less of the lowest non-county bidder. The resident vendor has the discretion to match the bid submitted by the non-county vendor and receive the contract award.

A vendor shall be deemed to be a “local vendor” if such vendor is an individual, partnership, association or corporation that is authorized to transact business within the state, maintains an office in the Beaufort County, has a business license of Beaufort County or one of the municipalities within Beaufort County, and maintains a representative inventory of commodities within Beaufort County or one of the municipalities on which the bid is submitted and has paid all taxes duly assessed.

If no bids are received, from a Beaufort County Local Vendor a vendor shall be deemed to be a “local vendor” if such vendor is an individual, partnership, association or corporation that is authorized to transact business within the state, maintains an office in Jasper, Hampton, or Colleton Counties (local preference only applies if Jasper, Hampton and Colleton Counties offer reciprocity to Beaufort County). A competitive procurement made by the county shall be made from responsive and responsible resident vendors in the respective counties for procurement, if such bid does not exceed the lowest qualified bid from a non-local vendor by more than five (5%) percent or \$10,000.00, whichever is less, local vendor has the discretion to match the bid submitted by the non-local vendor and receive the contract award.

If the procurement is to be made pursuant to state or federal guidelines, which prohibit or restrict a local or state preference, there shall be no local or state preference unless a more restricted variation is allowed under the guidelines. Local/state preference shall not be applied to the procurement of construction services.

The undersigned hereby attests that the criteria of the “RESIDENT VENDOR PREFERENCE, SECTION 2.537.1” are met for the purposes of bid document \_\_\_\_\_, dated \_\_\_\_\_.

Brantley Construction Services, LLC  
Company Name: DBA Brantley Construction Company, LLC Principal Name: Gary D. Brantley, President

Company Address: 8300 Dorchester Rd  
Charleston, SC 29418

Secretary of State Designation: (Corporation, Individual, Partnership, Other) LLC, S-Corp

Beaufort County Business License/Classification: \_\_\_\_\_

Tax Obligation Current: \_\_\_\_\_

Signature of Principal/Date: \_\_\_\_\_

Witness/Date: \_\_\_\_\_

Not Applicable

## Self-Performance Affidavit

***If self-performing 100% of the entire project with your own workforce/staff on your payroll, complete and return this form with your bid package. If self-performing all work, you do not need to solicit SMBs.***

I hereby certify my company's intent to self-perform 100% of the work required for the referenced project:

Project Name: Sun City EMS/FIRE Renovations

Project Number: IFB#101121E

By signing this affidavit, I further certify that my company has the capability to perform and will perform all elements of the work on the project referenced above with my company's employees.

I further agree to provide additional information or documentation requested by Beaufort County in support of the above statement.

**If a need to subcontract work on this project arises, I will notify the Beaufort County Purchasing Department in writing via email to [dthomas@bcgov.net](mailto:dthomas@bcgov.net) within two (2) business days after submission of the bid.**

Brantley Construction Services, LLC DBA Brantley Construction Company, LLC

Name of Company

Gary D. Brantley

Owner or Authorized Representative Name

Signature

President

Title

October 13, 2021

Date

State of South Carolina County of \_\_\_\_\_

Subscribed and sworn to before me this 13th day of October, 2021

Notary Public \_\_\_\_\_ My Commission Expires \_\_\_\_\_

## Good Faith Efforts Checklist

*This form and supporting documents are due with the bid package, if not self-performing 100% of the work.*

- ☒ Include copies of the written notice to SMBs notifying them of bid opportunities. Notices only need to be sent to those subcontractors and suppliers offering the services which the bidder intends to subcontract and purchase. Notices can be e-mailed or faxed. If emailed, the notice may be sent to all applicable subcontractors with one email. If faxed, include a copy of the fax transmittal confirmation slip.

The notice should contain the following:

- Bidder's name and contact information
- Project name and number
- Scope of work/bid packages available for subcontracting
- Information on availability of plans and specifications
- Bidder's insurance, bonding, and financial requirements

- ☒ Include Exhibits 1, 2 and 3, with all requested supporting documentation, where applicable. These exhibits are available on the Beaufort County website ([www.beaufortcountysc.gov](http://www.beaufortcountysc.gov)) under the Purchasing Department page.

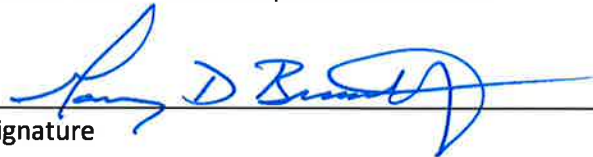
The undersigned acknowledges making a good faith effort to comply with the above areas checked.

Brantley Construction Services, LLC DBA Brantley Construction Company, LLC

Name of Company

Gary D. Brantley

Owner or Authorized Representative Name



Signature

President

Title

October 13, 2021

Date

## Exhibit 1

### Non-Discrimination Statement

*This form is due with the bid package.*

The bidder certifies the following:

- No person shall be excluded from participation in, denied the benefit of, or otherwise discriminated against on the basis of race, color, national origin, age, sex/gender, disability, religion, language, or income in connection with any bid submitted to Beaufort County or the performance of any contract resulting thereof;
- That it is and shall be the policy of the bidder to provide equal opportunity to all businesses or persons seeking to contract or otherwise interested in contracting with the bidder for Beaufort County contracts, including those businesses owned and controlled by socio-economic and racial minorities;
- In connection herewith, we acknowledge and warrant that this bidder has been made aware of, understands, and agrees to take affirmative action to provide such companies with the maximum practicable opportunities to do business with this bidder;
- That this promise of non-discrimination as made and set forth herein shall be continuing in nature and shall remain in full force and effect without interruption throughout the life of the referenced contract with Beaufort County;
- That the promises of non-discrimination as made and set forth herein shall be and are hereby deemed to be made a part of and included by reference into any contract or portion thereof which this bidder may hereafter obtain and;
- That the failure of this bidder to satisfactorily discharge any of the promises of non-discrimination as made and set forth herein shall constitute a material breach of contract entitling Beaufort County to declare the contract in default and to exercise any and all applicable right and remedies including, but not limited to cancellation of the contract, termination of the contract, suspension and debarment from future contracting opportunities, and withholding and/or forfeiture of compensation due and owing on a contract.

**Name of Company**

Brantley Construction Services, LLC DBA Brantley Construction Company, LLC

**Owner or Authorized Representative Name**

Gary D. Brantley

**Signature of Owner or Authorized Representative****Title**

President

**Date**

October 13, 2021

**EXHIBIT 2**  
**Outreach Documentation Log**

Item 13.

**Bidder Name:** Brantley Construction Services, LLC DBA Brantley Construction Company, LLC  
**Bid No.:** IFB #101321E  
**Bid Date:** 13-Oct-21  
**Project Name:** Sun City EMS/Fire Renovations

## LIST INFORMATION FOR THE SMBs YOU CONTACTED FOR INTEREST AND POTENTIAL PARTICIPATION IN THE REFERENCED PROJECT:

Name of SMB	Source, e.g. OSBMA or SCDOT, if applicable	City	State	Trade/Commodity	Email/Fax Sent e.g. Email	Response, e.g. No Response, Will Quote, Will Not Quote	Result, e.g. Accepted, Not Included
1 Manoutfit & Helpers	SCDOT	Blythewood	SC	Finishes: Drywall and Painting	9/24/2021	No Response	
1st Class Painting & Resotration	SBE	Summerville	SC	Finishes: Painting	9/24/2021	No Response	
A-C Electric Company, Inc.	SBE	Hollywood	SC	Electrical: Electrical	9/24/2021	No Response	
Acorn Sign Graphics	SBE	Richmond	VA	Specialties: Identifying Devices	9/24/2021	No Response	
Action Abatement & Demolition, Inc.	SBE	Moncks Corner	SC	Site Work: Misc Interior Demolition	9/24/2021	No Response	
AllGood Contractors	MBE	Greenville	SC	Finishes: Painting	9/24/2021	No Response	
Allstar Fire Protection, LLC	MBE	Aiken	SC	Mechanical: Fire Protection/Sprinkler	10/4/2021	No Response	
AOA Signs, Inc.	MBE	Yadkinville	NC	Specialties: Identifying Devices	9/24/2021	Will Quote	Received
Architectural Sign & Graphics, Inc	SBE	Yukon	OK	Specialties: Identifying Devices	9/24/2021	No Response	
Arrow Exterminators, Inc.	SBE	Greensboro	NC	Site Work: Soil Treatment	9/24/2021	Will Not	
Atlantic Meridian Contracting	MBE	Savannah	GA	Finishes: Gypsum Board	9/24/2021	No Response	
Benton Roofing, Inc.	SBE	East Flat Rock	NC	Thermal & Moisture Protection: Metal Roofing	9/24/2021	No Response	
BESCO Broadway Electric Service Corporation	MBE	Knoxville	TN	Electrical: Electrical	9/24/2021	No Response	
Best Plumbing Inc.	SBE	Walterboro	SC	Mechanical: Plumbing	9/24/2021	No Response	
Big Bend Rebar, Inc	MBE	Quincy	FL	Concrete: Reinforcing Steel	9/24/2021	Will Not	
Blankenship Associates, Inc.	SBE	Raleigh	NC	Wood & Plastics: Architectural Woodwork	9/24/2021	Will Quote	Received
Blyco Glass Co. of SC, LLC	SBE	Columbia	SC	Doors & Windows: Storefronts	9/24/2021	No Response	
Bob's Landscape & Irrigation Services	MBE	Ladson	SC	Site Work: Landscaping	10/4/2021	No Response	
Bridges Wood Products, Inc.	SBE	Savannah	GA	Wood & Plastics: Architectural Woodwork	9/24/2021	No Response	
Bugs R Us	MBE	Wando	SC	Site Work: Soil Treatment	9/24/2021	Will Quote	Received
Burgess Sales & Supply, Inc.	SBE	Charlotte	NC	Doors & Windows: Metal Doors and Frames	9/24/2021	No Response	
Burns Preferred Contractors, Inc.	MBE	Powder Springs	GA	Mechanical: Plumbing	9/24/2021	No Response	
CBC of Charleston, Inc.	SBE	N. Charleston	SC	Thermal & Moisture Protection: Metal Roofing	9/24/2021	No Response	
Century Fire Protection	SBE	Martinez	GA	Mechanical: Fire Protection/Sprinkler	9/24/2021	No Response	
CGA Stone Casting	SBE	West Palm Beach	FL	Concrete: Concrete Formwork	9/24/2021	No Response	
Cherokee Acoustical, LLC	MBE	Blairsville	GA	Finishes: Gypsum Board and Acoustical	9/24/2021	No Response	
Coastal Sprinkler Co., Inc.	SBE	Summerville	SC	Mechanical: Fire Protection/Sprinkler	10/4/2021	Will Not	
Cochrane Steel, Inc.	SBE	Monroe	NC	Concrete: Reinforcing Steel	9/24/2021	No Response	
Daniel Island Architectural Woodworking, LLC	SBE	North Charleston	SC	Wood & Plastics: Architectural Woodwork	9/24/2021	No Response	
Delta Metals, Inc.	SBE	Savannah	GA	Thermal & Moisture Protection: Metal Roofing	9/24/2021	No Response	
Division 10 Construction Specialties, Inc.	SBE	Raleigh	NC	Specialties: Toliet Accessories	9/24/2021	No Response	
Dominion Painting	SBE	Beaufort	SC	Finishes: Painting	9/24/2021	No Response	



**EXHIBIT 2**  
**Outreach Documentation Log**

Item 13.

Dunlap Lawn Service, Inc.	MBE	Greensboro	NC	Site Work: Landscaping	10/4/2021	Will Not	
E & D Coatings	MBE	Savannah	GA	Finishes: Painting	9/24/2021	No Response	
Elite Electric Company, Inc.	SBE	Summerville	SC	Electrical: Electrical	9/24/2021	No Response	
Elm Construcion LLC	MBE	Pamplico	SC	Finishes: Gypsum Board and Painting	9/24/2021	No Response	
First Defense Fire Protection, Inc.	SBE	Huntersville	NC	Mechanical: Fire Protection/Sprinkler	9/24/2021	No Response	
FloorChem, Inc	SBE	Raleigh	NC	Finishes: Resinous Flooring	9/24/2021	Will Not	
Garden Medic	SCDOT			Site Work: Landscaping	10/4/2021	No Response	
Gleaton Floor Covering	SBE	Sumter	SC	Finishes: Resilient Flooring	9/24/2021	No Response	
Green Acres Landscaping	SBE	St. George	SC	Site Work: Landscaping	9/24/2021	No Response	
H. D. Electric	SBE	Summerville	SC	Electrical: Electrical	9/24/2021	No Response	
Hanover Coatings, Inc	SBE	Wilmington	NC	Finishes: Painting	9/24/2021	Will Not	
Hart's Landscaping, Inc.	MBE	Charleston	SC	Site Work: Landscaping	10/4/2021	No Response	
Hill Plumbing and Electric Company, Inc.	SBE	Sumter	SC	Mechanical: Plumbing	9/24/2021	Will Not	
Hoppe Electric Inc.	SBE	Hardeeville	SC	Electrical: Electrical	9/24/2021	No Response	
I & E Specialties, Inc	SBE	Lexington	SC	Thermal & Moisture Protection: Metal Roofing	9/24/2021	Will Not	
Image Resource	MBE	Summerville	SC	Specialties: Identifying Devices	9/24/2021	No Response	
Industrial Cohesion Systems Inc.	SBE	Stockbridge	GA	Finishes: Resinous Flooring	9/24/2021	No Response	
Interior Wood Specialties, Inc.	MBE	High Point	NC	Wood & Plastics: Architectural Woodwork	9/24/2021	No Response	
J & L Glass Co., Inc.	SBE	Savannah	GA	Doors & Windows: Storefronts	9/24/2021	Will Not	
Jones' Glass Inc.	SBE	Macon	GA	Doors & Windows: Storefronts	9/24/2021	No Response	
Kapasi Glass Mart, Inc.	MBE	Spartanburg	SC	Doors & Windows: Storefronts	9/24/2021	Will Not	
Keating Roofing & Sheet Metal	SBE	Charleston	SC	Thermal & Moisture Protection: Metal Roofing	9/24/2021	No Response	
Low Country Case & Millwork	SBE	Ladson	SC	Wood & Plastics: Architectural Woodwork	9/24/2021	Will Not	
Lucas Designs, Inc. Painting & Paperhanging	SCDOT	Bluffton	SC	Finishes: Painting	9/24/2021	Will Quote	Received
McComb Landscaping	SBE	Mount Pleasant	SC	Site Work: Landscaping	10/4/2021	Will Not	
Miller Signs	SBE	Charleston	SC	Specialties: Identifying Devices	9/24/2021	No Response	
ML Builders, LLC	MBE	Greenville	SC	Finishes: Gypsum Board, Acoustical and Painting	9/24/2021	No Response	
Multi-graphics Incorporated	SBE	Pelham	GA	Specialties: Identifying Devices	9/24/2021	No Response	
Neat & Clean, LLC	SBE	North Charleston	SC	Finishes: Gypsum Board	9/24/2021	No Response	
Nueva Drywall & Painting Inc.	MBE	Raleigh	NC	Finishes: Gypsum Board, Acoustical and Painting	9/24/2021	No Response	
P.C. Painting, LLC	MBE	Mount Pleasant	SC	Finishes: Painting	9/24/2021	No Response	
Palmetto Metal Products, Inc.	SBE	Columbia	SC	Doors & Windows: Metal Doors and Frames	9/24/2021	No Response	
Palmetto Sales and Marketing Group	SBE	Mount Pleasant	SC	Wood & Plastics: Architectural Woodwork	9/24/2021	No Response	
Palmetto State Steel Company	SBE	Mt Pleasant	SC	Concrete: Reinforcing Steel	9/24/2021	No Response	
Patriots Management LLC	MBE	Summerville	SC	Finishes: Gypsum Board and Painting	9/24/2021	No Response	
Peters Paint & Wall Covering, Inc.	SBE	Mt Pleasant	SC	Finishes: Painting	9/24/2021	Will Not	
Piedmont Industrial Coatings	SBE	Piedmont	SC	Finishes: Resinous Flooring	9/24/2021	No Response	
Professional Painting Service	SBE	Summerville	SC	Finishes: Painting	9/24/2021	No Response	
R.W. Ford Company, Inc.	SBE	Lexington	SC	Thermal & Moisture Protection: Joint Sealants	9/24/2021	No Response	
S & S Service King Plumbing, LLC	MBE	Georgetown	SC	Mechanical: Plumbing	9/24/2021	No Response	
SanGlo Carolina, Inc.	SBE	Florence	SC	Doors & Windows: Storefronts	9/24/2021	No Response	

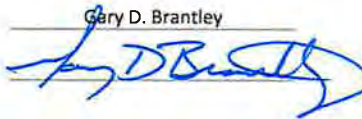
**EXHIBIT 2**  
**Outreach Documentation Log**

Item 13.

Sears Contract	SBE	Charlotte	NC	Finishes: Gypsum Board and Acoustical	9/24/2021	No Response	
Seed Slingers, LLC	MBE	Aynor	SC	Site Work: Landscaping	10/4/2021	No Response	
Sentry Sprinklers, Inc.	SBE	Hilton Head	SC	Mechanical: Fire Protection/Sprinkler	9/24/2021	No Response	
Shocking Electrical Services	SBE		SC	Electrical: Electrical	9/24/2021	No Response	
Smith & Associates, Inc.	SBE	Summerville	SC	Mechanical: Plumbing and HVAC	9/24/2021	No Response	
Southern Concrete & Construction, Inc.	MBE	Anderson	SC	Concrete: Concrete Formwork	9/24/2021	No Response	
Southern Glass & Mirror	SBE	Swansboro	NC	Doors & Windows: Storefronts	9/24/2021	No Response	
Southern Palmetto Landscapes Inc.	SBE	Ridgeland	SC	Site Work: Landscaping	9/24/2021	No Response	
Southern Site Development	SCDOT	Chamblee	GA	Site Work: Misc Interior Demolition	9/24/2021	No Response	
Spec Painters / Finishing Business LLC	SBE	Columbia	SC	Finishes: Painting	9/24/2021	No Response	Received
Summerville Mechanical, Inc.	SBE	Summerville	SC	Mechanical: Plumbing and HVAC	9/24/2021	Will Not	
T & M Specialties, Inc.	SBE	Powell	TN	Doors & Windows: Metal Doors and Frames	9/24/2021	No Response	
TCM Waterproofing, LLC	MBE	Suwanee	GA	Thermal & Moisture Protection: Joint Sealants	9/24/2021	No Response	
The Flooring Connection, LLC	SBE	Conway	SC	Finishes: Resilient Flooring	9/24/2021	No Response	
The Wall, LLC	MBE	Myrtle Beach	SC	Concrete: Concrete Formwork	9/24/2021	No Response	
Thomas & Associates, LLC	MBE	Effingham	SC	Finishes: Gypsum Board	9/24/2021	No Response	
Thompson Cabinets & Millwork, Inc.	SBE	Murrells Inlet	SC	Wood & Plastics: Architectural Woodwork	9/24/2021	No Response	
Trademark Concrete Services	SBE	Iron Station	NC	Concrete: Concrete Formwork	9/24/2021	No Response	
Troika Group	MBE	Dillon	SC	Finishes: Gypsum Board and Acoustical	9/24/2021	No Response	
Troika Group	MBE	Dillon	SC	Concrete: Concrete Formwork	9/24/2021	No Response	
Unity Foundation Company, LLC	MBE	Charleston	SC	Concrete: Concrete Formwork	9/24/2021	No Response	
USA Waterproofing	MBE	Charlotte	NC	Thermal & Moisture Protection: Joint Sealants	9/24/2021	No Response	
VSS Logistics	MBE	Savannah	GA	Specialties: Toilet Accessories	9/24/2021	No Response	
W & W Cabinet Shop Inc	SBE	Charleston	SC	Wood & Plastics: Architectural Woodwork	9/24/2021	No Response	Received
Waterproofing Specialties, Inc. - NC	MBE	Raleigh/Charlotte/Ch	NC/SC	Thermal & Moisture Protection: Joint Sealants	9/24/2021	No Response	
Watts & Associates Waterproofing, Inc.	SBE	Columbia	SC	Thermal & Moisture Protection: Metal Roofing	9/24/2021	No Response	
Youmas Heating and Air Inc.	MBE	N. Charleston	SC	Mechanical: HVAC	9/24/2021	No Response	

The undersigned confirms contacting the above listed SMBs regarding subcontracting and/or purchase opportunities for the referenced contract.

Representative Name:

Gary D. Brantley  


Title: President

Signature:

Date: 13-Oct-21



**EXHIBIT 3**  
**Proposed Utilization Plan**

Item 13.

**Bidder Name:** Brantley Construction Services, LLC DBA Brantley Construction Company, LLC  
**Bid No.:** IFB #101321E  
**Bid Date:** 13-Oct-21  
**Project Name:** Sun City EMS/Fire Renovations

**LIST INFORMATION FOR THE SMBs YOU INTEND TO UTILIZE FOR THE REFERENCED PROJECT:**

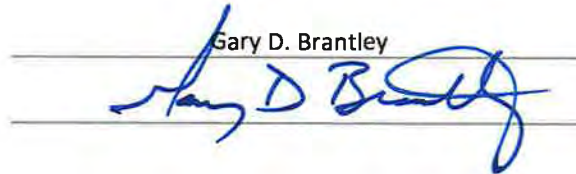
Name of SMB Firm	City	State	Tel # with Area Code	Point of Contact	Trade/Commodity	Contract/PO Amount
AOA Signs, Inc	Yadkinville	NC	336-679-3344	John Herring	Identifying Devices	\$ 1,519.00 -
						\$ -
						\$ -
						\$ -
						\$ -
						\$ -
						\$ -
						\$ -

Total Anticipated SMB  
Participation Dollar Value \$1,519.00 -

The undersigned proposes to enter into a formal agreement with the SMBs identified for work and value listed conditioned upon execution of a contract with Beaufort County for the referenced project.

**Representative Name:**

Gary D. Brantley

**Title:** President**Signature:****Date:** 13-Oct-21