RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services

March 3, 2008

Attn: Division of Permits
City of Raleigh
Inspections Department
One Exchange Plaza, Suite 404
Raleigh, North Carolina 27601

Re: Grading Permit Application - Transfer and Recycling Center
Shotwell Transfer Station, Inc. (NC Solid Waste Permit No. 92-27T)
5565 Thornton Road, Raleigh, North Carolina

Dear Permits Division:

On behalf of Shotwell Transfer Station, Inc., Richardson Smith Gardner & Associates, Inc. (RSGA) is hereby transmitting the enclosed Grading Permit Applications {one (1) hard copy and one (1) electronic copy} as well as three (3) copies of the design plans for the above referenced project. Additionally, we have included supporting information as included in the Stormwater Permit Checklist (attached) as follows:

- Grading Permit Application;
- Stormwater Permit Checklist;
- Plan Review Fee of $888 (7.4 AC @ $120);
- Financial Responsibility Forms;
- Stormwater Installation and Maintenance Manual; and
- Two (2) extra sets of Plan Drawings (one (1) copy is included in the manual)

Should you have any questions or require clarification, please contact us at (919) 828-0577 or by email below.

Sincerely,

Richardson Smith Gardner & Associates, Inc.

Kinjal B. Shah, E.I.
Staff Engineer

Stacey A. Smith, P.E.
Project Manager

Att.
Cc: Mr. David King, Shotwell Transfer Station, Inc.
Ms. Donna Wilson, NCDENR
Ms. Michelle Pearson, Dynasty Holdings, LLC
File

H:\Projects\David King\King 07-1 (Thornton Road Transfer)\letter3-3-08.wpd

City of Raleigh, N.C.

One Exchange Plaza, Suite 404
PO Box 590
Raleigh, NC 27602
919-516-2150 / Fax: 919-516-2685

Permit Application

Satellite Location:
8320-130 Litchford Road
Raleigh, NC 27615
919-713-4200 / Fax: 919-713-4221

THIS IS A ONE SHEET DOCUMENT. COPY SECOND SHEET ON BACK OF FIRST SHEET. MUST BE TYPED OR PRINTED IN INK

☐ 2006 North Carolina State Building Code ☐ 2006 North Carolina Rehab Code **DATE:** MARCH 3, 2008 **Front page**

Tran # (OFFICE USE) **Group #** (OFFICE USE)

Applicant: SHOTWELL TRANSFER STATION, INC. Residential ☐ Commercial ☒ Express Review Commercial ☐

Project Address 5565 Thornton Road **Suite #:**

Subdivision/Tenant Lot #

Property Owner Dynasty Holdings, LLC

Telephone: (919) (790-1119) FAX: ( ) ( ) E-Mail daviddebris@bellsouth.net

Project Contact Person David King

Telephone: (919) (790-1119) FAX: ( ) ( ) E-Mail

Proposed Work Initial Site Grading Waste Transfer Station

Will impervious surface change? Yes ☒ or No ☐ Increase ☒ or Decreased ☐ 78,740 sq. ft.

Owner/ Agent Signature

BUILDING — SINGLE FAMILY. . . EARLY POWER RELEASE – 516-2500

Other Permits Issued: Land Disturbing Permit # Wake Co. Well/Septic Permit #

Contractor NC License #/Class

Address City/State/Zip

Telephone: ( ) ( ) FAX: ( ) ( ) City Business Lic. # E-Mail

Total Project Sq. Ft. **Total Project Cost $**

Utilities: WATER ☐ **Public** ☐ **Private** **SEWER** ☐ **Public** ☐ **Private**

ELECTRICAL

Contractor NC License #/Class

Address City/State/Zip

Telephone: ( ) ( ) FAX ( ) ( ) City Business Lic. # E-Mail

Voltage ☐ 50 or less ☐ 600 or less ☐ over 600 volts **ELECTRICAL COST $**

PLUMBING

Contractor NC License #/Class

Address City/State/Zip

Telephone: ( ) ( ) FAX: ( ) ( ) City Business Lic. # E-Mail

MECHANICAL

HVAC Contractor NC License #/Class

Address City/State/Zip

Telephone: ( ) ( ) FAX: ( ) ( ) City Business Lic. # E-Mail

TYPE OF HEATING: Electrical ☐ Gas ☐ Hot Water ☐ Oil ☐ Air Condition Size in Tons

Work Includes: Appliances ☐ Appliance/Duct ☐ Ventilation ☐ Fire Suppression ☐ Refrigeration ☐ Fuel Piping ☐

REFRIGERATION **Contractor** NC License #/Class

Address City/State/Zip

Telephone: ( ) ( ) FAX: ( ) ( ) City Privilege Lic. # E-Mail

HOOD SUPPRESSION **Contractor**

Address Privilege City/State/Zip

Telephone: ( ) ( ) FAX: ( ) ( ) City Business Lic. # E-Mail

FIRE

SPRINKLER **Contractor** NC License #/Class

Address City/State/Zip

Telephone: ( ) ( ) FAX: ( ) ( ) City Business Lic. # E-Mail

Type of System: ☐ Fire Pump ☐ Standpipe ☐ Sprinklers ☐ Alternate Suppression

FIRE ALARM **Contractor** NC Electrical License #/Class

Address City/State/Zip

Telephone: ( ) ( ) FAX: ( ) ( ) City Business Lic. # E-Mail

City of Raleigh, N.C.

Permit Application

One Exchange Plaza, Suite 404
PO Box 590
Raleigh, NC 27602
919-516-2150 / Fax: 919-516-2685

Satellite Location:
8320-130 Litchford Road
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DATE: ☐ 2006 North Carolina State Building Code ☐ 2006 North Carolina Rehab Code

Tran # (OFFICE USE) **Group #** (OFFICE USE) **Back page**

Project Address 5565 Thornton Road Lot # **Suite #:**

SIGN

Contractor

Address City/State/Zip

Telephone: ( ) ( ) FAX: ( ) ( ) City Business Lic. # E-Mail

☐Temp. Const. Sign ☐Off Premise Sign ☐ Wall Sign ☐ Ground Sign ☐ Awning Sign ☐ Projecting Sign

☐Special Events Sign ☐ Tract Identification ☐Canopy ☐Under Canopy ☐ Other

Business Owner

Address City/State/Zip

Telephone: ( ) ( ) FAX: ( ) ( ) City Business Lic. # E-Mail

ZONING

Contractor

Address City/State/Zip

Telephone: ( ) ( ) FAX: ( ) ( ) E-Mail Accessory Structure ☐ Open Fence ☐

Dish Antenna ☐ Parking Lot ☐ Site Plan ☐ Tree Conservation ☐ Landscaping ☐ Swimming Pools ☐ Other ☐

LAND DISTURBING (GRADING)

Contractor King's Grading, Inc. NC License #/Class 50306

Address 2008 Mt High Drive City/State/Zip Wake Forest NC 27587

Telephone: (9) ( ) FAX: (869) (673) City Business Lic. # 33491 E-Mail DavidDebris@bellsouth.net

Construction Cost $ 500K-600K Disturbed Area: 7.4

FLOOD

Applicant NC License #/Class

Address City/State/Zip

Telephone: ( ) ( ) FAX: ( ) ( ) City Business Lic. # E-Mail

RIGHT-OF-WAY

Contractor

Address City/State/Zip

Telephone: ( ) ( ) FAX: ( ) ( ) City Business Lic. # E-Mail

For Driveway ( ) Number to be installed: For Sidewalk: ( ) Total Linear Feet:

For Maintenance Purpose: ( ) For Construction Purpose: ( ) Certificate #:

FACILITY FEE

Name of Payer

Address City/State/Zip

Telephone: ( ) ( ) FAX" ( ) ( ) E-Mail

UTILITY

☐ Residential ☐Non-residential **You are:** ☐ **Owner** ☐ **Renter**

Type of Service: ☐ Water ☐ Sewer ☐ Irrigation (new or split meter?) Size of Meter

Contact Person Telephone: ( ) ( ) FAX: ( ) ( )

Tap will be installed by Water Size Sewer Size

City Business License # E-Mail

Revised 5/22/2007 ke

City Of Raleigh
North Carolina

APPENDIX V

City of Raleigh Public Works

STORMWATER PERMIT CHECKLIST

Name of Project: Shotwell Transfer Station – Stormwater Installation & Maintenance Manual

Location: (address or Wake PIN) 5565 Thornton Road, Raleigh, North Carolina 27616

Designer: Richardson Smith Gardner & Associates, Inc.

☒Total Site Area 9.85 Acres

☒Existing Impervious Area 38,000 s.f

☒Proposed Impervious Area 116,740 s.f

☒Pre-development Nitrogen load 2.97 lbs/ac/yr.

☒Post-development Nitrogen load 6.64 lbs/ac/yr.

☒Nitrogen removed by BMP (s) 1.59 (6.64-5.05) lbs/ac/yr.

☒Fee Paid to State Yes☒ No☐

☒Total Nitrogen load offset by fee 1.45 lbs/ac/yr.

☒Note: Fee must be paid prior to issuance of permit. A letter, receipt, or other form of verification from the State that the fee has been paid will be required prior to issuance of permit.

☒Percent increase in stormwater runoff -0.54 %

☒Supporting calculations.

☒Sealed maintenance manual and ~~replacement budget~~ to be determined

One Exchange Plaza, Suite 304
P.O. Box 590
Raleigh, NC 27602
919/516-2155(phone) 919/516-2681(fax)
www.raleighnc.gov/stormwater

SHOTWELL TRANSFER STATION, INC.
3209 GRESHAM LAKE RD SUITE 114-115
RALEIGH, NC 27615

BB&T
BRANCH BANKING AND TRUST COMPANY
1-800-BANK BBT BBT.com
66-112/531

1105

3/3/2008

PAY TO THE ORDER OF City of Raleigh

$ **888.00

Eight Hundred Eighty-Eight and 00/100********** DOLLARS

City of Raleigh

MEMO Shotwell Transfer Station, Inc.

AUTHORIZED SIGNATURE

Details on Back. Security Features Included

⑈001105⑈ ⑆053101121⑆0005297758197⑈

SHOTWELL TRANSFER STATION, INC.

1105

City of Raleigh 3/3/2008

888.00

BB&T checking Shotwell Transfer Station, Inc. 888.00

SAB

FINANCIALLY RESPONSIBLE PERSON/AGENT

1. Person to contact should sediment control issues arise during land-disturbing activity.

Name: David King Telephone: 919-790-1119 Fax 919-790-5730

2. Person (s) firm (s) financially responsible for this land-disturbing activity.

Shotwell Transfer Station, Inc.
Name of Person (s) Firm (s)

3209 Gresham Lake Road, Suite 115			5565 Thornton Road		
Mailing Address			Street Address		
Raleigh	NC	27615	Raleigh	NC	27616
City	State	Zip	City	State	Zip

3. Appointed Agent to receive any notice, process, or pleading in any action or legal proceeding arising out of any matter relating to Raleigh City Code Chapter 5 Part 10.

David King
Name of Individual

Signature of Agent

Shotwell Transfer Station, Inc. 919-790-1119
Place of Business inside the City of Raleigh Business Telephone

3209 Gresham Lake Road, Suite 115 Raleigh, North Carolina 27615
Address

Complete the above and adhere to cover sheet of erosion control plans. This does not take the place of a complete financial responsibility form. A completed form must be filed with the Raleigh Inspections Department prior to issuance of permit.

Revised 07/03/2007 - bb

Transaction Number: _____

FINANCIAL RESPONSIBILITY / OWNERSHIP FORM
SEDIMENTATION POLLUTION CONTROL ACT
(TO BE COMPLETED BY THE DEVELOPER AND OWNER OF THE PROPERTY)

No person may obtain any land-disturbing activity permit before this form has been completed and filed with the Department of Inspections. (Please type or print and, if a question is not applicable, place N/A in the blank.)

Raleigh City Code §14-1011 sets forth that, ***(i)t shall be unlawful and a violation of this code for any person to give false information or misrepresentations in any application or permit required by this code.*** Failure to provide full disclosure of the requested information may be grounds for denial of a land-disturbing activity permit. **READ ALL INSTRUCTIONS CAREFULLY.**

SECTION 1	**GENERAL INFORMATION**

N/A a. Subdivision where land-disturbing activity is to be undertaken

_____ lots _____ block(s).

X b. Approximate date land-disturbing activity will be commenced?

April 2008 or upon approval of City of Raleigh grading permit.

X c. Purpose of development (residential, commercial, industrial, etc.)?

Commercial/Industrial_____

X d. Size of tract?

9.849 acres_____

X e. Approximate acreage of land to be disturbed or uncovered?

acres 7.4 ACRES

X f. Has an erosion and sedimentation control plan been filed?

Yes _____ No X (WITH THIS FORM)

X g. Indicate County, Book, and Page where deed or instrument is filed (use additional pages to list additional deeds or instruments):

County: Wake Book: BM2007 Page: 2838

County: _____ Book: _____ Page: _____

County: _____ Book: _____ Page: _____

_____ h. Wake County P.I.N. 1738429684
(If multiple parcels, list each PIN number)

_____ i. Site Address(es): (Use Additional Pages to list multiple site addresses)

5565 Thornton Road, Raleigh, North Carolina 27616

SECTION 2(a)	LANDOWNER(S) OF RECORD

In the spaces below, identify the landowner(s) of record. Use additional sheets if necessary.

NAME
Dynasty Holdings, LLC

TITLE

BUSINESS ADDRESS
3209 Gresham Lake Road, Suite 115

RESIDENCE ADDRESS

Raleigh, North Carolina 27615

(919) 790-1119 Fax 790-1158
BUSINESS TELEPHONE

( )
RESIDENCE TELEPHONE

SECTION 2(b)	OWNER'S ACKNOWLEDGMENT

The undersigned acknowledges that he/she is the owner, or holds the owner's power of attorney, of the property which is the subject of this application, and further states that the applicant/developer herein is authorized to conduct land-disturbing activities on the subject property and does so with the full knowledge, permission and consent of the owner(s).

This the 3RD day of MARCH, 20 08.

SIGNATURE

OWNER
TITLE DYNASTY HOLDINGS, LLC

SECTION 2(c)	OWNER'S APPOINTED AGENT

The owner of the property upon which land-disturbing activities will be undertaken is required to appoint an agent for service with business and residence addresses within Wake County, North Carolina.

The owner of the subject property appoints the following person(s) as an agent(s) to receive service of any notice, process, or pleading in any action or legal proceeding arising out of any matter relating to Raleigh City Code, Chapter 5, Part 10. It is agreed that any notice, process, or pleading against the owner of the property upon which land-disturbing activities will be undertaken may be served by and through the undersigned and such service shall have the same force and effect as if service was accomplished upon the owner.

NAME OF APPOINTED AGENT
David King

~~SIGNATURE~~ OF APPOINTED AGENT

BUSINESS ADDRESS IN WAKE COUNTY
3209 Gresham Lake Road, Suite 115

RESIDENCE ADDRESS IN WAKE COUNTY

Raleigh, North Carolina 27615

(919) 790-1119 Fax 790-1158
BUSINESS TELEPHONE

( )
RESIDENCE TELEPHONE

SECTION 2(c) CONTINUED

ALTERNATE AGENT

NAME OF ALTERNATE AGENT	SIGNATURE OF ALTERNATE AGENT
N/A	
BUSINESS ADDRESS IN WAKE COUNTY	RESIDENCE ADDRESS IN WAKE COUNTY
( ) Fax	( )
BUSINESS TELEPHONE	RESIDENCE TELEPHONE

SECTION 3(a) — **PERSON(S) OR FIRM(S) FINANCIALLY RESPONSIBLE / CONTRACTOR**

In the spaces below, identify the person(s) or firm(s) financially responsible (developer) for this land-disturbing activity. Use additional sheets if necessary.

NAME	TITLE
Shotwell Transfer Station, Inc.	DAVID KING, PRESIDENT
BUSINESS ADDRESS	RESIDENCE ADDRESS
3209 Gresham Lake Road, Suite 115	
Raleigh, North Carolina 27615	
(919) 790-1119 Fax 790-1158	( )
BUSINESS TELEPHONE	RESIDENCE TELEPHONE

SECTION 3(b) — **CONTRACTOR'S APPOINTED AGENT**

The person(s) or firm(s) financially responsible (developer) of the property which upon which land-disturbing activities will be undertaken is required to appoint an agent for service with business and residence addresses within Wake County, North Carolina.

The person(s) or firm(s) financially responsible (developer) of the subject property appoints the following person(s) as an agent(s) to receive service of any notice, process, or pleading in any action or legal proceeding arising out of any matter relating to Raleigh City Code, Chapter 5, Part 10. It is agreed that any notice, process, or pleading against the developer may be served on the undersigned and such service shall have the same force and effect as if service was accomplished upon the owner.

NAME OF APPOINTED AGENT	SIGNATURE OF APPOINTED AGENT
David King	
BUSINESS ADDRESS IN WAKE COUNTY	RESIDENCE ADDRESS IN WAKE COUNTY
Same	
( ) Fax	( )
BUSINESS TELEPHONE	RESIDENCE TELEPHONE

SECTION 3(b) CONTINUED	

ALTERNATE AGENT

NAME OF ALTERNATE AGENT	SIGNATURE OF ALTERNATE AGENT
BUSINESS ADDRESS IN WAKE COUNTY	RESIDENCE ADDRESS IN WAKE COUNTY
( ) Fax	( )
BUSINESS TELEPHONE	RESIDENCE TELEPHONE

PLEASE BE CAREFUL TO READ THE INSTRUCTIONS BY THE BOLLARD WHETHER YOU SHOULD SELECT TO COMPLETE SECTION 4 AND 5, OR SHOULD SELECT TO COMPLETE ONLY SECTION 4. DO NOT SELECT TO COMPLETE SECTION 4 IF YOU ARE REQUIRED TO COMPLETE SECTION 4 AND 5.

SECTION 4	LANDOWNER(S) DISCLOSURE

In the spaces provided below, list **ALL** landowner(s) of record, including home and business addresses. In the event that the property is held by a corporate or unincorporated business entity, list **ALL** directors, officers, managers, partners, and managing agents including business and personal addresses. Use additional pages if necessary. **Failure to provide full disclosure of the identities of these individuals may be grounds for denial of a land-disturbing activity permit.**

NAME

TITLE

BUSINESS ADDRESS

RESIDENCE ADDRESS

( )
BUSINESS TELEPHONE

( )
RESIDENCE TELEPHONE

NAME

TITLE

BUSINESS ADDRESS

RESIDENCE ADDRESS

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BUSINESS TELEPHONE

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RESIDENCE TELEPHONE

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NAME	TITLE
BUSINESS ADDRESS	RESIDENCE ADDRESS
( )	( )
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BUSINESS TELEPHONE	RESIDENCE TELEPHONE
NAME	TITLE
BUSINESS ADDRESS	RESIDENCE ADDRESS
( )	( )
BUSINESS TELEPHONE	RESIDENCE TELEPHONE

SECTION 5	CONTRACTOR(S) DISCLOSURE

In the spaces provided below, list **ALL** developer(s) of the property, including home and business addresses . In the event that the property shall be developed by a corporate or unincorporated business entity, list **ALL** directors, officers, managers, partners, and/or managing agents including business and personal addresses. Use additional pages if necessary. **Failure to provide full disclosure of the identities of these individuals may be grounds for denial of a land-disturbing activity permit.**

NAME ____________ TITLE ____________

BUSINESS ADDRESS ____________ RESIDENCE ADDRESS ____________

( ) BUSINESS TELEPHONE ____________ ( ) RESIDENCE TELEPHONE ____________

NAME ____________ TITLE ____________

BUSINESS ADDRESS ____________ RESIDENCE ADDRESS ____________

( ) BUSINESS TELEPHONE ____________ ( ) RESIDENCE TELEPHONE ____________

NAME ____________ TITLE ____________

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NAME | TITLE

BUSINESS ADDRESS | RESIDENCE ADDRESS

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NAME | TITLE

BUSINESS ADDRESS | RESIDENCE ADDRESS

( ) BUSINESS TELEPHONE | ( ) RESIDENCE TELEPHONE

SECTION 6	CONSENT FOR SERVICE

In lieu of completing Sections 4 and 5 above, an applicant may execute the following consent for service.

1. The person(s) or firm(s) financially responsible (developer) for this land-disturbing activity hereby consents and agrees to accept service of any notice, process or pleading, including any Notice of Violation or Notice of Civil Penalty issued pursuant to Raleigh City Code §10-5011 or §10-5013, against the person or firm who is financially responsible for this land-disturbing activity through any means authorized by North Carolina General Statues §1A-1, Rule 4, as well as personal service accomplished by any employee of the City of Raleigh.

2. The person(s) or firm(s) financially responsible (developer) for this land-disturbing activity agree that service of any document referenced above may be accomplished by delivering a copy of such document to any person or entity authorized by North Carolina General Statutes § 1A-1, Rule 4, the developer's agent disclosed herein, the owner, or the owner's agent disclosed herein.

3. The person(s) or firm(s) financially responsible (developer) further acknowledges that by indicating consent on this form it has waived its right to be served exclusively by means authorized by North Carolina General Statues §1A-1, Rule 4, and has waived its right to raise insufficiency of service as a defense so long as service is accomplished in accordance with this consent for service.

IN WITNESS WHEREOF, the undersigned has hereunto set his/her hand and seal, this 3RD day of MARCH, 20 08.

_____ (SEAL)
Signature

DAVID WALL KIRK, JR.
Printed Name

OWNER / PRES
Title / Position

Sworn to and subscribed before me this the 3RD day of MARCH, 20 08.

_____
Notary Public

My Commission Expires: JULY 11, 2009

STACEY A. SMITH NOTARY PUBLIC WAKE COUNTY, N.C.

SECTION 7	OWNER(S) EXECUTION

The owner of the property upon which the land-disturbing activity is to be undertaken states and affirms that he/she has read and understands the statements and disclosures made in this form, that the information disclosed herein is true and correct to the best of his/her knowledge and belief, and that all information disclosed herein was provided by the undersigned while under oath.

This form must be signed by the owner of the property if an individual and by an officer, director, general partner, attorney-in-fact, or other person with authority to execute instruments for the owner if not an individual.

This the 3rd day of March, 2008.

Signature (SEAL)

DAVID WALL KING, JR

Printed Name

OWNER / PRES.

Title / Position

Sworn to and subscribed before me this the 3rd day of March, 2008.

STACEY A. SMITH NOTARY PUBLIC WAKE COUNTY, N.C.

Notary Public

My Commission Expires: July 11, 2009

If the person executing this document is an individual acting on behalf of a corporation or other business entity, execute the acknowledgment below in addition to signing above

I, the undersigned Notary Public, certify that on the 3rd day of March, 2008,

before me personally came DAVID KING (NAME), to me personally known, who

being by me duly sworn, did depose and say that (s)he is OWNER (TITLE) of

~~KING'S GRADING, INC~~ DYNASTY HOLDINGS, LLC (NAME OF CORPORATION OR OTHER ENTITY) described in the foregoing instrument, and that by

authority duly given and as an act of said corporation or other entity, the foregoing instrument

was signed by DAVID KING (NAME) in his/her official capacity and does hereby

serve to bind ~~KING'S GRADING, INC~~ DYNASTY HOLDINGS, LLC (NAME OF CORPORATION OR OTHER ENTITY) to the terms of the foregoing instrument.

STACEY A. SMITH NOTARY PUBLIC WAKE COUNTY, N.C.

(SEAL)

Notary Public

My Commission Expires: July 11, 2009

SECTION 7	CONTRACTOR (S) EXECUTION

The person(s) or firm(s) financially responsible (developer) of the property upon which the land-disturbing activity is to be undertaken states and affirms that he/she has read and understands the statements and disclosures made in this form, that the information disclosed herein is true and correct to the best of his/her knowledge and belief, and that all information disclosed herein was provided by the undersigned while under oath.

This form must be signed by the person(s) or firm(s) financially responsible (developer) of the property if an individual and by an officer, director, general partner, attorney-in-fact, or other person with authority to execute instruments for the owner if not an individual.

This the 3RD day of March, 2008.

Signature (SEAL)

DAVID WALL KIRK, JR.
Printed Name

OWNER / PRES
Title / Position

Sworn to and subscribed before me this the 3RD day of March, 2008.

Notary Public

My Commission Expires: July 11, 2009

STACEY A. SMITH NOTARY PUBLIC WAKE COUNTY, N.C.

If the person executing this document is an individual acting on behalf of a corporation or other business entity, execute the acknowledgment below in addition to signing above

I, the undersigned Notary Public, certify that on the 3RD day of March, 2008, before me personally came DAVID KIRK (NAME), to me personally known, who being by me duly sworn, did depose and say that (s)he is OWNER (TITLE) of KIRK'S GRADING, INC (NAME OF CORPORATION OR OTHER ENTITY) described in the foregoing instrument, and that by authority duly given and as an act of said corporation or other entity, the foregoing instrument was signed by DAVID KIRK (NAME) in his/her official capacity and does hereby serve to bind KIRK'S GRADING, INC (NAME OF CORPORATION OR OTHER ENTITY) to the terms of the foregoing instrument.

(SEAL)

STACEY A. SMITH NOTARY PUBLIC WAKE COUNTY, N.C.

Notary Public

My Commission Expires: July 11, 2009

Stormwater Installation and Maintenance Manual

Shotwell Transfer Station, Inc.

Raleigh, North Carolina

Prepared For:

Shotwell Transfer Station, Inc.
5565 Thornton Road
Raleigh, North Carolina

March 2008

PRELIMINARY ISSUE

RICHARDSON SMITH GARDNER
& ASSOCIATES
ENGINEERING & GEOLOGICAL
SERVICES

Stormwater Installation and Maintenance Manual

Shotwell Transfer Station, Inc.

Raleigh, Wake County, North Carolina

Prepared for:
Shotwell Transfer Station, Inc.
Raleigh, North Carolina

To the Attention of:
David King
Shotwell Transfer Station, Inc.

RSG Project No. King 07-2

3-3-08

Kinjal B. Shah, E.I.
Staff Engineer

Stacey A. Smith, P.E.
Project Manager

NORTH CAROLINA PROFESSIONAL SEAL 023002 ENGINEER STACEY A. SMITH 3-3-08

March 2008

RICHARDSON SMITH GARDNER & ASSOCIATES
ENGINEERING & GEOLOGICAL SERVICES

SHOTWELL TRANSFER STATION, INC.
CITY OF RALEIGH, NORTH CAROLINA

STORMWATER INSTALLATION AND MAINTENANCE MANUAL

TABLE OF CONTENTS

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APPENDICES

SHOTWELL TRANSFER STATION, INC.

STORMWATER INSTALLATION AND MAINTENANCE MANUAL

1.0 NARRATIVE

1.1 Project Description

Shotwell Transfer Station, Inc. operates construction and operation of Mixed Waste transfer station and Recycling under NC Solid Waste Permit No. 92-27T at their facility located off of Thornton Road (S.R. 2233) in Raleigh as shown in **Figure 1**.

This plan addresses the expansion of the existing transfer station facility to include MSW and C&D transfer operation over the closed Neuse Demolition Landfill. The proposed modification of the erosion control plan for the site includes a total disturbed area of 5.8 acres.

1.2 Contact Information

1.2.1 Engineer: For questions regarding this erosion and sedimentation control plan, please contact the following:

Richardson Smith Gardner & Associates, Inc.
Attn.: Stacey A. Smith, P.E.
14 N. Boylan Ave.
Raleigh, NC 27607
Phone: (919) 828-0577
Fax: (919) 828-3899.

1.2.2 Owner: The owner of the site and the person to contact should sediment control issues arise during the land-disturbing activity is as follows:

Dynasty Holdings, LLC.
Suite 115, 3209 Gresham Lake Road
Raleigh, North Carolina 27615
Phone: (919) 790-1119
Fax: (919) 790-9730

Contact Person : David King

1.2.3 Operator: The operator of the site and the person to contact should sediment control issues arise during the land-disturbing activity is as follows:

Shotwell Transfer Station, Inc.
Suite 115, 3209 Gresham Lake Road
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Shotwell Transfer Station, Inc. (Site & Scalehouse Office)
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Raleigh, North Carolina 27616

1.3 Existing Site Conditions

Existing ground surface elevations vary from El. 230 (feet) within the central area of the property to about El. 200 within the northwest, north and northeast portion of the site. Topographically, the site is a broad dissected ridge, generally sloping to the northwest and northeast. The site lies within the Neuse River drainage basin. The majority of the property is a closed LCID landfill (Neuse Landfill, Inc.).

1.4 Adjacent Areas

The site is accessed by Thornton Road on southeast side. The transfer station is bounded by the commercial and residential properties to the north and east. The nearest water body is an unnamed creek of Neuse River located on the northeast site of the transfer station. Neuse River is located approximate 1.0 miles from the site.

1.5 Site Soils Information

The native surficial soils at the site fall under the categories of Sandy Loam (ApB & WmE) and Silty Loam (Wo & Wn) according to the GIS Website for Wake County. However, Shotwell Transfer Station will be on the top of closed Neuse Demolition Landfill. In our site visit to transfer station, we found surficial soils Clayey Sandy soil on western area of the property and loamy soil on the north, south and east area of the property. Therefore, based on the permeability of the soil, hydrologic soil groups (HSG) “B” and “C” are considered for purposes of runoff calculations.

2.0 DESIGN GUIDELINES AND PROCEDURES

The erosion and sediment control design for the landfill was conducted based on guidelines and procedures as set forth in the following references:

1. HydroCAD Software Solutions, LLC (2004), HydroCAD Stormwater Modeling System Owner's Manual - Version 7, Chocorua, NH.

2. North Carolina Division of Land Resources (1988 and 1993 Update), North Carolina Erosion & Sediment Control Planning & Design Manual, Raleigh, NC.

3. Stormwater Management Design Manual by City of Raleigh, January 2002.

4. North Carolina Division of Water Quality (July 2005) Updated Draft Manual of

Stormwater Best Management Practices, (Public Comment Version), Raleigh, NC.

5. Malcom, H. Rooney (1989 & 2003 Supplement), Elements of Urban Stormwater Design, NC State Univ., Raleigh, NC.

3.0 RUNOFF CALCULATIONS

All stormwater flow volumes were calculated using the HydroCAD 7.10 computer program (utilizing USDA-NRCS (SCS) methods) based on 25-year &10-year 24-hour storm event. Rainfall quantities and/or intensities used in the analyses were derived from NOAA-35 and TP-40 data and have been included in **Appendix A**. Drainage areas were determined using a planimeter and/or AutoCAD on topographic sheets of the project area. For each drainage area, runoff curve numbers (SCS methods) and/or runoff coefficients (Rational Method) were selected based on ground cover conditions. Times of concentration were calculated by HydroCAD using SCS methods.

As per City of Raleigh Stormwater Design Manual, **(Ref.3, Sec. 1.2.6.5)** the increase in peak stormwater runoff between pre and post development conditions for the site for the 2-year storm is ten percent (10%) or less. As per Neuse River Nutrient Sensitive Waters Management Strategy (**Ref. 3, Sec 1.2.6)**, no net increase in peak flow leaving the site from the Pre-Development Conditions for the 1-Year, 24-Hour storm. However, since Raleigh has historically utilized the 2-year design storm for peak runoff control, new development within Raleigh's jurisdiction is required to attenuate the 2-year design storm, not the 1-year, 24-hour storm. Therefore, the peak discharge for the 2-year 24-hour storm event was evaluated for both Pre-Developed and Post-Developed Conditions summarized in **Table 1.** However, the results for pre and post development conditions of transfer station are not comparable for any discharge point as the flow leaving from four different drainage areas in pre-development condition was sheet flow towards the existing wetlands on northwest, north and northeast direction.

TABLE 1: SUMMARY OF RUNOFF VALUES

Discharge Point (As shown in HydroCAD Model)	Pre–development Condition			Post–development Condition		
	Area (Ac)	2-Year Storm (cfs)	10-Year Storm (cfs)	Area (Ac)	2-Year Storm (cfs)	10-Year Storm (cfs)
Drainage Area -1 / Wet Detention Basin	2.11	4.00	8.9	3.47	003	0.96
Drainage Area-2 / Permanent Sediment Basin	1.16	2.55	5.47	2.13	0.18	6.02
Drainage Area-3	4.17	7.76	17	2.8	4.78	10.9
Drainage Area-4	2.38	4.18	9.42	2.09	3.64	5.9

Note:

Drainage Area-1 (pre-development) and Basin-1 (post-development) is located on the northeast side of the transfer station.

Drainage Area-2 (pre-development) and Basin-2 (post-development) is located on the northen side of the transfer station.

Drainage Area-3 (pre & post development) is located on the northwest side of the transfer station.

Drainage Area-4 (pre & post development) is located on the eastern side of the transfer station.

4.0 IMPERVIOUS AREAS:

Total impervious areas for Post-Developed Conditions breakdown as follows:

- Access roads: 2.23 AC
- Building: 0.45 AC

Total : 2.68 AC or 27.2 % of the total facility area (9.85 Ac).

Therefore, the total impervious area for Post-Developed Condition is above the 15% threshold.

5.0 NITROGEN LOADING ESTIMATIONS

As per City of Raleigh – Stormwater Management Design Manual (**Ref:3, Section 3.1.2**), total Nitrogen (TN) Loading was evaluated for three conditions: (1) Pre-Developed Condition, (2) Post-Developed Condition without BMPs & (3) Post-Development Condition with BMPs which are summarized in **Table 2**. Also, see **Appendix B** for detail calculations.

TABLE 2: SUMMARY OF TOTAL NITROGEN (TN) LOADING

Conditions	Drainage Area (AC)	TN Loading (lb/ac/yr)
Pre-Developed Condition	**9.85**	**2.97**
Post-Developed Condition without BMPs	**9.85**	**6.64**
Post-Developed Condition with BMPs	**9.85**	**5.05**

Total Drainage Area for the Post-Developed Condition is less than the Pre-Developed Condition. However, the TN-loading for Post-Development condition from the site is more than the 3.6 lbs/ac limit; and therefore, nitrogen offset payment will be required for 1.45 lbs/ac (5.05 lb/ac -3.6 lb/ac).

6.0 EROSION AND SEDIMENTATION CONTROL MEASURES

The following erosion and sedimentation control measures are to be constructed as part of the proposed construction. Appendices A, B, C and D to this plan include calculations, nitrogen loading calculations, technical specifications, and plans and details for each of these measures, respectively.

In most cases, the following erosion and sedimentation control measures were designed using the final drainage areas which were found to represent a worst case for design. Each calculation indicates what condition was used in the analysis.

6.1 Sediment Basins

One permanent sediment basin that will serve the site is designed in accordance with E&SCCP&DM Section 6.61. The proposed basin is identified on the attached Plan (Drawing Sheet S2 & S3) as Permanent Sediment Basin.

The permanent sediment basin is proposed on the northern tip of the proposed area and receiving runoff of 2.13 acres from northeast and northwest side of the area via drainage channels DC-2A & DC-2B. The cross section of sediment basin with all pertinent information like elevations, diameter of orifice, outlet pipe size etc. is provided in Drawing Sheet No. 4 (S3).

Sediment basin design is subject to several requirements. The sediment basins must provide a basin volume of 1,800 ft^3/acre of disturbed area. Other E&SCP&DM requirements for permanent basins include barrel and emergency weir-type spillway. Faircloth Skimmer is used to dewater the basins. The size of the skimmer orifice is considered based on typical drawdown requirements of 2 to 5 days. 2" diameter of skimmer is used for basin-1 and 2. The basin will be built on the top of closed Neuse Demolition Landfill and therefore, the bottom of the basin will be covered with 40 mil LLPDE Geomembrane on the top of 2' thick soil liner to avoid infiltration through the closed Neuse Demolition Landfill. In addition to E&SCP&DM requirements, sediment basin was designed to have an adequate surface area to achieve an 80% settling efficiency of a 40 micron (silt size) particle at the peak discharge from the design storm. Also, sediment basin was modeled with the HydroCAD computer program and a spreadsheet was used to verify the design requirements.

6.2 Wet Detention Basin

One wet detention basin is located on the southern side of the proposed area and receiving around 2.7 acres runoff from the central portion of the parking lot and southern side of road and around 0.77 acres runoff from eastern side of the property via drainage channel DC-1A followed by drop inlet and 18" RCP pipe. The wet detention basin is designed in accordance with the DWQ-Updated Draft Manual of Stormwater Best Management Practices (July 2005), North Carolina **(Ref.4)**.

The wet detention basin is subject to a number of detailed design requirements in order to operate effectively in the removal of stormwater pollutants (TSS, nutrients, etc.). The wet detention basin must provide a permanent water quality pool and temporary water quality pool (for smaller storms), and be able to effectively handle the flow from a larger design storm through a peak attenuation storage zone. This wet detention basin was modeled with the HydroCAD computer program and a spreadsheet was used to verify the design requirements.

In initial grading plan, the wet detention basin is placed only up to the existing road as shown in drawing plan with riser/barrel assembly. However, this basin will be considered as a temporary basin in the initial grading plan and will be replaced with the wet detention basin in the final grading plan.

6.3 Drainage Channels

Drainage channel DC-1A associated with drainage area-1 will serve the site are designed in accordance with E&SCP&DM.

Drainage channel calculations were conducted using a reformulation of Manning's Equation in a spreadsheet format for 25-yr storm event, which exceeds the stormwater requirement of 10-year storm event by City of Raleigh. The calculations determine the normal depth of flow based on the peak discharge from the design storm (from HydroCAD) and assumed channel dimensions/slope(s). Permanent channel linings were chosen, as appropriate, based on the calculated velocity and/or shear stress.

6.4 Water Quality Swales

The water quality swales are identified in the plan (drawing sheets S2 & S3) as DC-2A & DC-2B associated with drainage area-2

Water Quality Swales calculations were conducted using a reformulation of Manning's Equation in a spreadsheet format for 25-yr storm event, a requirement by City of Raleigh. The calculations determine the normal depth of flow based on the peak discharge from the design storm (from HydroCAD) and assumed channel dimensions/slope(s). Temporary and permanent channel linings were chosen, as appropriate, based on the calculated velocity and/or shear stress.

Water Quality Swales were also designed as per City of Raleigh stormwater management requirements.
Design guidelines included (City of Raleigh *Stormwater Design Manual*):

- Peak discharges generally less than 5 to 10 cfs
- Runoff velocities less than 2.5 ft/s
- Maximum flow depth 1’
- Swale slope less than 4%
- Swale cross-slope less than 3:1 (h:v)
- Designed for water quality volume (WQv)

6.5 Temporary Diversion Channels

Temporary diversion ditches were designed using criteria and standard cross section of E&SCP&DM Section 6.20.

6.6 Culvert Pipe

Total three (3) reinforce Concrete pipes (RCP) will be used in storm water system for Shotwell Transfer Station. These three culvert pipes are identified in the plan as C-1, C-2 & C-3. C-1 & C-2 are located at the two road entrances and C-3 carries water to the wet detention basin. Culverts were designed using HydroCAD to determine the maximum headwater elevation.

6.7 Drop Inlets

Weir-type drop inlet will be used in the drainage channel DC-1A to route flow to the wet detention basin. Prior to vegetative stabilization of the drainage channel DC-1A, drop inlet will be protected from sedimentation by a placing a wire mesh and coarse aggregate filter around all sides of the drop inlet.

6.8 Temporary Sediment Traps

Temporary sediment traps (ST-1 & ST-2) were designed in accordance with E&SCP&DM Section 6.60.

Temporary sediment traps are subject to several design requirements. Each temporary sediment trap must have a drainage area of no more than 5 acres, must have a basin volume of 1,800 ft^3/acre of disturbed area (measured at the spillway crest), and should have a surface area (measured at the spillway crest) of 0.01 acres/cfs (based on the peak flow from the 10-year storm). Also, each temporary sediment trap must have a minimum spillway weir length (across top of rock embankment) sized to pass the peak runoff from the design storm (or as prescribed in Table 6.60a or E&SCP&DM). Other requirements for temporary sediment traps also meet the criteria of Section 6.60. Each temporary sediment trap was modeled with the HydroCAD computer program and a spreadsheet was used to verify the design requirements.

6.9 Silt Fence

Silt fencing design was based on criteria set forth in E&SCP&DM, Section 6.62 including the limitation of 100 feet of fencing for each ¼ acre of drainage area.

6.10 Vegetative Stabilization

Vegetative stabilization will be in accordance with the seeding schedule in the project specifications (provided as an attachment to this plan). The seeding schedule was based on Table 6.11k of E&SCP&DM which is applicable to this site.

7.0 SCHEDULE FOR IMPLEMENTATION

All erosion control measures will be placed before any land disturbance or waste placement may begin in that portion of the site which drains to the erosion control measures. Vegetative stabilization of disturbed areas will be in accordance with the following requirements:

- Temporary or permanent ground cover (or other acceptable measure(s)) adequate to restrain erosion on erodible slopes or other areas will be stabilized within fifteen (15) working days or twenty-one (21) calendar days following completion of any phase of grading.

8.0 INSPECTION AND MAINTENANCE

As per NCDENR requirement, all erosion and sedimentation control measures will be inspected at

least once every seven calendar days and within 24 hours after any storm event of greater than 0.5 inches of rain per 24 hour period. A rain gauge will be maintained on the site and a record of the rainfall amounts and dates will be kept properly.

During inspections, any stormwater discharges from the site will be observed for stormwater discharge characteristics to evaluate the effectiveness of the erosion and sedimentation control measures incorporating Best Management Practices (BMPs). If visible sedimentation is leaving the disturbed limits of the site, corrective action will be taken immediately to control the discharge of sediments.

Repairs to erosion and sedimentation control measures will be made as needed and accumulated sediment removed if necessary. All sediments which are removed from erosion and sedimentation control measures will be disposed of in an approved manner at a location to be designated by the Engineer in such a manner that further erosion and sedimentation will not occur.

Also, all erosion and sedimentation control measures will be inspected and maintained in accordance with the City of Raleigh guidelines as follows:

8.1 Sediment Basins

Proper maintenance is essential for the continued function of the sediment basins as designed, to provide runoff mitigation.

8.1.1 Maintenance of Embankment

8.1.1A Vegetation

The embankment should be inspected for vegetation to prevent erosion.

Maintenance shall include, but not be limited to, the following items:

a. Regrade and revegetate all eroded areas until adequately stabilized by grass.

b. Remulch with new mulch in areas where mulch has been disturbed by wind or maintenance operations sufficiently to nullify its purpose. Anchor as required to prevent displacement.

c. Replant bare areas using same materials specified.

8.1.1B Erosion

Erosion problems may develop on the upstream face of the pond embankment due to failure of the vegetation or excessive fluctuation of water level in the pond. The pond embankment should be inspected for these areas every three months and following any rain event of one inch or greater over a twenty-four hour period or less. When eroded area detected, take the necessary action with proper care of vegetative areas that develop erosion.

8.1.1C Seepage

The embankment should be inspected for seepage as embankment fill and natural ground interface is very common location for seepage. Also the contact between the embankment and the faircloth skimmer-conduit is a very common location for seepage. The natural foundation area immediately downstream of the pond embankment abutment should also be inspected to ensure that "piping" is not occurring underneath the embankment. If someone notices seepage, take the action immediately to stop the seepage.

8.1.1D Cracks, slides and settlement

The entire embankment should be inspected for cracks every three months and following any rain event greater than one inch over a twenty-four hour period. Slides and slumps are serious threats to the safety of an embankment. Also, embankment should be inspected for the settlement as it occurs both during construction and after the embankment has been completed and placed into service. All necessary repairs should be made immediately. If necessary, additional soil may need to be brought in and re-compacted to make repairs.

8.1.2 Pest

Rodents such as ground hogs, beavers should be inspected every three months as they can be dangerous to structural integrity and proper performance of the embankment. Also pests like mosquito should be inspected weekly during the spring, summer and early fall months besides every three months inspection.

8.1.3 Maintenance of Faircloth skimmer

Faircloth skimmer should be inspected periodically. If the sediment restricts skimmer movement, pull the skimmer to one side and excavate under it. The skimmer is made of plastic and will withstand heat, cold and sunlight but it needs to be handled by hand, NOT grabbed with backhoe bucket. To remove the skimmer, disconnect the hose first, and then disconnect the barrel from the inlet extension.

8.1.4 Maintenance of Outlet pipe/barrel

The outlet pipe should be inspected thoroughly once a year. The pipe should be inspected for proper alignment (sagging), elongation and displacement at joints, cracks, piping, surface water, and surface wear, loss of protective coating, corrosion and blockage. Piped soil will need to be re-excavated and re-compacted. Check the area around the outlet pipe for erosion, scour, and displaced or dislodged rip rap. Immediately make all needed repairs to prevent further damage.

8.1.5 Records & Checkliksts

See attached forms.

8.2 LLDPE

40-mil thick textured Linear Low Density Polyethylene (LLDPE) is placed under a 2' protective soil cover in the permanent sediment basin. If the LLDPE is ripped, torn or damaged, it must be patched. A patch piece of LLDPE will need to be extrusion welded to the existing piece of LLDPE. The patch should extend 2-feet beyond the damaged area on all sides. After the patch is made, the protective soil layer will need to be returned to its

original conditions.

8.3 Drainage Channel & Water Quality Swales

All three drainage channels & water quality swales in the Shotwell Transfer Station will be grass lined channels. Therefore, grass channels should be inspected periodically for any change in grass line. Also, channels will be inspected for cracks, gulleys or slides in the side slope. Any of the area disturbed by other works will need to be re-seeded.

8.4 Culvert Pipe

All pipes should be inspected periodically for fitting and couplings which provide sufficient longitudinal strength to preserve pipe alignment. Also, pipes should be inspected for cracks, any accumulation of silt, debris or foreign matter. If someone finds any leakage or crack in the installed pipe, then the pipe should be replaced immediately with new pipe.

8.5 Silt Fence

The fence should be checked a minimum of twice a year. Sediment should be removed and placed in a designated disposal area if it is one third the height of the silt fence posts. The silt fence should be inspected to make certain it is not ripped or damaged, and remains attached to the supporting posts. The supporting posts must be replaced if they become bent or damaged.

8.6 Vegetative Stabilization

Vegetative growth is a key element in the cover stabilization. The vegetated area should be inspected once a month for any changes in the vegetation. In the growing season, the grass should remain green and vigorous. Areas with dead or diseased vegetation should be treated and/or replanted. Any area of the cover that is disturbed by other work or repairs will also need to be re-seeded.

SHOTWELL TRANSFER STATION, INC.
RALEIGH, NORTH CAROLINA

STORMWATER & EROSION AND SEDIMENTATION CONTROL PLAN

APPENDIX A: STORMWATER & E&SC PLAN CALCULATIONS.

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Appendix A

Erosion and Sedimentation Control Calculations

Analysis of Design Storms

RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services
14 N. Boylan Avenue Tel: 919-828-0577
Raleigh, NC 27603 Fax: 919-828-3899

SHEET: /
JOB #: King o7-1
DATE: 12/13/07
BY: KBS
CHKD BY:

Shotwell Transfer Station, Inc.
Analysis of Design Storms

DEPTH-DURATION-FREQUENCY TABLE*
LOCATION: **Shotwell Transfer Station, Inc.**

DURATION	RETURN PERIOD 2-YR (in)	5-YR (in)	10-YR (in)	25-YR (in)	50-YR (in)	100-YR (in)
5 min	0.48	0.54	0.59	0.66	0.72	0.78
10 min	0.80	0.92	1.02	1.16	1.28	1.39
15 min	1.02	1.19	1.32	1.51	1.66	1.81
30 min	1.36	1.68	1.89	2.20	2.44	2.68
60 min	1.76	2.18	2.48	2.91	3.25	3.58
2 hr	1.97	2.49	2.81	3.31	3.70	4.09
3 hr	2.17	2.74	3.14	3.71	4.16	4.60
6 hr	2.70	3.46	3.98	4.73	5.31	5.89
12 hr	3.17	4.10	4.74	5.64	6.35	7.05
24 hr	3.64	4.73	5.49	6.55	7.38	8.20

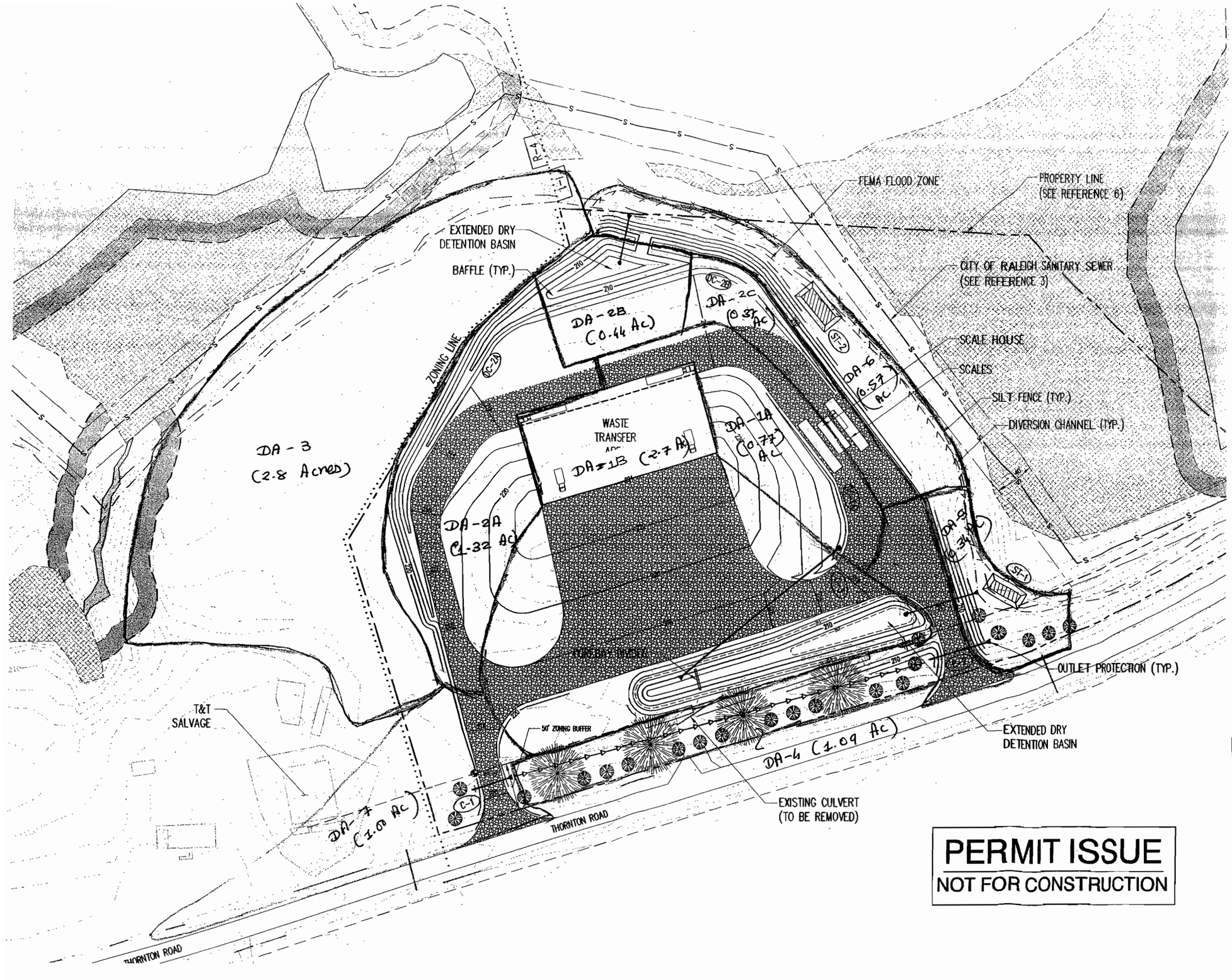
INTENSITY-DURATION-FREQUENCY TABLE*
LOCATION: **Shotwell Transfer Station, Inc.**

DURATION	RETURN PERIOD 2-YR (in/hr)	5-YR (in/hr)	10-YR (in/hr)	25-YR (in/hr)	50-YR (in/hr)	100-YR (in/hr)
5 min	5.76	6.48	7.08	7.92	8.66	9.36
10 min	4.80	5.52	6.12	6.96	7.66	8.34
15 min	4.08	4.76	5.28	6.04	6.64	7.24
30 min	2.72	3.36	3.78	4.40	4.87	5.36
60 min	1.76	2.18	2.48	2.91	3.25	3.58
2 hr	0.99	1.25	1.41	1.66	1.85	2.05
3 hr	0.72	0.91	1.05	1.24	1.39	1.53
6 hr	0.45	0.58	0.66	0.79	0.89	0.98
12 hr	0.26	0.34	0.40	0.47	0.53	0.59
24 hr	0.15	0.20	0.23	0.27	0.31	0.34

Notes: * Source Information from NOAA Hydro-35 and USWB TP-40

HydroCAD Analysis

HydroCAD Analysis for the Post-Development Condition
(25-Yr storm)



POST-DEVELOPMENT
CONDITION

PERMIT ISSUE
NOT FOR CONSTRUCTION

Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-6 Runoff Area=0.570 ac Runoff Depth>3.89"
Tc=5.0 min CN=79 Runoff=4.18 cfs 0.185 af

Subcatchment 2S: DA-5 Runoff Area=0.340 ac Runoff Depth>3.89"
Tc=5.0 min CN=79 Runoff=2.50 cfs 0.110 af

Subcatchment 3S: DA - 2C Runoff Area=0.370 ac Runoff Depth>4.20"
Tc=5.0 min CN=82 Runoff=2.89 cfs 0.130 af

Subcatchment 4S: DA-1B Runoff Area=2.700 ac Runoff Depth>3.99"
Tc=5.0 min CN=80 Runoff=20.25 cfs 0.898 af

Subcatchment 5S: DA-7 Runoff Area=1.000 ac Runoff Depth>3.09"
Tc=5.0 min CN=71 Runoff=6.01 cfs 0.257 af

Subcatchment 6S: DA - 2B Runoff Area=0.440 ac Runoff Depth>3.89"
Tc=5.0 min CN=79 Runoff=3.23 cfs 0.143 af

Subcatchment 8S: DA - 2A Runoff Area=1.320 ac Runoff Depth>4.09"
Tc=5.0 min CN=81 Runoff=10.10 cfs 0.450 af

Subcatchment 9S: DA-1A Runoff Area=0.770 ac Runoff Depth>3.48"
Tc=5.0 min CN=75 Runoff=5.15 cfs 0.223 af

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland a Runoff Area=2.800 ac Runoff Depth>2.89"
Flow Length=190' Tc=7.1 min CN=69 Runoff=14.88 cfs 0.675 af

Subcatchment 14S: DA-4 Runoff Area=1.090 ac Runoff Depth>3.28"
Tc=5.0 min CN=73 Runoff=6.93 cfs 0.298 af

Reach 3R: 18" RCP Pipe Peak Depth=1.50' Max Vel=3.7 fps Inflow=12.87 cfs 0.555 af
D=18.0" n=0.013 L=950.0' S=0.0032 '/' Capacity=5.90 cfs Outflow=5.90 cfs 0.552 af

Reach 4R: Water Quality Swale DC - 2B Peak Depth=0.76' Max Vel=2.4 fps Inflow=2.89 cfs 0.130 af
n=0.030 L=310.0' S=0.0097 '/' Capacity=16.80 cfs Outflow=2.62 cfs 0.129 af

Reach 5R: Warter Quality Swale DC-2A Peak Depth=0.68' Max Vel=3.5 fps Inflow=10.10 cfs 0.450 af
n=0.030 L=400.0' S=0.0150 '/' Capacity=102.94 cfs Outflow=9.23 cfs 0.449 af

Reach 6R: 18" Culvert Peak Depth=0.80' Max Vel=5.0 fps Inflow=4.86 cfs 0.223 af
D=18.0" n=0.013 L=220.0' S=0.0068 '/' Capacity=8.67 cfs Outflow=4.68 cfs 0.223 af

Reach 7R: Channel DC-1A Peak Depth=0.78' Max Vel=2.7 fps Inflow=5.15 cfs 0.223 af
n=0.030 L=170.0' S=0.0118 '/' Capacity=28.90 cfs Outflow=4.86 cfs 0.223 af

Reach 8R: 18" RCP Pipe Peak Depth=0.79' Max Vel=6.4 fps Inflow=6.01 cfs 0.257 af
D=18.0" n=0.013 L=45.0' S=0.0111 '/' Capacity=11.07 cfs Outflow=5.95 cfs 0.257 af

Pond 1P: Wet Detention Basin Peak Elev=211.82' Storage=27,505 cf Inflow=24.31 cfs 1.121 af
Primary=4.15 cfs 0.563 af Secondary=0.00 cfs 0.000 af Outflow=4.15 cfs 0.563 af

Pond 2P: Permanent Sediment Basin Peak Elev=209.87' Storage=11,912 cf Inflow=14.58 cfs 0.721 af
Primary=0.20 cfs 0.152 af Secondary=11.53 cfs 0.357 af Outflow=11.74 cfs 0.509 af

Pond ST-1: Temp. Sed. Trap-1 Peak Elev=202.45' Storage=1,197 cf Inflow=4.18 cfs 0.185 af
Primary=3.66 cfs 0.183 af Secondary=0.00 cfs 0.000 af Outflow=3.66 cfs 0.183 af

Pond ST-2: Temp. Sed. Trap-2 Peak Elev=201.15' Storage=551 cf Inflow=2.50 cfs 0.110 af
Primary=2.32 cfs 0.110 af Secondary=0.00 cfs 0.000 af Outflow=2.32 cfs 0.110 af

Total Runoff Area = 11.400 ac Runoff Volume = 3.368 af Average Runoff Depth = 3.55"

Subcatchment 1S: DA-6

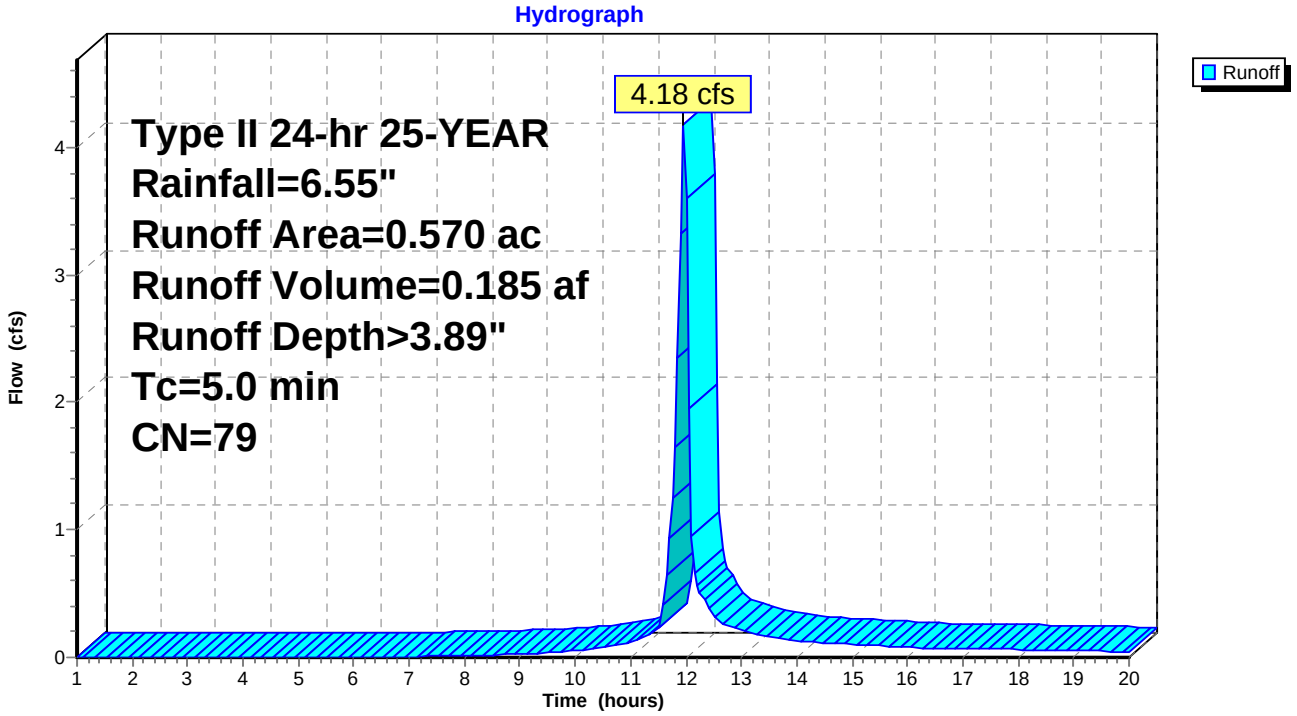
Runoff = 4.18 cfs @ 11.95 hrs, Volume= 0.185 af, Depth> 3.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YEAR Rainfall=6.55"

Area (ac)	CN	Description
0.570	79	<50% Grass cover, Poor, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: DA-6



Subcatchment 2S: DA-5

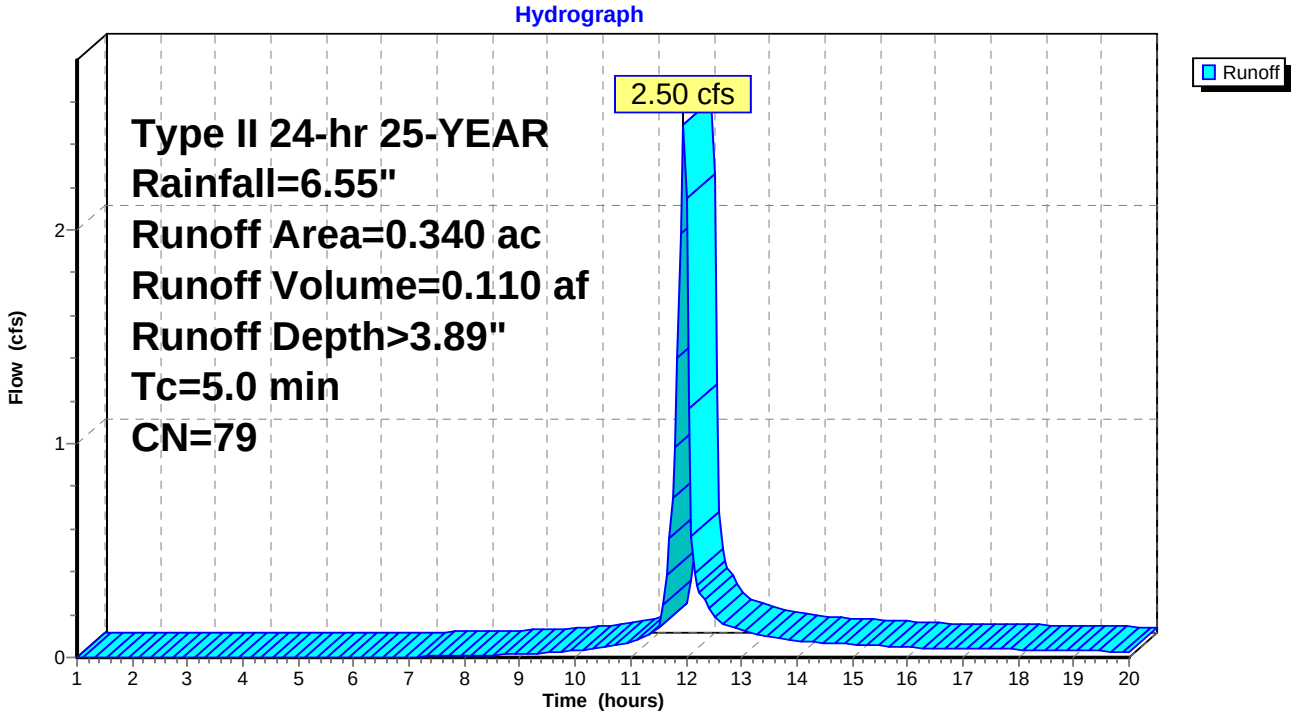
Runoff = 2.50 cfs @ 11.95 hrs, Volume= 0.110 af, Depth> 3.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YEAR Rainfall=6.55"

Area (ac)	CN	Description
0.340	79	<50% Grass cover, Poor, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: DA-5



Subcatchment 3S: DA - 2C

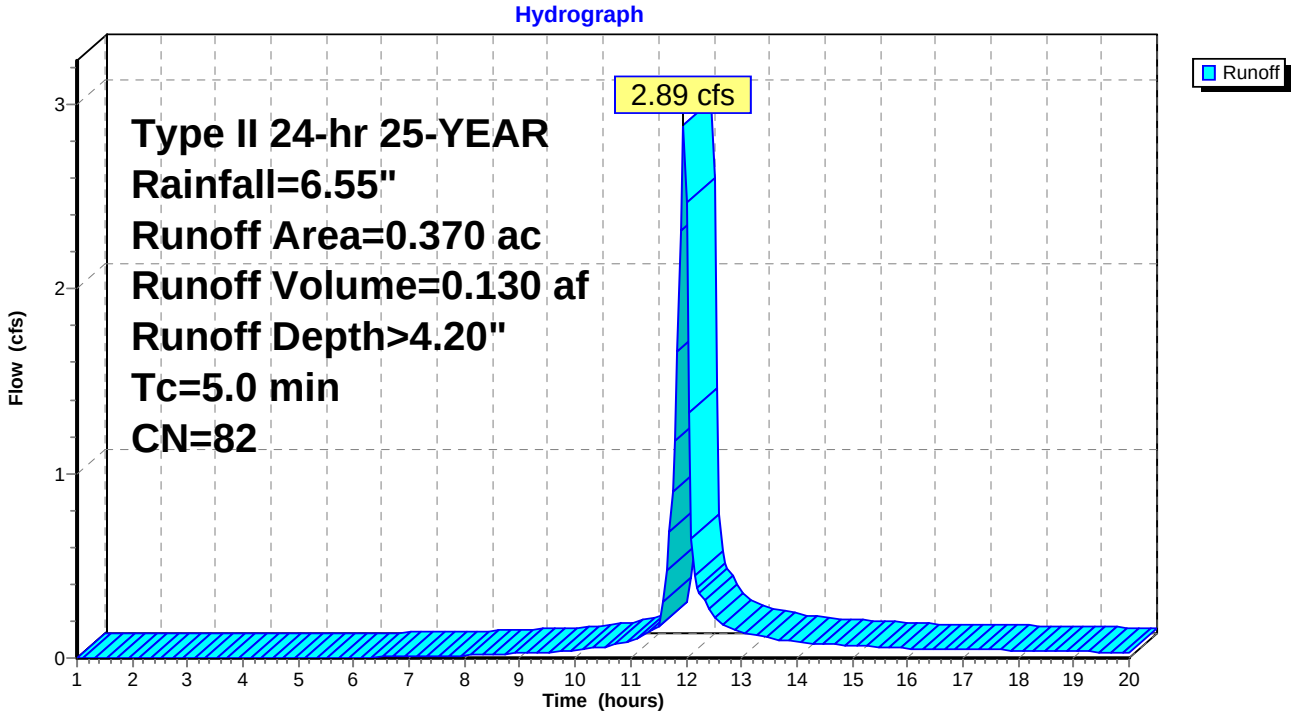
Runoff = 2.89 cfs @ 11.95 hrs, Volume= 0.130 af, Depth> 4.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YEAR Rainfall=6.55"

Area (ac)	CN	Description
0.240	79	<50% Grass cover, Poor, HSG B
0.110	85	Gravel roads, HSG B
0.020	98	Paved parking & roofs
0.370	82	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: DA - 2C



Subcatchment 4S: DA-1B

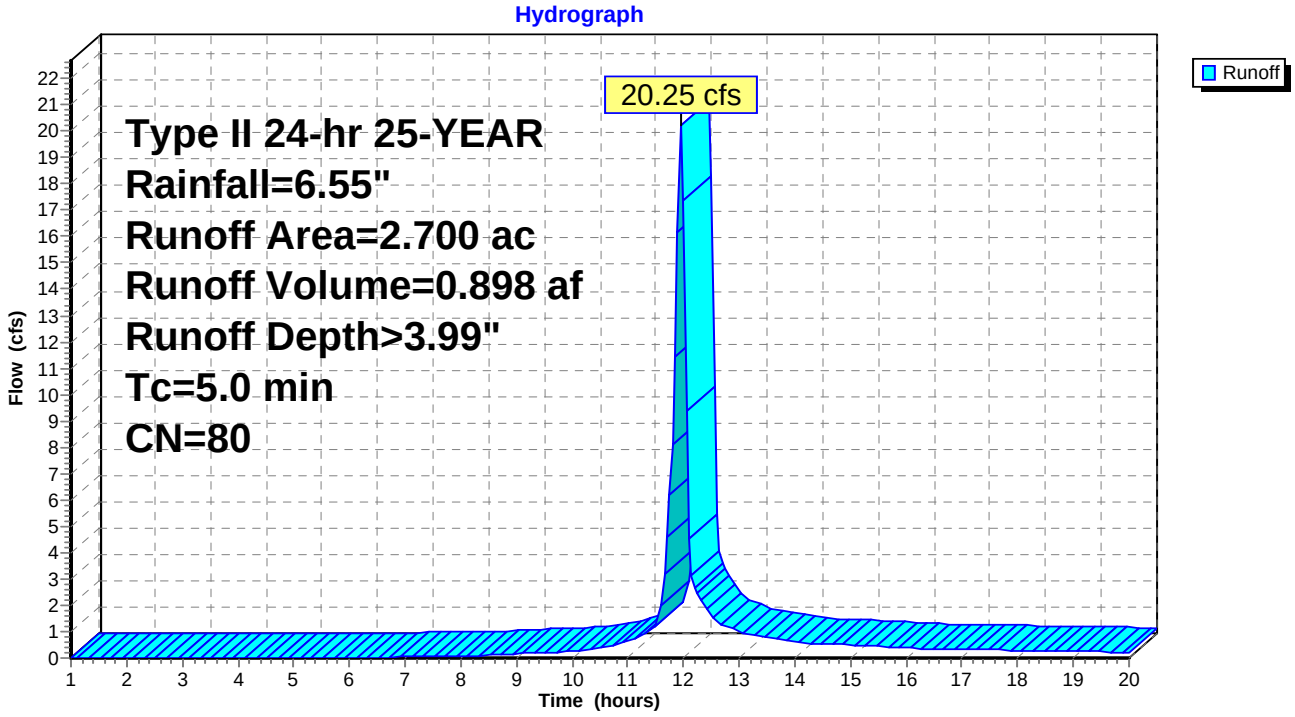
Runoff = 20.25 cfs @ 11.95 hrs, Volume= 0.898 af, Depth> 3.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YEAR Rainfall=6.55"

Area (ac)	CN	Description
1.130	69	50-75% Grass cover, Fair, HSG B
1.120	85	Gravel roads, HSG B
0.450	98	Paved parking & roofs
2.700	80	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 4S: DA-1B



Subcatchment 5S: DA-7

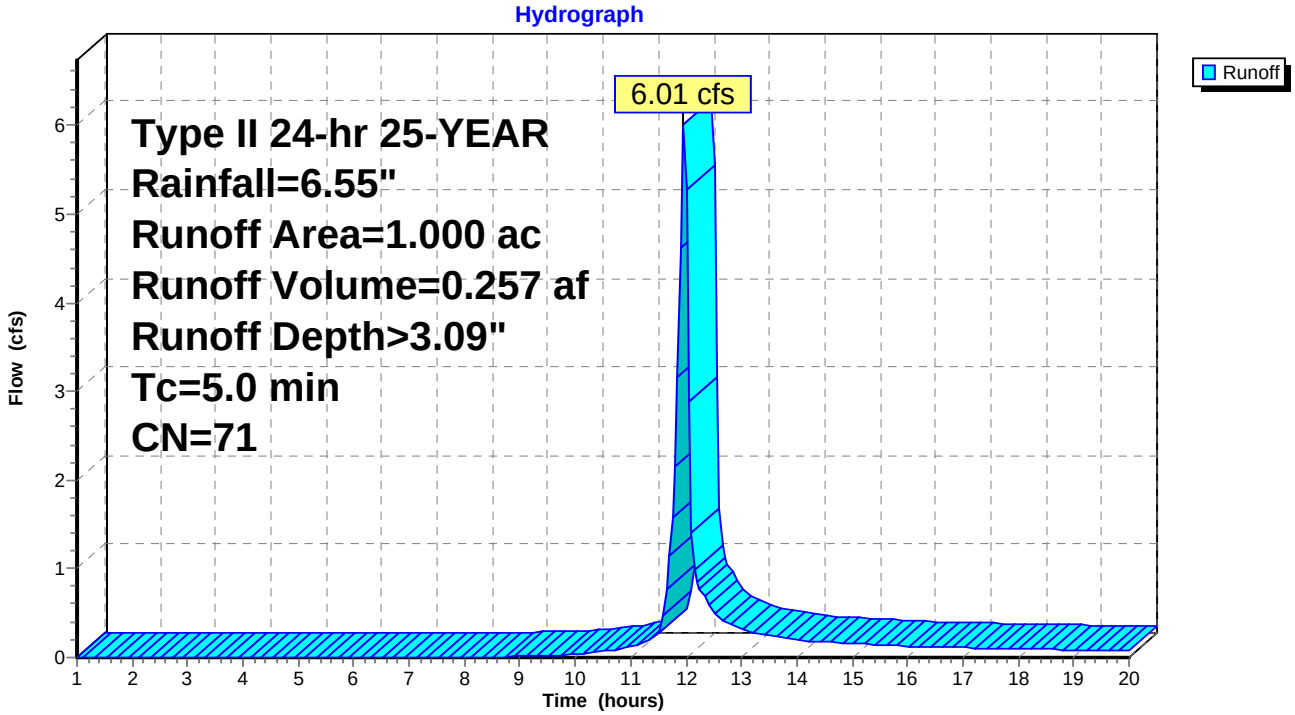
Runoff = 6.01 cfs @ 11.96 hrs, Volume= 0.257 af, Depth> 3.09"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YEAR Rainfall=6.55"

Area (ac)	CN	Description
0.880	69	Pasture/grassland/range, Fair, HSG B
0.120	85	Gravel roads, HSG B
1.000	71	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5S: DA-7



Subcatchment 6S: DA - 2B

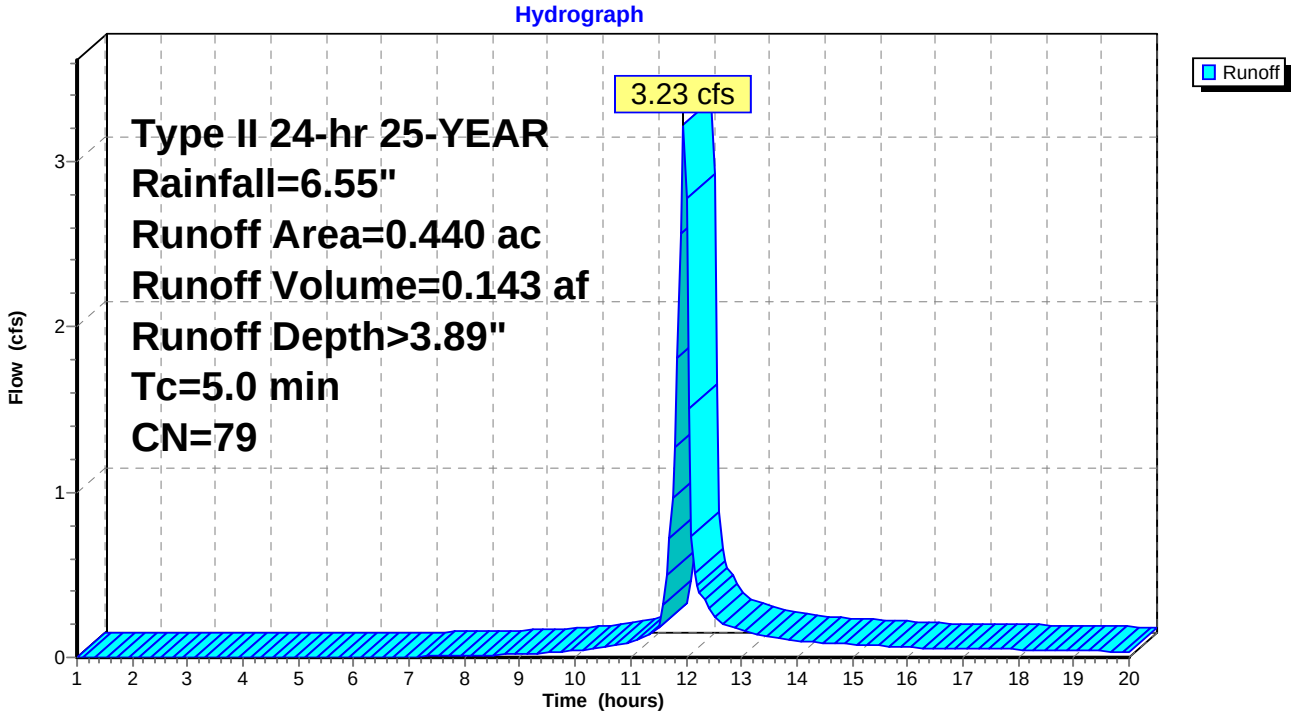
Runoff = 3.23 cfs @ 11.95 hrs, Volume= 0.143 af, Depth> 3.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YEAR Rainfall=6.55"

Area (ac)	CN	Description
0.440	79	<50% Grass cover, Poor, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 6S: DA - 2B



Subcatchment 8S: DA - 2A

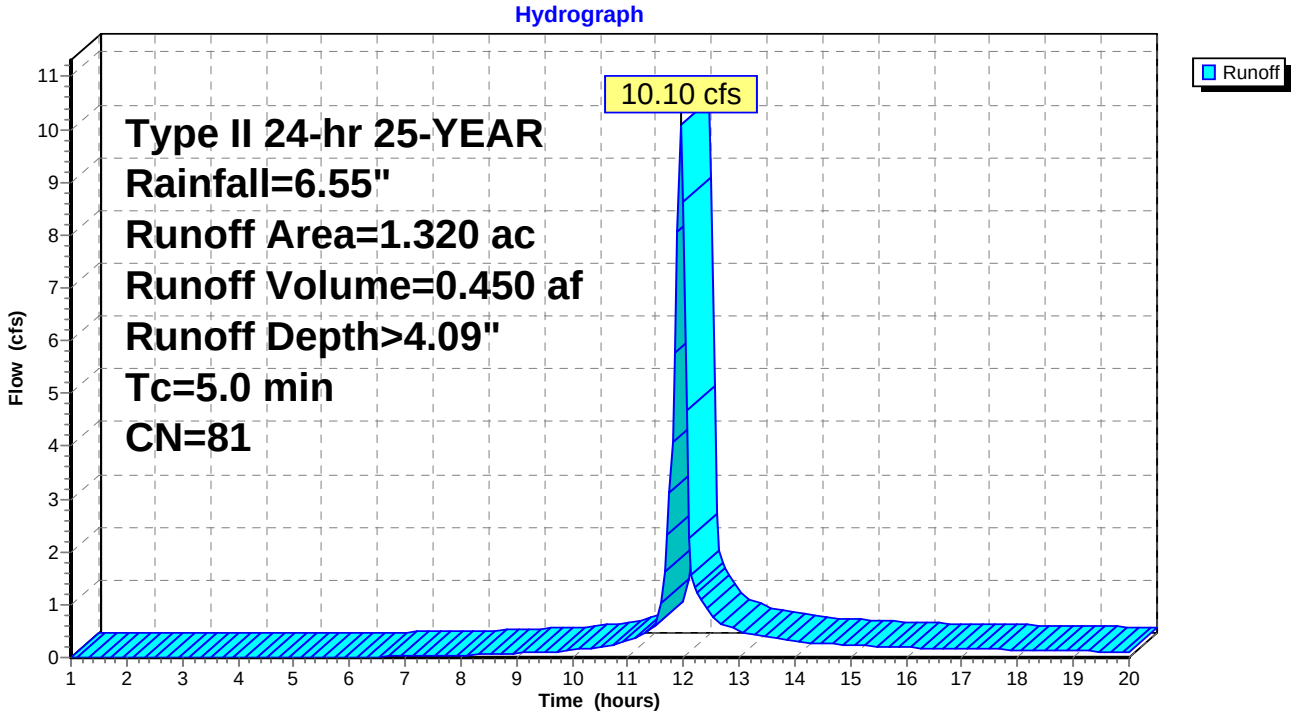
Runoff = 10.10 cfs @ 11.95 hrs, Volume= 0.450 af, Depth> 4.09"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YEAR Rainfall=6.55"

Area (ac)	CN	Description
1.020	79	50-75% Grass cover, Fair, HSG C
0.300	89	Gravel roads, HSG C
1.320	81	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 8S: DA - 2A



Subcatchment 9S: DA-1A

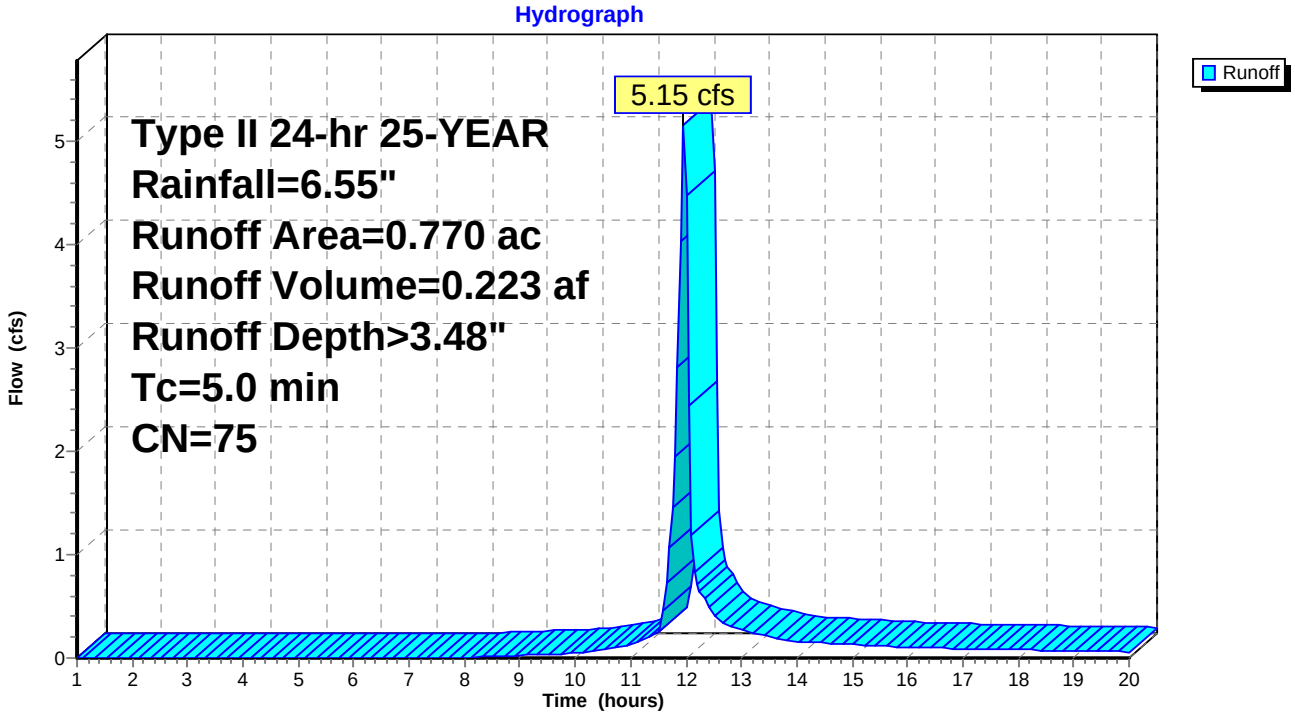
Runoff = 5.15 cfs @ 11.96 hrs, Volume= 0.223 af, Depth> 3.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YEAR Rainfall=6.55"

Area (ac)	CN	Description
0.510	69	50-75% Grass cover, Fair, HSG B
0.240	85	Gravel roads, HSG B
0.020	98	Paved parking & roofs
0.770	75	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9S: DA-1A



Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland at Northern Site)

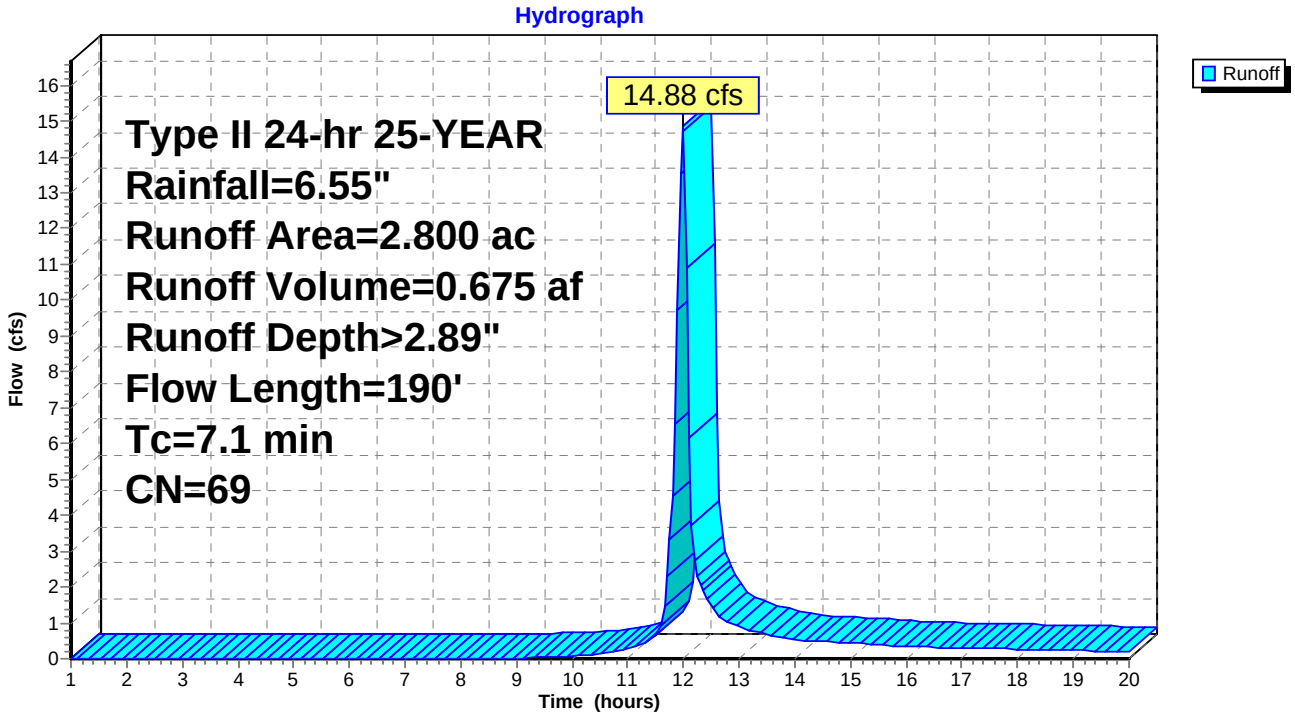
Runoff = 14.88 cfs @ 11.99 hrs, Volume= 0.675 af, Depth> 2.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YEAR Rainfall=6.55"

Area (ac)	CN	Description
2.800	69	Pasture/grassland/range, Fair, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	190	0.1000	0.4		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland at Northern Site)



Subcatchment 14S: DA-4

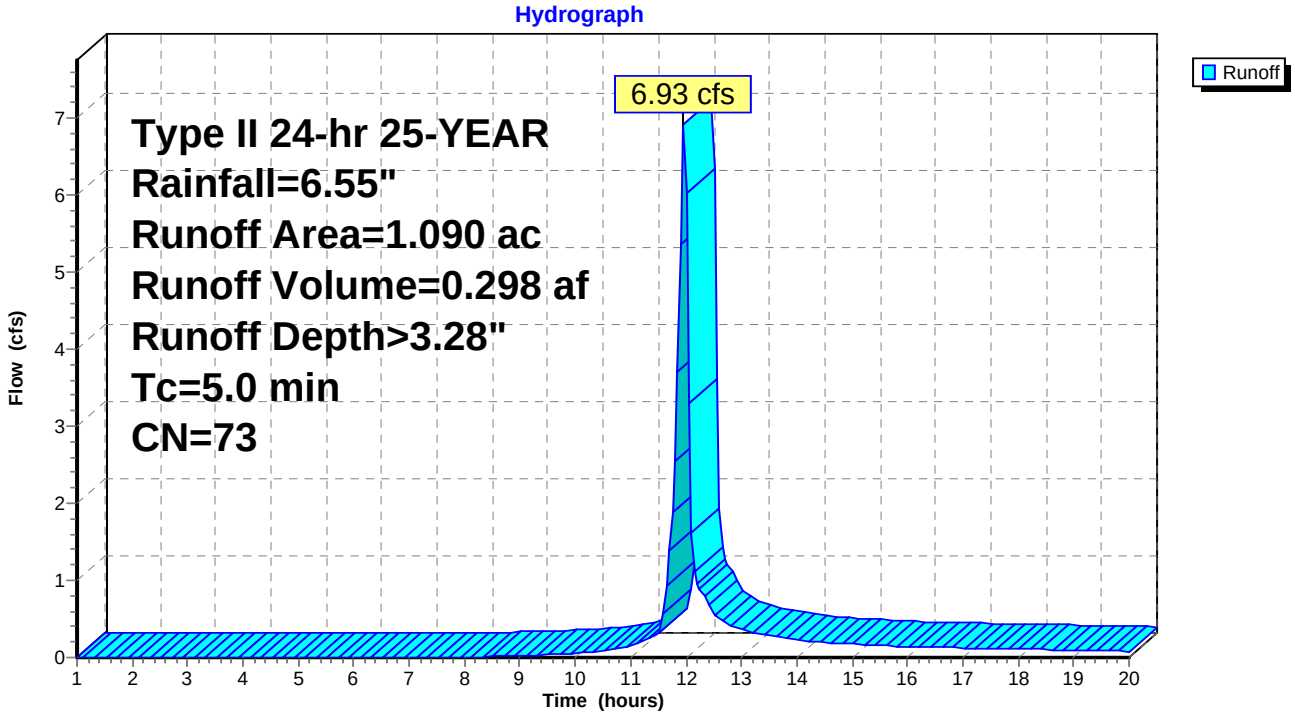
Runoff = 6.93 cfs @ 11.96 hrs, Volume= 0.298 af, Depth> 3.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YEAR Rainfall=6.55"

Area (ac)	CN	Description
0.790	69	Pasture/grassland/range, Fair, HSG B
0.300	85	Gravel roads, HSG B
1.090	73	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 14S: DA-4



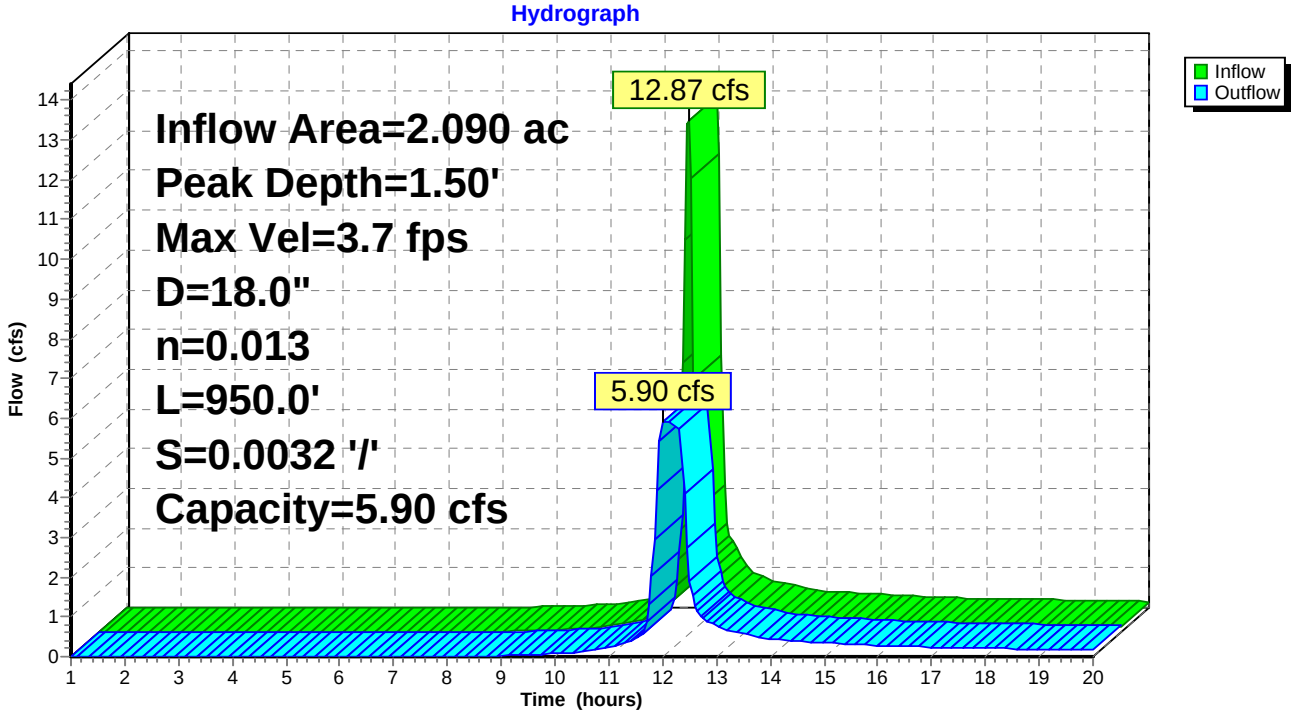
Reach 3R: 18" RCP Pipe

Inflow Area = 2.090 ac, Inflow Depth > 3.19" for 25-YEAR event
Inflow = 12.87 cfs @ 11.96 hrs, Volume= 0.555 af
Outflow = 5.90 cfs @ 12.00 hrs, Volume= 0.552 af, Atten= 54%, Lag= 2.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.7 fps, Min. Travel Time= 4.2 min
Avg. Velocity = 1.7 fps, Avg. Travel Time= 9.5 min

Peak Depth= 1.50' @ 11.90 hrs
Capacity at bank full= 5.90 cfs
Inlet Invert= 207.00', Outlet Invert= 204.00'
18.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 950.0' Slope= 0.0032 '/'

Reach 3R: 18" RCP Pipe



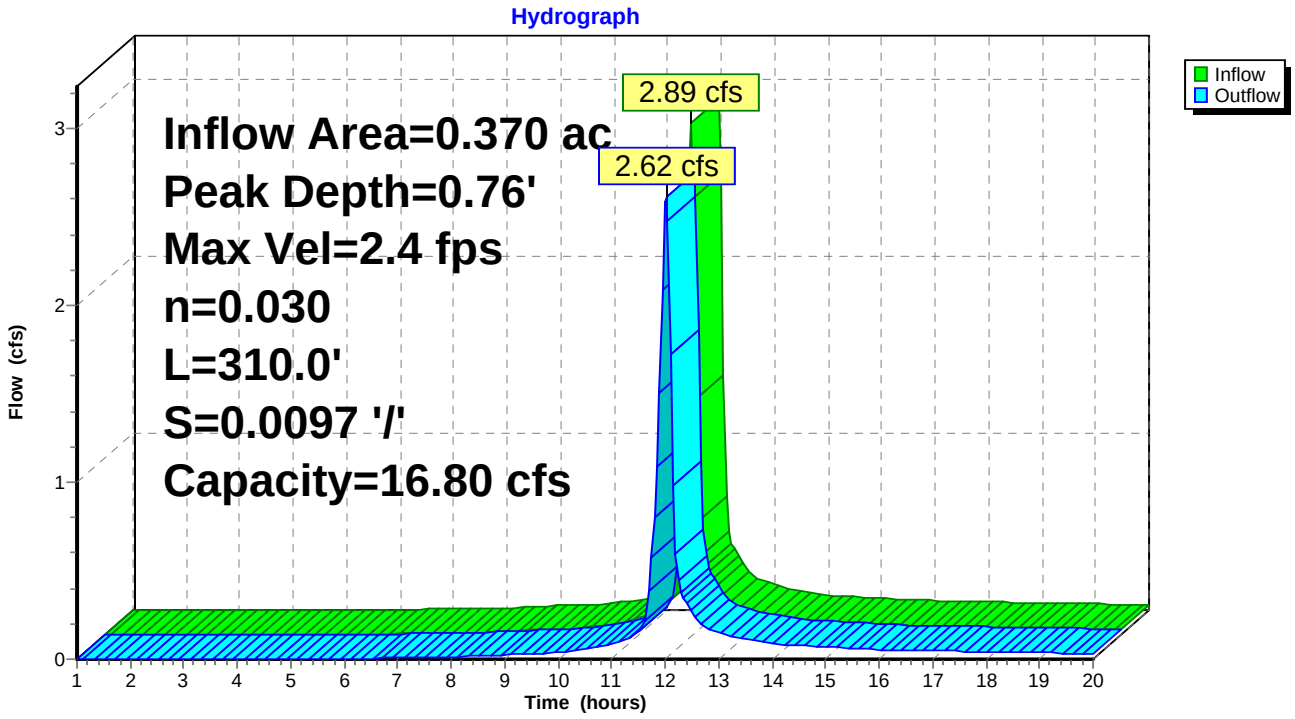
Reach 4R: Water Quality Swale DC - 2B

Inflow Area = 0.370 ac, Inflow Depth > 4.20" for 25-YEAR event
Inflow = 2.89 cfs @ 11.95 hrs, Volume= 0.130 af
Outflow = 2.62 cfs @ 12.02 hrs, Volume= 0.129 af, Atten= 9%, Lag= 3.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.4 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.9 fps, Avg. Travel Time= 6.0 min

Peak Depth= 0.76' @ 11.98 hrs
Capacity at bank full= 16.80 cfs
Inlet Invert= 214.00', Outlet Invert= 211.00'
0.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 310.0' Slope= 0.0097 '/'

Reach 4R: Water Quality Swale DC - 2B



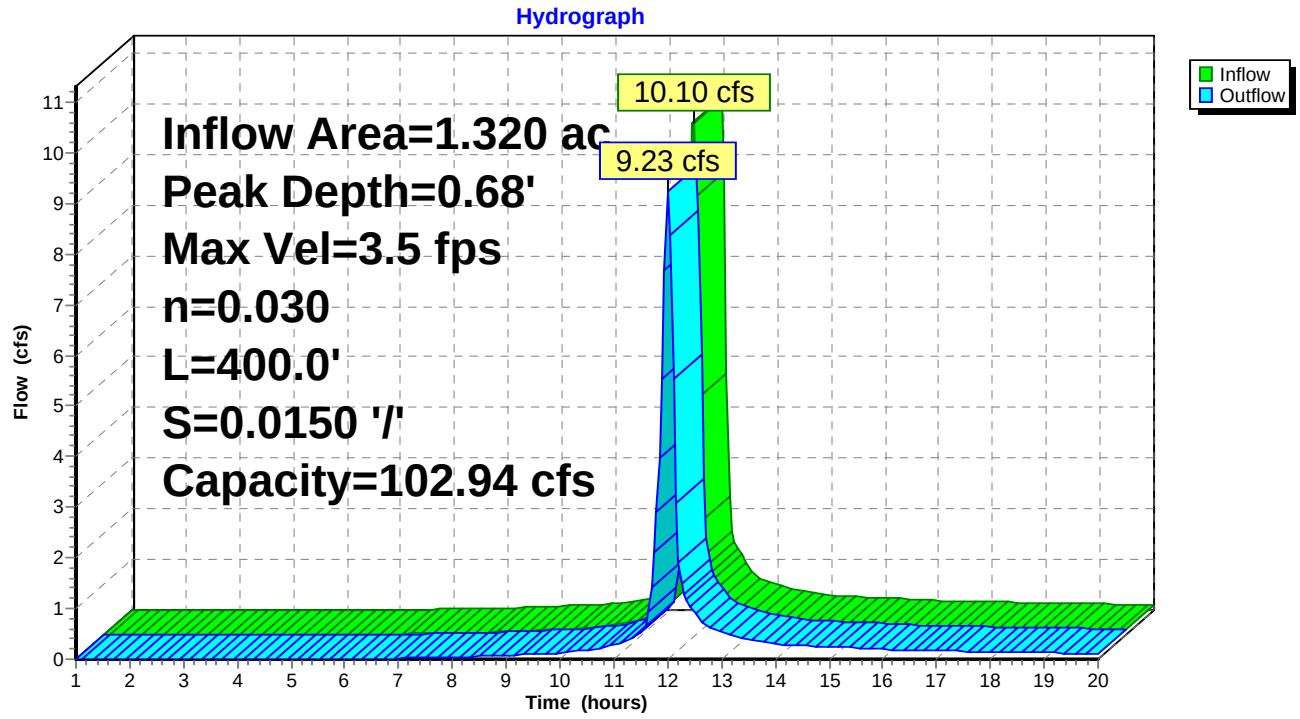
Reach 5R: Warter Quality Swale DC-2A

Inflow Area = 1.320 ac, Inflow Depth > 4.09" for 25-YEAR event
Inflow = 10.10 cfs @ 11.95 hrs, Volume= 0.450 af
Outflow = 9.23 cfs @ 12.01 hrs, Volume= 0.449 af, Atten= 9%, Lag= 3.2 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.5 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 1.0 fps, Avg. Travel Time= 6.4 min

Peak Depth= 0.68' @ 11.98 hrs
Capacity at bank full= 102.94 cfs
Inlet Invert= 216.00', Outlet Invert= 210.00'
2.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 400.0' Slope= 0.0150 '/'

Reach 5R: Warter Quality Swale DC-2A



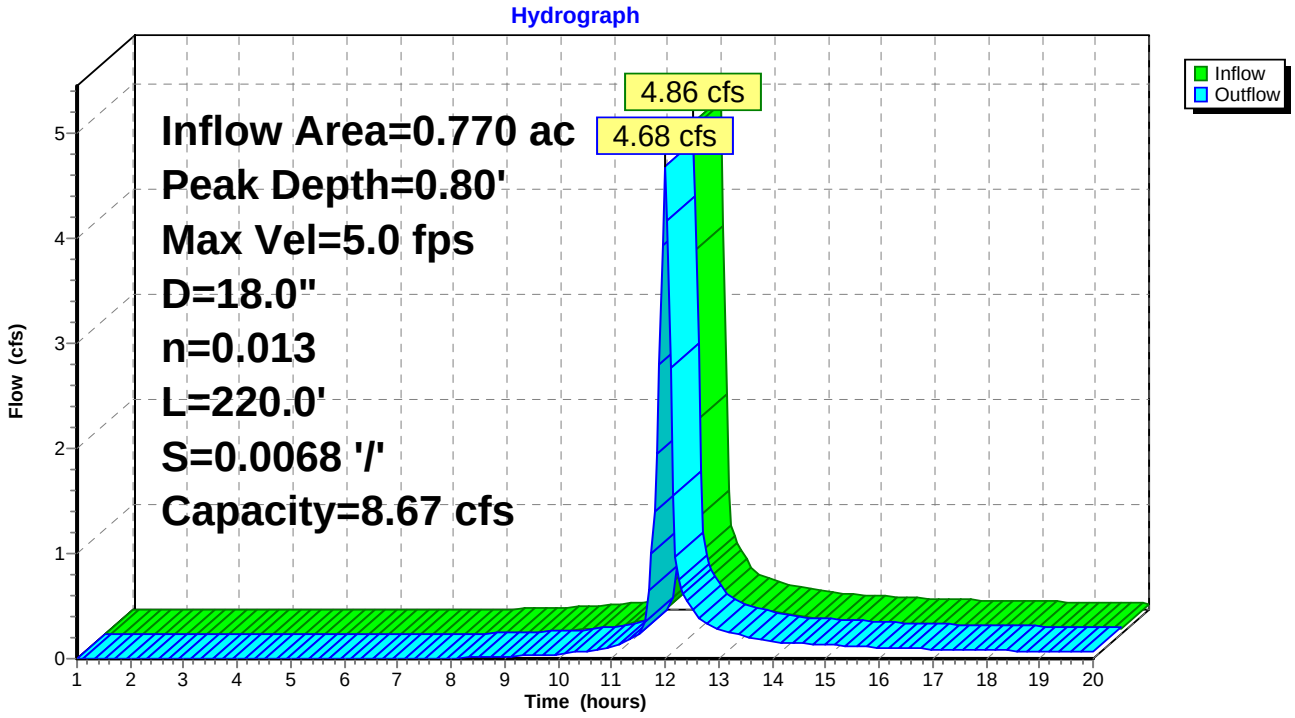
Reach 6R: 18" Culvert

Inflow Area = 0.770 ac, Inflow Depth > 3.47" for 25-YEAR event
Inflow = 4.86 cfs @ 11.99 hrs, Volume= 0.223 af
Outflow = 4.68 cfs @ 12.00 hrs, Volume= 0.223 af, Atten= 4%, Lag= 1.1 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.0 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.7 fps, Avg. Travel Time= 2.2 min

Peak Depth= 0.80' @ 12.00 hrs
Capacity at bank full= 8.67 cfs
Inlet Invert= 209.50', Outlet Invert= 208.00'
18.0" Diameter Pipe, n= 0.013 Corrugated PE, smooth interior
Length= 220.0' Slope= 0.0068 '/'

Reach 6R: 18" Culvert



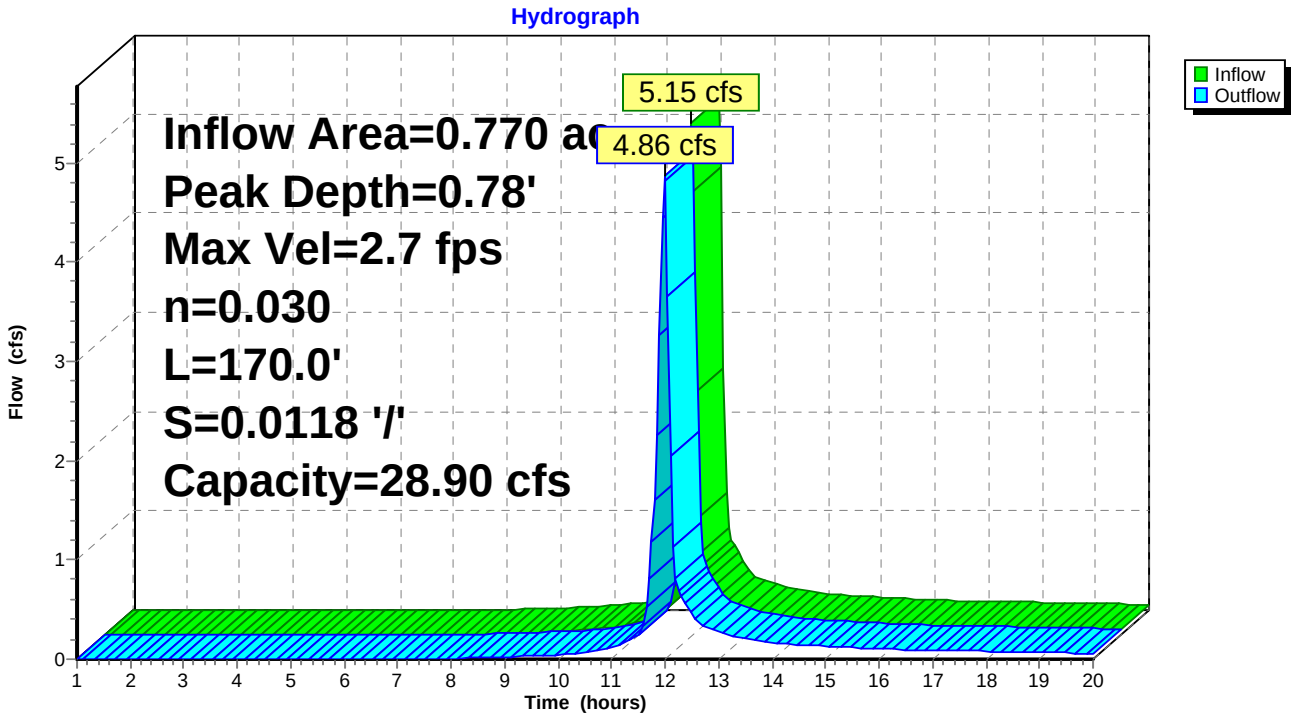
Reach 7R: Channel DC-1A

Inflow Area = 0.770 ac, Inflow Depth > 3.48" for 25-YEAR event
Inflow = 5.15 cfs @ 11.96 hrs, Volume= 0.223 af
Outflow = 4.86 cfs @ 11.99 hrs, Volume= 0.223 af, Atten= 6%, Lag= 1.8 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.7 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.0 fps, Avg. Travel Time= 2.7 min

Peak Depth= 0.78' @ 11.97 hrs
Capacity at bank full= 28.90 cfs
Inlet Invert= 213.00', Outlet Invert= 211.00'
0.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 170.0' Slope= 0.0118 '/'

Reach 7R: Channel DC-1A



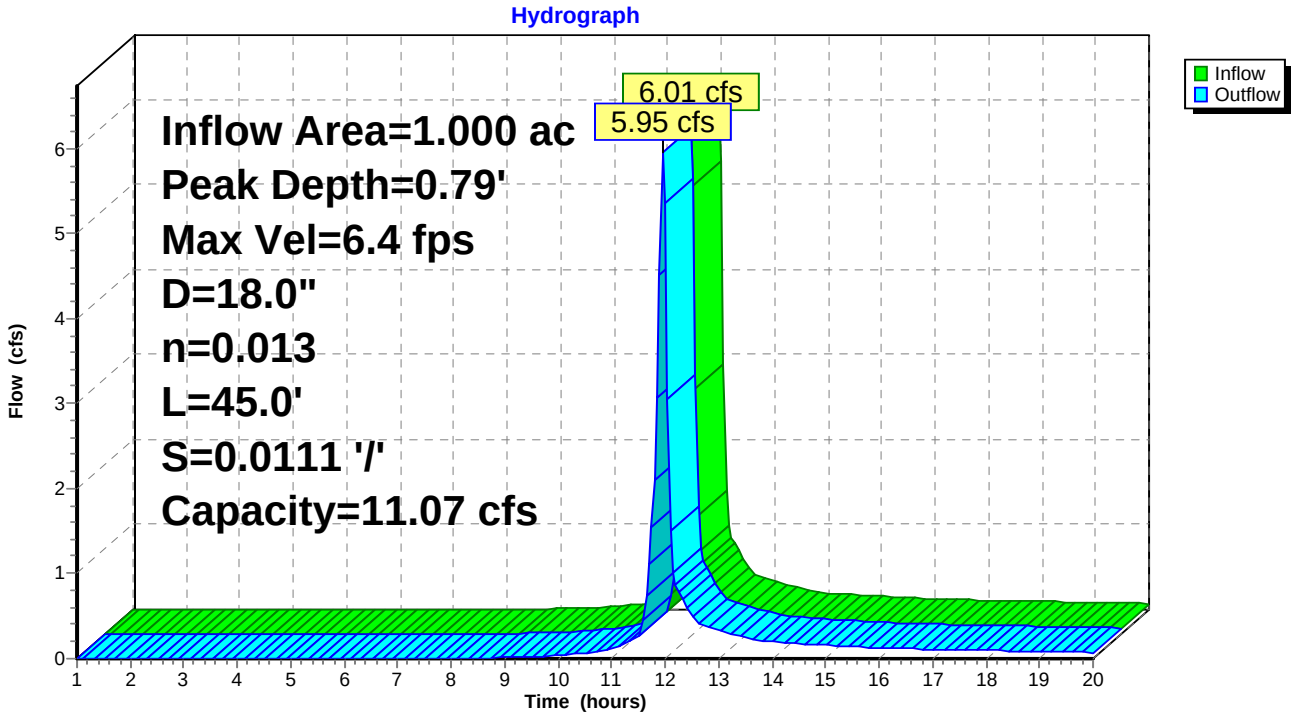
Reach 8R: 18" RCP Pipe

Inflow Area = 1.000 ac, Inflow Depth > 3.09" for 25-YEAR event
Inflow = 6.01 cfs @ 11.96 hrs, Volume= 0.257 af
Outflow = 5.95 cfs @ 11.96 hrs, Volume= 0.257 af, Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.4 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.1 fps, Avg. Travel Time= 0.3 min

Peak Depth= 0.79' @ 11.96 hrs
Capacity at bank full= 11.07 cfs
Inlet Invert= 215.50', Outlet Invert= 215.00'
18.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 45.0' Slope= 0.0111 '/'

Reach 8R: 18" RCP Pipe



Pond 1P: Wet Detention Basin

Inflow Area = 3.470 ac, Inflow Depth > 3.88" for 25-YEAR event
Inflow = 24.31 cfs @ 11.96 hrs, Volume= 1.121 af
Outflow = 4.15 cfs @ 12.18 hrs, Volume= 0.563 af, Atten= 83%, Lag= 13.1 min
Primary = 4.15 cfs @ 12.18 hrs, Volume= 0.563 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 211.82' @ 12.18 hrs Surf.Area= 10,318 sf Storage= 27,505 cf
Plug-Flow detention time= 170.1 min calculated for 0.563 af (50% of inflow)
Center-of-Mass det. time= 91.7 min (863.6 - 771.9)

Volume	Invert	Avail.Storage	Storage Description
#1	207.00'	40,711 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

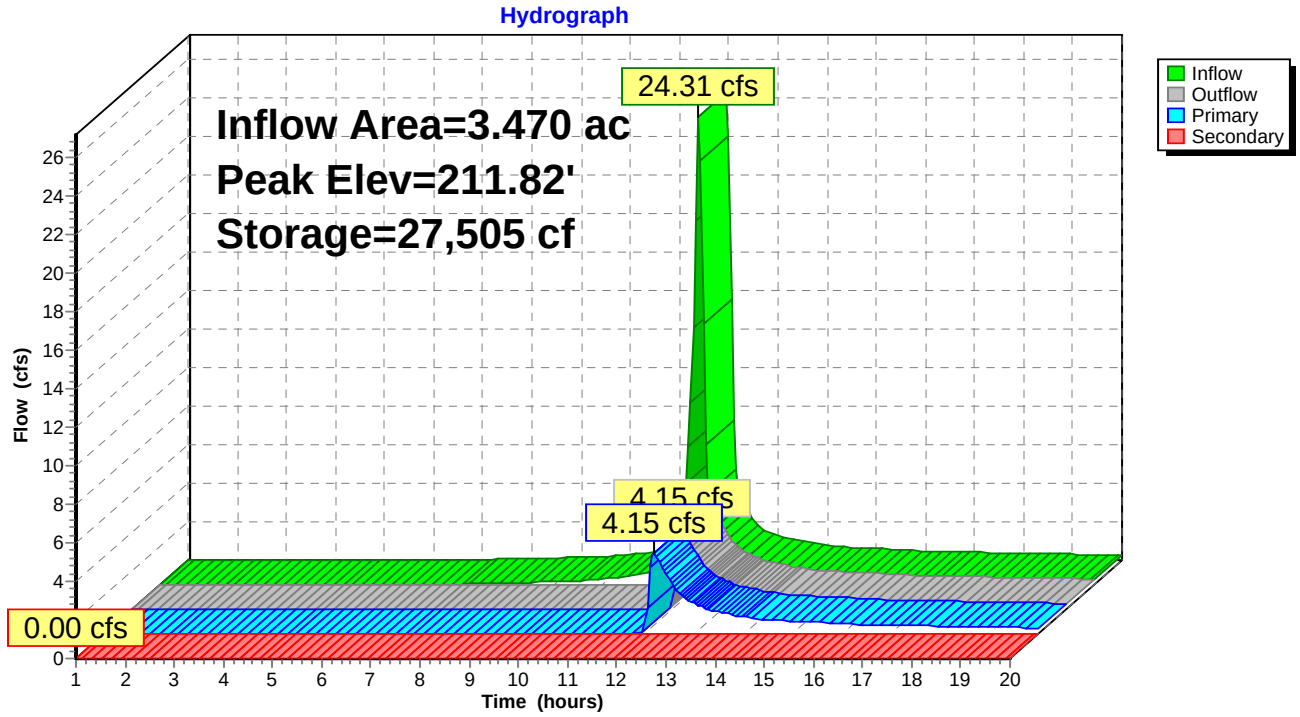
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
207.00	1,898	0	0
208.00	3,673	2,786	2,786
210.50	6,966	13,299	16,084
212.00	10,770	13,302	29,386
213.00	11,880	11,325	40,711

Device	Routing	Invert	Outlet Devices
#1	Primary	207.00'	**18.0" x 80.0' long Barrel** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 202.00' S= 0.0625 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections
#2	Device 1	210.80'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	211.50'	**24.0" Horiz. Riser** Limited to weir flow C= 0.600
#4	Secondary	212.00'	**20.0' long x 10.0' breadth Emergency Spillway** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=4.11 cfs @ 12.18 hrs HW=211.82' (Free Discharge)
└**1=Barrel** (Passes 4.11 cfs of 17.17 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.39 cfs @ 4.4 fps)
  └**3=Riser** (Weir Controls 3.72 cfs @ 1.9 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=207.00' (Free Discharge)
└**4=Emergency Spillway** (Controls 0.00 cfs)

Pond 1P: Wet Detention Basin



Pond 2P: Permanent Sediment Basin

Inflow Area = 2.130 ac, Inflow Depth > 4.06" for 25-YEAR event
Inflow = 14.58 cfs @ 12.00 hrs, Volume= 0.721 af
Outflow = 11.74 cfs @ 12.07 hrs, Volume= 0.509 af, Atten= 19%, Lag= 4.3 min
Primary = 0.20 cfs @ 12.07 hrs, Volume= 0.152 af
Secondary = 11.53 cfs @ 12.07 hrs, Volume= 0.357 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 209.87' @ 12.07 hrs Surf.Area= 4,968 sf Storage= 11,912 cf
Plug-Flow detention time= 106.2 min calculated for 0.508 af (70% of inflow)
Center-of-Mass det. time= 41.5 min (812.8 - 771.3)

Volume	Invert	Avail.Storage	Storage Description
#1	206.00'	12,556 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

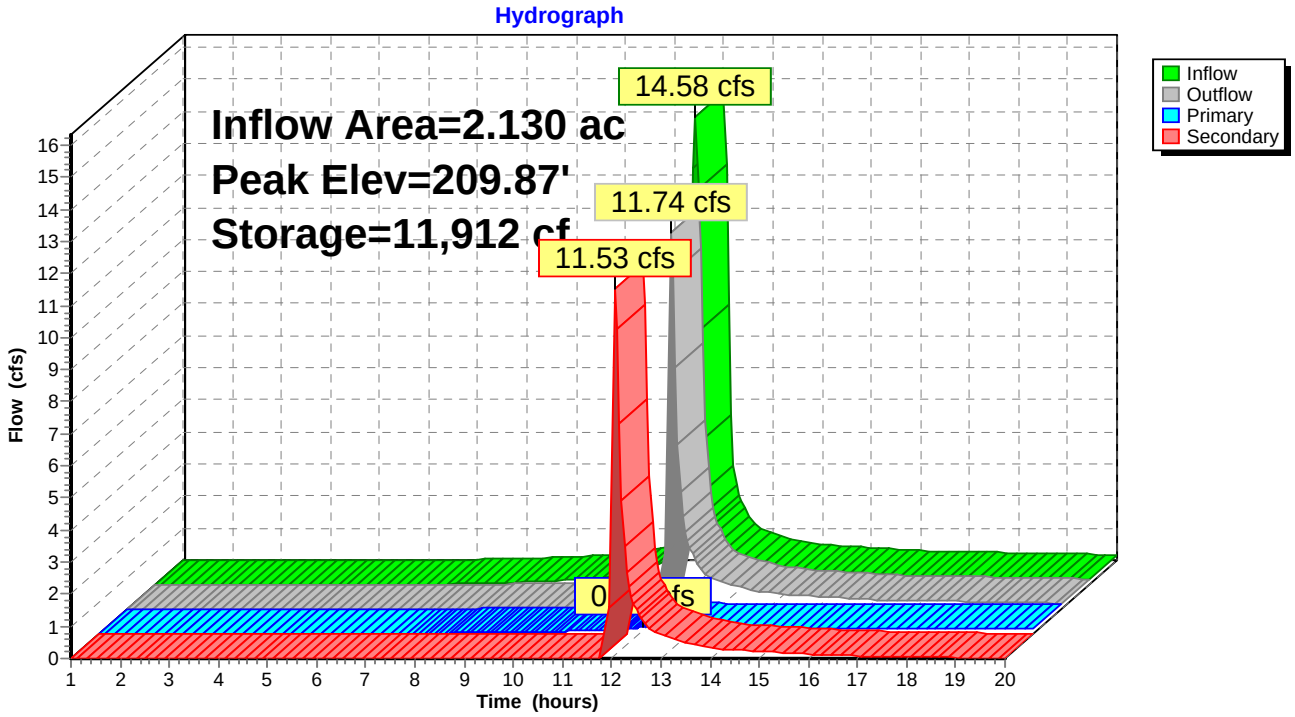
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
206.00	1,185	0	0
210.00	5,093	12,556	12,556

Device	Routing	Invert	Outlet Devices
#1	Primary	206.00'	**4.0" x 40.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 205.00' S= 0.0250 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior
#2	Secondary	209.30'	**10.0' long x 10.0' breadth Emergency Spillway** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#3	Device 1	206.00'	**2.0" Vert. Faircloth Skimmer** C= 0.600

Primary OutFlow Max=0.20 cfs @ 12.07 hrs HW=209.85' (Free Discharge)
↑—**1=Culvert** (Passes 0.20 cfs of 0.39 cfs potential flow)
↑—**3=Faircloth Skimmer** (Orifice Controls 0.20 cfs @ 9.3 fps)

Secondary OutFlow Max=10.87 cfs @ 12.07 hrs HW=209.85' (Free Discharge)
↑—**2=Emergency Spillway** (Weir Controls 10.87 cfs @ 2.0 fps)

Pond 2P: Permanent Sediment Basin



Pond ST-1: Temp. Sed. Trap-1

Inflow Area = 0.570 ac, Inflow Depth > 3.89" for 25-YEAR event
Inflow = 4.18 cfs @ 11.95 hrs, Volume= 0.185 af
Outflow = 3.66 cfs @ 12.00 hrs, Volume= 0.183 af, Atten= 13%, Lag= 2.5 min
Primary = 3.66 cfs @ 12.00 hrs, Volume= 0.183 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 202.45' @ 12.00 hrs Surf.Area= 751 sf Storage= 1,197 cf
Plug-Flow detention time= 12.6 min calculated for 0.183 af (99% of inflow)
Center-of-Mass det. time= 10.0 min (781.3 - 771.2)

Volume	Invert	Avail.Storage	Storage Description
#1	201.00'	2,881 cf	**Custom Stage Data (Prismatic)** Listed below

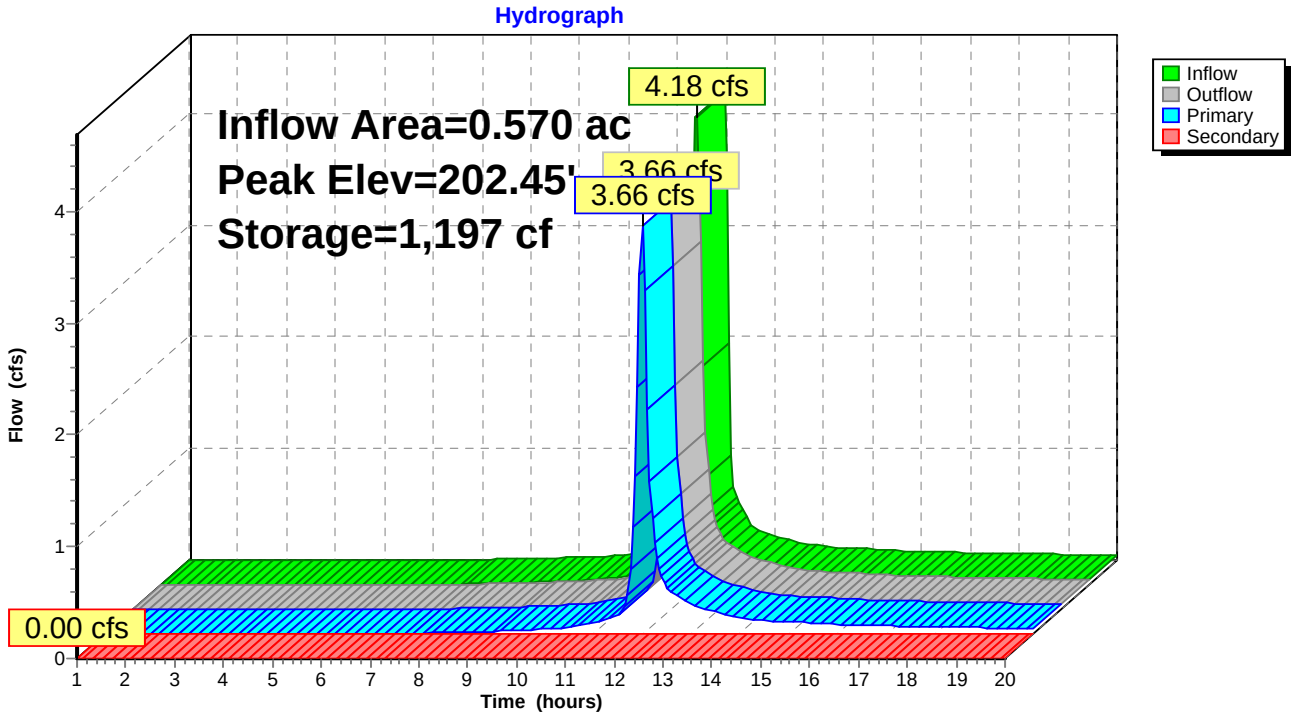
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
201.00	396	0	0
204.50	1,250	2,881	2,881

Device	Routing	Invert	Outlet Devices
#1	Primary	201.00'	**Rock Dam** Head (feet) 0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 Disch. (cfs) 0.000 0.390 1.640 3.860 7.140 11.610 17.360 24.500
#2	Secondary	204.50'	**143.0 deg x 10.0' long Sharp-Crested Vee/Trap Weir** C= 2.47

Primary OutFlow Max=3.63 cfs @ 12.00 hrs HW=202.45' (Free Discharge)
└**1=Rock Dam** (Custom Controls 3.63 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=201.00' (Free Discharge)
└**2=Sharp-Crested Vee/Trap Weir** (Controls 0.00 cfs)

Pond ST-1: Temp. Sed. Trap-1



Pond ST-2: Temp. Sed. Trap-2

Inflow Area = 0.340 ac, Inflow Depth > 3.89" for 25-YEAR event
Inflow = 2.50 cfs @ 11.95 hrs, Volume= 0.110 af
Outflow = 2.32 cfs @ 11.99 hrs, Volume= 0.110 af, Atten= 7%, Lag= 2.0 min
Primary = 2.32 cfs @ 11.99 hrs, Volume= 0.110 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 201.15' @ 11.99 hrs Surf.Area= 368 sf Storage= 551 cf
Plug-Flow detention time= 8.0 min calculated for 0.110 af (100% of inflow)
Center-of-Mass det. time= 6.5 min (777.8 - 771.2)

Volume	Invert	Avail.Storage	Storage Description
#1	200.00'	1,673 cf	**Custom Stage Data (Prismatic)** Listed below

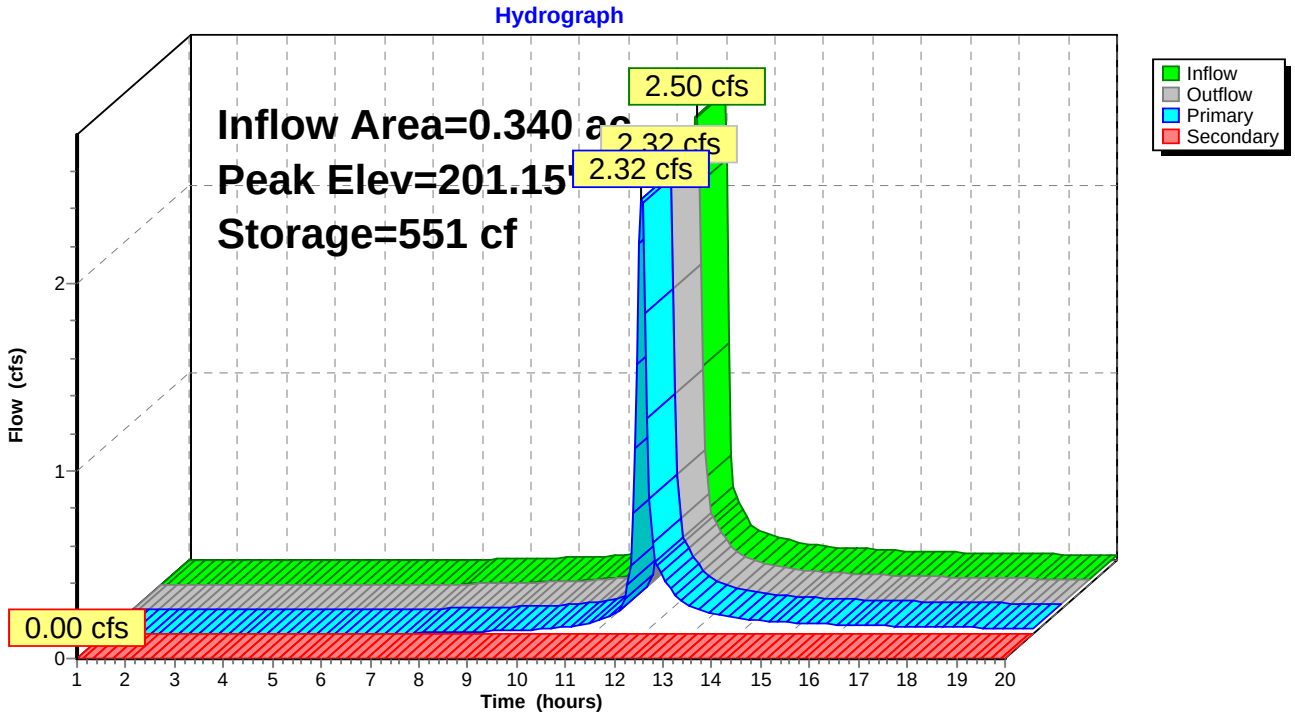
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
200.00	156	0	0
203.50	800	1,673	1,673

Device	Routing	Invert	Outlet Devices
#1	Primary	200.00'	**Rock Dam** Head (feet) 0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 Disch. (cfs) 0.000 0.390 1.640 3.860 7.140 11.610 17.360 24.500
#2	Secondary	203.50'	**143.0 deg x 10.0' long Sharp-Crested Vee/Trap Weir** C= 2.47

Primary OutFlow Max=2.25 cfs @ 11.99 hrs HW=201.14' (Free Discharge)
└**1=Rock Dam** (Custom Controls 2.25 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=200.00' (Free Discharge)
└**2=Sharp-Crested Vee/Trap Weir** (Controls 0.00 cfs)

Pond ST-2: Temp. Sed. Trap-2



HydroCAD Analysis for Post-Development Condition
(10-Year Storm Event)

Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-6 Runoff Area=0.570 ac Runoff Depth>2.99"
Tc=5.0 min CN=79 Runoff=3.27 cfs 0.142 af

Subcatchment 2S: DA-5 Runoff Area=0.340 ac Runoff Depth>2.99"
Tc=5.0 min CN=79 Runoff=1.95 cfs 0.085 af

Subcatchment 3S: DA - 2C Runoff Area=0.370 ac Runoff Depth>3.28"
Tc=5.0 min CN=82 Runoff=2.29 cfs 0.101 af

Subcatchment 4S: DA-1B Runoff Area=2.700 ac Runoff Depth>3.09"
Tc=5.0 min CN=80 Runoff=15.90 cfs 0.695 af

Subcatchment 5S: DA-7 Runoff Area=1.000 ac Runoff Depth>2.29"
Tc=5.0 min CN=71 Runoff=4.50 cfs 0.191 af

Subcatchment 6S: DA - 2B Runoff Area=0.440 ac Runoff Depth>2.99"
Tc=5.0 min CN=79 Runoff=2.52 cfs 0.110 af

Subcatchment 8S: DA - 2A Runoff Area=1.320 ac Runoff Depth>3.18"
Tc=5.0 min CN=81 Runoff=7.97 cfs 0.350 af

Subcatchment 9S: DA-1A Runoff Area=0.770 ac Runoff Depth>2.63"
Tc=5.0 min CN=75 Runoff=3.94 cfs 0.169 af

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland a Runoff Area=2.800 ac Runoff Depth>2.12"
Flow Length=190' Tc=7.1 min CN=69 Runoff=10.98 cfs 0.494 af

Subcatchment 14S: DA-4 Runoff Area=1.090 ac Runoff Depth>2.46"
Tc=5.0 min CN=73 Runoff=5.24 cfs 0.223 af

Reach 3R: 18" RCP Pipe Peak Depth=1.50' Max Vel=3.8 fps Inflow=9.68 cfs 0.414 af
D=18.0" n=0.013 L=950.0' S=0.0032 '/' Capacity=5.90 cfs Outflow=5.90 cfs 0.411 af

Reach 4R: Water Quality Swale DC - 2B Peak Depth=0.69' Max Vel=2.2 fps Inflow=2.29 cfs 0.101 af
n=0.030 L=310.0' S=0.0097 '/' Capacity=16.80 cfs Outflow=2.07 cfs 0.101 af

Reach 5R: Warter Quality Swale DC-2A Peak Depth=0.61' Max Vel=3.3 fps Inflow=7.97 cfs 0.350 af
n=0.030 L=400.0' S=0.0150 '/' Capacity=102.94 cfs Outflow=7.25 cfs 0.349 af

Reach 6R: 18" Culvert Peak Depth=0.68' Max Vel=4.7 fps Inflow=3.71 cfs 0.169 af
D=18.0" n=0.013 L=220.0' S=0.0068 '/' Capacity=8.67 cfs Outflow=3.55 cfs 0.168 af

Reach 7R: Channel DC-1A Peak Depth=0.71' Max Vel=2.6 fps Inflow=3.94 cfs 0.169 af
n=0.030 L=170.0' S=0.0118 '/' Capacity=28.90 cfs Outflow=3.71 cfs 0.169 af

Reach 8R: 18" RCP Pipe Peak Depth=0.66' Max Vel=5.9 fps Inflow=4.50 cfs 0.191 af
D=18.0" n=0.013 L=45.0' S=0.0111 '/' Capacity=11.07 cfs Outflow=4.44 cfs 0.190 af

Pond 1P: Wet Detention Basin Peak Elev=211.59' Storage=25,232 cf Inflow=18.92 cfs 0.863 af
Primary=0.96 cfs 0.312 af Secondary=0.00 cfs 0.000 af Outflow=0.96 cfs 0.312 af

Pond 2P: Permanent Sediment Basin Peak Elev=209.68' Storage=10,956 cf Inflow=11.40 cfs 0.559 af
Primary=0.20 cfs 0.144 af Secondary=5.82 cfs 0.207 af Outflow=6.02 cfs 0.351 af

Pond ST-1: Temp. Sed. Trap-1 Peak Elev=202.26' Storage=1,039 cf Inflow=3.27 cfs 0.142 af
Primary=2.80 cfs 0.141 af Secondary=0.00 cfs 0.000 af Outflow=2.80 cfs 0.141 af

Pond ST-2: Temp. Sed. Trap-2 Peak Elev=201.02' Storage=488 cf Inflow=1.95 cfs 0.085 af
Primary=1.73 cfs 0.085 af Secondary=0.00 cfs 0.000 af Outflow=1.73 cfs 0.085 af

Total Runoff Area = 11.400 ac Runoff Volume = 2.560 af Average Runoff Depth = 2.69"

Subcatchment 1S: DA-6

Runoff = 3.27 cfs @ 11.96 hrs, Volume= 0.142 af, Depth> 2.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
0.570	79	<50% Grass cover, Poor, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: DA-5

Runoff = 1.95 cfs @ 11.96 hrs, Volume= 0.085 af, Depth> 2.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
0.340	79	<50% Grass cover, Poor, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: DA - 2C

Runoff = 2.29 cfs @ 11.95 hrs, Volume= 0.101 af, Depth> 3.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
0.240	79	<50% Grass cover, Poor, HSG B
0.110	85	Gravel roads, HSG B
0.020	98	Paved parking & roofs
0.370	82	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 4S: DA-1B

Runoff = 15.90 cfs @ 11.96 hrs, Volume= 0.695 af, Depth> 3.09"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
1.130	69	50-75% Grass cover, Fair, HSG B
1.120	85	Gravel roads, HSG B
0.450	98	Paved parking & roofs
2.700	80	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5S: DA-7

Runoff = 4.50 cfs @ 11.96 hrs, Volume= 0.191 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
0.880	69	Pasture/grassland/range, Fair, HSG B
0.120	85	Gravel roads, HSG B
1.000	71	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 6S: DA - 2B

Runoff = 2.52 cfs @ 11.96 hrs, Volume= 0.110 af, Depth> 2.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
0.440	79	<50% Grass cover, Poor, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 8S: DA - 2A

Runoff = 7.97 cfs @ 11.96 hrs, Volume= 0.350 af, Depth> 3.18"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
1.020	79	50-75% Grass cover, Fair, HSG C
0.300	89	Gravel roads, HSG C
1.320	81	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9S: DA-1A

Runoff = 3.94 cfs @ 11.96 hrs, Volume= 0.169 af, Depth> 2.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
0.510	69	50-75% Grass cover, Fair, HSG B
0.240	85	Gravel roads, HSG B
0.020	98	Paved parking & roofs
0.770	75	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland at Northern Site)

Runoff = 10.98 cfs @ 11.99 hrs, Volume= 0.494 af, Depth> 2.12"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
2.800	69	Pasture/grassland/range, Fair, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	190	0.1000	0.4		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 14S: DA-4

Runoff = 5.24 cfs @ 11.96 hrs, Volume= 0.223 af, Depth> 2.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
0.790	69	Pasture/grassland/range, Fair, HSG B
0.300	85	Gravel roads, HSG B
1.090	73	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Reach 3R: 18" RCP Pipe

Inflow Area = 2.090 ac, Inflow Depth > 2.37" for 10-YEAR event
Inflow = 9.68 cfs @ 11.96 hrs, Volume= 0.414 af
Outflow = 5.90 cfs @ 12.05 hrs, Volume= 0.411 af, Atten= 39%, Lag= 5.4 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.8 fps, Min. Travel Time= 4.2 min
Avg. Velocity = 1.6 fps, Avg. Travel Time= 10.0 min

Peak Depth= 1.50' @ 11.95 hrs
Capacity at bank full= 5.90 cfs
Inlet Invert= 207.00', Outlet Invert= 204.00'
18.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 950.0' Slope= 0.0032 '/'

Reach 4R: Water Quality Swale DC - 2B

Inflow Area = 0.370 ac, Inflow Depth > 3.28" for 10-YEAR event
Inflow = 2.29 cfs @ 11.95 hrs, Volume= 0.101 af
Outflow = 2.07 cfs @ 12.02 hrs, Volume= 0.101 af, Atten= 10%, Lag= 4.0 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.2 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.8 fps, Avg. Travel Time= 6.2 min

Peak Depth= 0.69' @ 11.98 hrs
Capacity at bank full= 16.80 cfs
Inlet Invert= 214.00', Outlet Invert= 211.00'
0.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 310.0' Slope= 0.0097 '/'

Reach 5R: Warter Quality Swale DC-2A

Inflow Area = 1.320 ac, Inflow Depth > 3.18" for 10-YEAR event
Inflow = 7.97 cfs @ 11.96 hrs, Volume= 0.350 af
Outflow = 7.25 cfs @ 12.01 hrs, Volume= 0.349 af, Atten= 9%, Lag= 3.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.3 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 1.0 fps, Avg. Travel Time= 6.8 min

Peak Depth= 0.61' @ 11.98 hrs
Capacity at bank full= 102.94 cfs
Inlet Invert= 216.00', Outlet Invert= 210.00'
2.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 400.0' Slope= 0.0150 '/'

Reach 6R: 18" Culvert

Inflow Area = 0.770 ac, Inflow Depth > 2.63" for 10-YEAR event
Inflow = 3.71 cfs @ 11.99 hrs, Volume= 0.169 af
Outflow = 3.55 cfs @ 12.01 hrs, Volume= 0.168 af, Atten= 4%, Lag= 1.2 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.7 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.6 fps, Avg. Travel Time= 2.3 min

Peak Depth= 0.68' @ 12.00 hrs
Capacity at bank full= 8.67 cfs
Inlet Invert= 209.50', Outlet Invert= 208.00'
18.0" Diameter Pipe, n= 0.013 Corrugated PE, smooth interior
Length= 220.0' Slope= 0.0068 '/'

Reach 7R: Channel DC-1A

Inflow Area = 0.770 ac, Inflow Depth > 2.63" for 10-YEAR event
Inflow = 3.94 cfs @ 11.96 hrs, Volume= 0.169 af
Outflow = 3.71 cfs @ 11.99 hrs, Volume= 0.169 af, Atten= 6%, Lag= 2.0 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.6 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 1.0 fps, Avg. Travel Time= 2.8 min

Peak Depth= 0.71' @ 11.98 hrs
Capacity at bank full= 28.90 cfs
Inlet Invert= 213.00', Outlet Invert= 211.00'
0.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 170.0' Slope= 0.0118 '/'

Reach 8R: 18" RCP Pipe

Inflow Area = 1.000 ac, Inflow Depth > 2.29" for 10-YEAR event
Inflow = 4.50 cfs @ 11.96 hrs, Volume= 0.191 af
Outflow = 4.44 cfs @ 11.96 hrs, Volume= 0.190 af, Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.9 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.0 fps, Avg. Travel Time= 0.4 min

Peak Depth= 0.66' @ 11.96 hrs
Capacity at bank full= 11.07 cfs
Inlet Invert= 215.50', Outlet Invert= 215.00'
18.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 45.0' Slope= 0.0111 '/'

Pond 1P: Wet Detention Basin

Inflow Area = 3.470 ac, Inflow Depth > 2.98" for 10-YEAR event
Inflow = 18.92 cfs @ 11.96 hrs, Volume= 0.863 af
Outflow = 0.96 cfs @ 13.13 hrs, Volume= 0.312 af, Atten= 95%, Lag= 69.9 min
Primary = 0.96 cfs @ 13.13 hrs, Volume= 0.312 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 211.59' @ 13.13 hrs Surf.Area= 9,743 sf Storage= 25,232 cf
Plug-Flow detention time= 233.4 min calculated for 0.312 af (36% of inflow)
Center-of-Mass det. time= 146.4 min (924.2 - 777.8)

Volume	Invert	Avail.Storage	Storage Description
#1	207.00'	40,711 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
207.00	1,898	0	0
208.00	3,673	2,786	2,786
210.50	6,966	13,299	16,084
212.00	10,770	13,302	29,386
213.00	11,880	11,325	40,711

Device	Routing	Invert	Outlet Devices
#1	Primary	207.00'	**18.0" x 80.0' long Barrel** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 202.00' S= 0.0625 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections
#2	Device 1	210.80'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	211.50'	**24.0" Horiz. Riser** Limited to weir flow C= 0.600
#4	Secondary	212.00'	**20.0' long x 10.0' breadth Emergency Spillway** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.93 cfs @ 13.13 hrs HW=211.59' (Free Discharge)
└**1=Barrel** (Passes 0.93 cfs of 16.68 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 0.33 cfs @ 3.8 fps)
└**3=Riser** (Weir Controls 0.60 cfs @ 1.0 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=207.00' (Free Discharge)
└**4=Emergency Spillway** (Controls 0.00 cfs)

Pond 2P: Permanent Sediment Basin

Inflow Area = 2.130 ac, Inflow Depth > 3.15" for 10-YEAR event
Inflow = 11.40 cfs @ 12.00 hrs, Volume= 0.559 af
Outflow = 6.02 cfs @ 12.12 hrs, Volume= 0.351 af, Atten= 47%, Lag= 7.2 min
Primary = 0.20 cfs @ 12.12 hrs, Volume= 0.144 af
Secondary = 5.82 cfs @ 12.12 hrs, Volume= 0.207 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 209.68' @ 12.12 hrs Surf.Area= 4,776 sf Storage= 10,956 cf
Plug-Flow detention time= 128.1 min calculated for 0.350 af (63% of inflow)
Center-of-Mass det. time= 57.1 min (834.4 - 777.3)

Volume	Invert	Avail.Storage	Storage Description
#1	206.00'	12,556 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
206.00	1,185	0	0
210.00	5,093	12,556	12,556

Device	Routing	Invert	Outlet Devices
#1	Primary	206.00'	**4.0" x 40.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 205.00' S= 0.0250 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior
#2	Secondary	209.30'	**10.0' long x 10.0' breadth Emergency Spillway** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#3	Device 1	206.00'	**2.0" Vert. Faircloth Skimmer** C= 0.600

Primary OutFlow Max=0.20 cfs @ 12.12 hrs HW=209.65' (Free Discharge)
└**1=Culvert** (Passes 0.20 cfs of 0.38 cfs potential flow)
└**3=Faircloth Skimmer** (Orifice Controls 0.20 cfs @ 9.1 fps)

Secondary OutFlow Max=5.37 cfs @ 12.12 hrs HW=209.65' (Free Discharge)
└**2=Emergency Spillway** (Weir Controls 5.37 cfs @ 1.5 fps)

Pond ST-1: Temp. Sed. Trap-1

Inflow Area = 0.570 ac, Inflow Depth > 2.99" for 10-YEAR event
Inflow = 3.27 cfs @ 11.96 hrs, Volume= 0.142 af
Outflow = 2.80 cfs @ 12.00 hrs, Volume= 0.141 af, Atten= 14%, Lag= 2.7 min
Primary = 2.80 cfs @ 12.00 hrs, Volume= 0.141 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 202.26' @ 12.00 hrs Surf.Area= 704 sf Storage= 1,039 cf
Plug-Flow detention time= 13.3 min calculated for 0.141 af (99% of inflow)
Center-of-Mass det. time= 10.6 min (787.8 - 777.1)

Volume	Invert	Avail.Storage	Storage Description
#1	201.00'	2,881 cf	**Custom Stage Data (Prismatic)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
201.00	396	0	0
204.50	1,250	2,881	2,881

Device	Routing	Invert	Outlet Devices
#1	Primary	201.00'	**Rock Dam** Head (feet) 0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 Disch. (cfs) 0.000 0.390 1.640 3.860 7.140 11.610 17.360 24.500
#2	Secondary	204.50'	**143.0 deg x 10.0' long Sharp-Crested Vee/Trap Weir** C= 2.47

Primary OutFlow Max=2.79 cfs @ 12.00 hrs HW=202.26' (Free Discharge)
└**1=Rock Dam** (Custom Controls 2.79 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=201.00' (Free Discharge)
└**2=Sharp-Crested Vee/Trap Weir** (Controls 0.00 cfs)

Pond ST-2: Temp. Sed. Trap-2

Inflow Area = 0.340 ac, Inflow Depth > 2.99" for 10-YEAR event
Inflow = 1.95 cfs @ 11.96 hrs, Volume= 0.085 af
Outflow = 1.73 cfs @ 12.00 hrs, Volume= 0.085 af, Atten= 11%, Lag= 2.5 min
Primary = 1.73 cfs @ 12.00 hrs, Volume= 0.085 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 201.02' @ 12.00 hrs Surf.Area= 344 sf Storage= 488 cf
Plug-Flow detention time= 8.4 min calculated for 0.085 af (100% of inflow)
Center-of-Mass det. time= 6.9 min (784.0 - 777.1)

Volume	Invert	Avail.Storage	Storage Description
#1	200.00'	1,673 cf	**Custom Stage Data (Prismatic)**Listed below

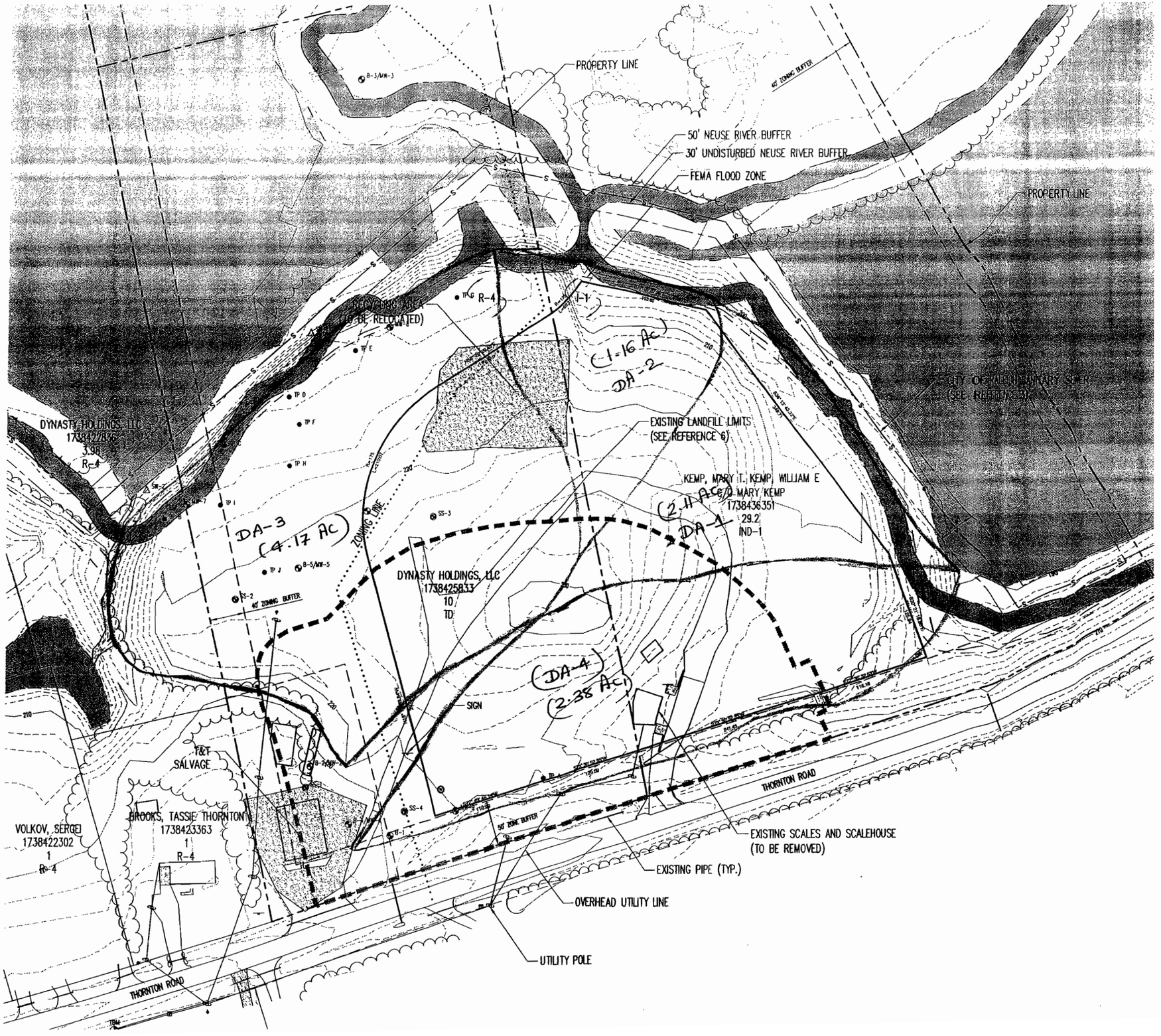
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
200.00	156	0	0
203.50	800	1,673	1,673

Device	Routing	Invert	Outlet Devices
#1	Primary	200.00'	**Rock Dam** Head (feet) 0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 Disch. (cfs) 0.000 0.390 1.640 3.860 7.140 11.610 17.360 24.500
#2	Secondary	203.50'	**143.0 deg x 10.0' long Sharp-Crested Vee/Trap Weir** C= 2.47

Primary OutFlow Max=1.71 cfs @ 12.00 hrs HW=201.01' (Free Discharge)
└**1=Rock Dam** (Custom Controls 1.71 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=200.00' (Free Discharge)
└**2=Sharp-Crested Vee/Trap Weir** (Controls 0.00 cfs)

HydroCAD Analysis of Pre-Development Condition
(10-Year Storm Event)



PRE - DEVELOPMENT CONDITION

Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland a Runoff Area=4.170 ac Runoff Depth>2.20"
Flow Length=200' Tc=6.3 min CN=70 Runoff=17.35 cfs 0.765 af

Subcatchment 14S: DA-4 (Direct Sheet Flow into the Wetland Runoff Area=2.380 ac Runoff Depth>2.20"
Flow Length=240' Tc=7.9 min CN=70 Runoff=9.42 cfs 0.436 af

Subcatchment 15S: DA-2 (Direct Sheet Flow into the wetland Runoff Area=1.160 ac Runoff Depth>2.37"
Flow Length=150' Tc=4.7 min CN=72 Runoff=5.47 cfs 0.229 af

Subcatchment 16S: DA-1 (Direct Sheet Flow into the wetland Runoff Area=2.110 ac Runoff Depth>2.20"
Flow Length=180' Tc=5.6 min CN=70 Runoff=8.91 cfs 0.387 af

Total Runoff Area = 9.820 ac Runoff Volume = 1.818 af Average Runoff Depth = 2.22"

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland at northwest site)

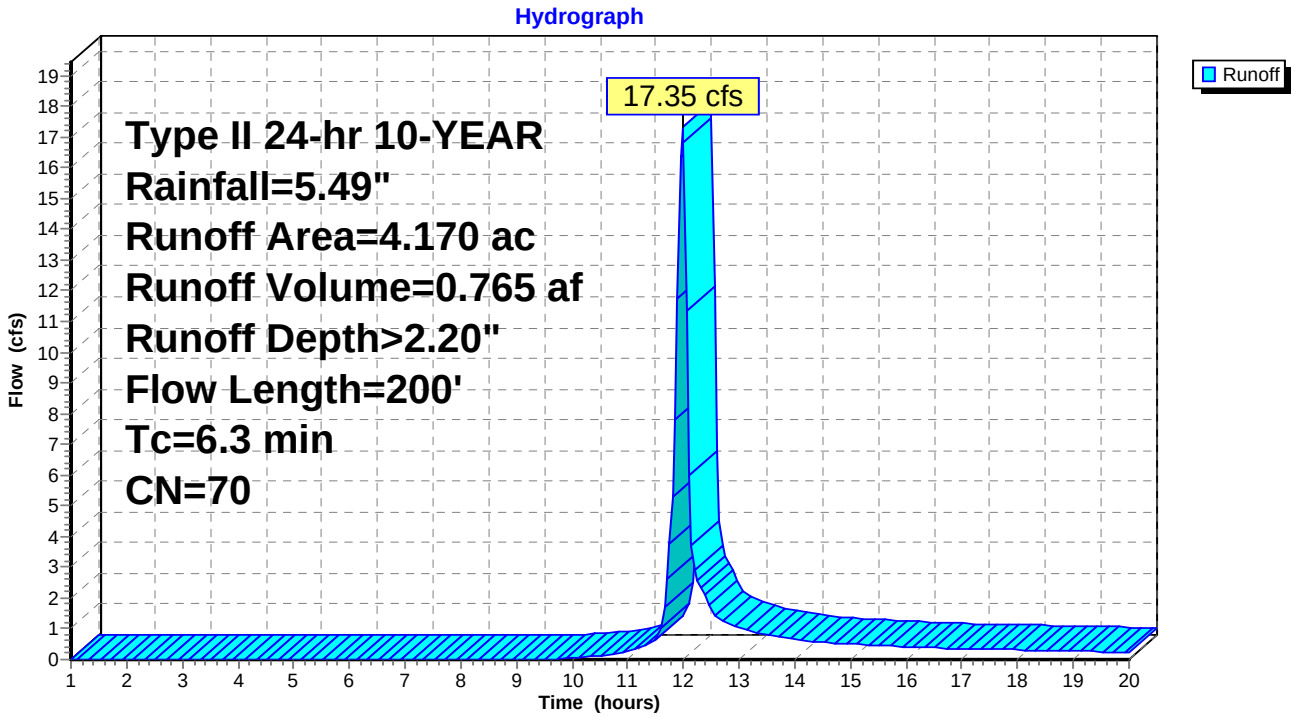
Runoff = 17.35 cfs @ 11.98 hrs, Volume= 0.765 af, Depth> 2.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
3.790	69	Pasture/grassland/range, Fair, HSG B
0.160	85	Gravel roads, HSG B
0.220	85	Gravel roads, HSG B
4.170	70	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	200	0.1500	0.5		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland at northwest site)



Subcatchment 14S: DA-4 (Direct Sheet Flow into the Wetland at Easterm Site)

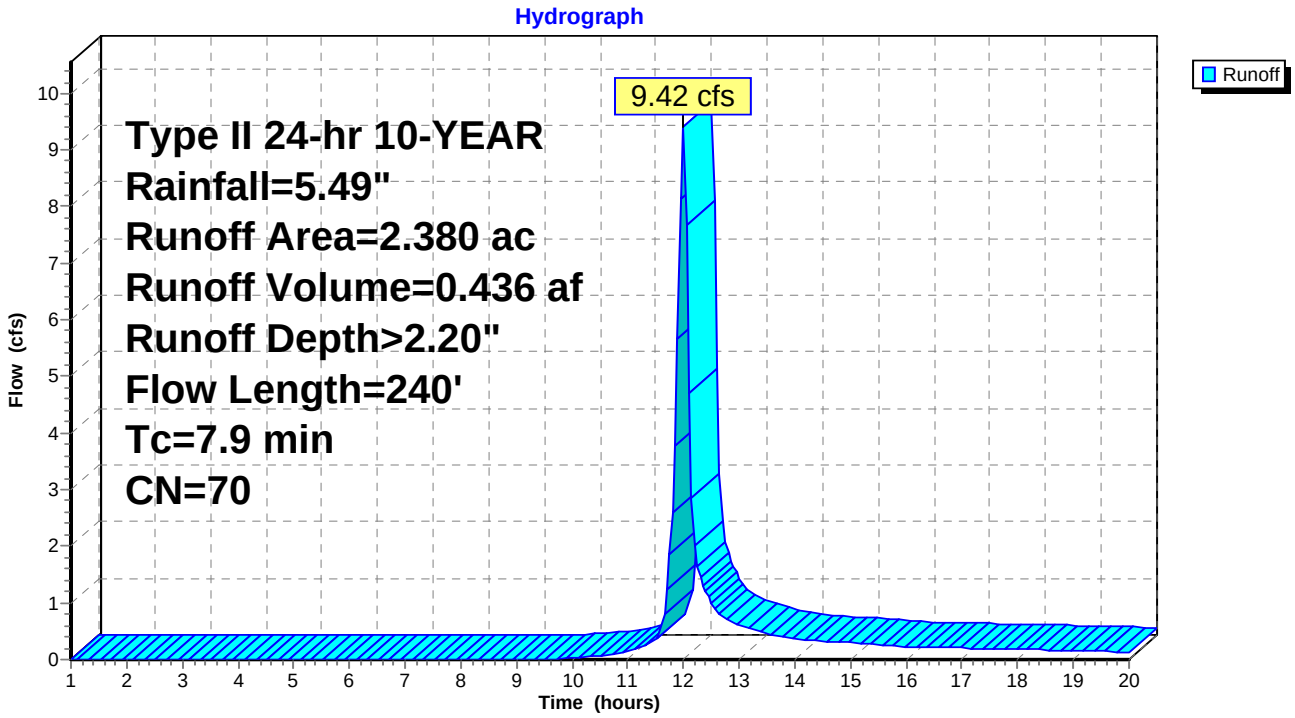
Runoff = 9.42 cfs @ 12.00 hrs, Volume= 0.436 af, Depth> 2.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
2.190	69	Pasture/grassland/range, Fair, HSG B
0.150	85	Gravel roads, HSG B
0.040	98	Paved parking & roofs
2.380	70	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	240	0.1250	0.5		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 14S: DA-4 (Direct Sheet Flow into the Wetland at Easterm Site)



Subcatchment 15S: DA-2 (Direct Sheet Flow into the wetland on northern side)

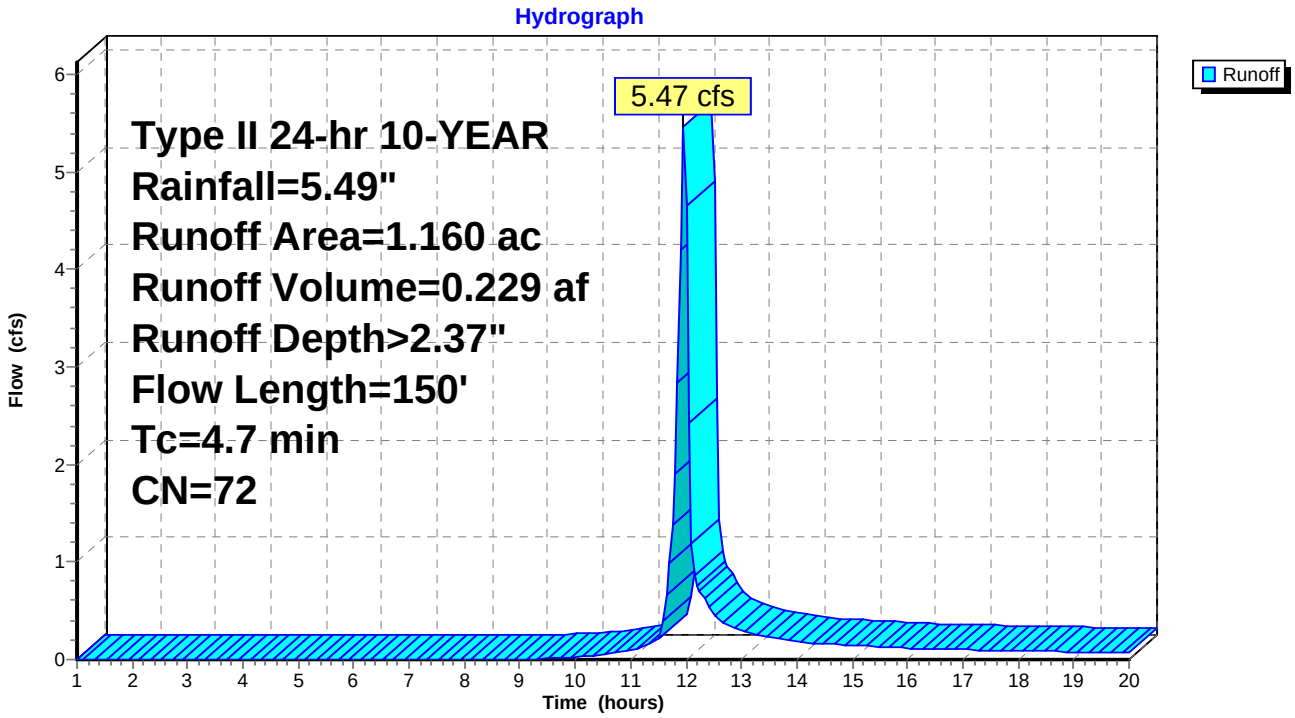
Runoff = 5.47 cfs @ 11.96 hrs, Volume= 0.229 af, Depth> 2.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
0.966	69	Pasture/grassland/range, Fair, HSG B
0.074	85	Gravel roads, HSG B
0.120	85	Recycling area
1.160	72	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	150	0.1800	0.5		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 15S: DA-2 (Direct Sheet Flow into the wetland on northern side)



Subcatchment 16S: DA-1 (Direct Sheet Flow into the wetland on northeast side)

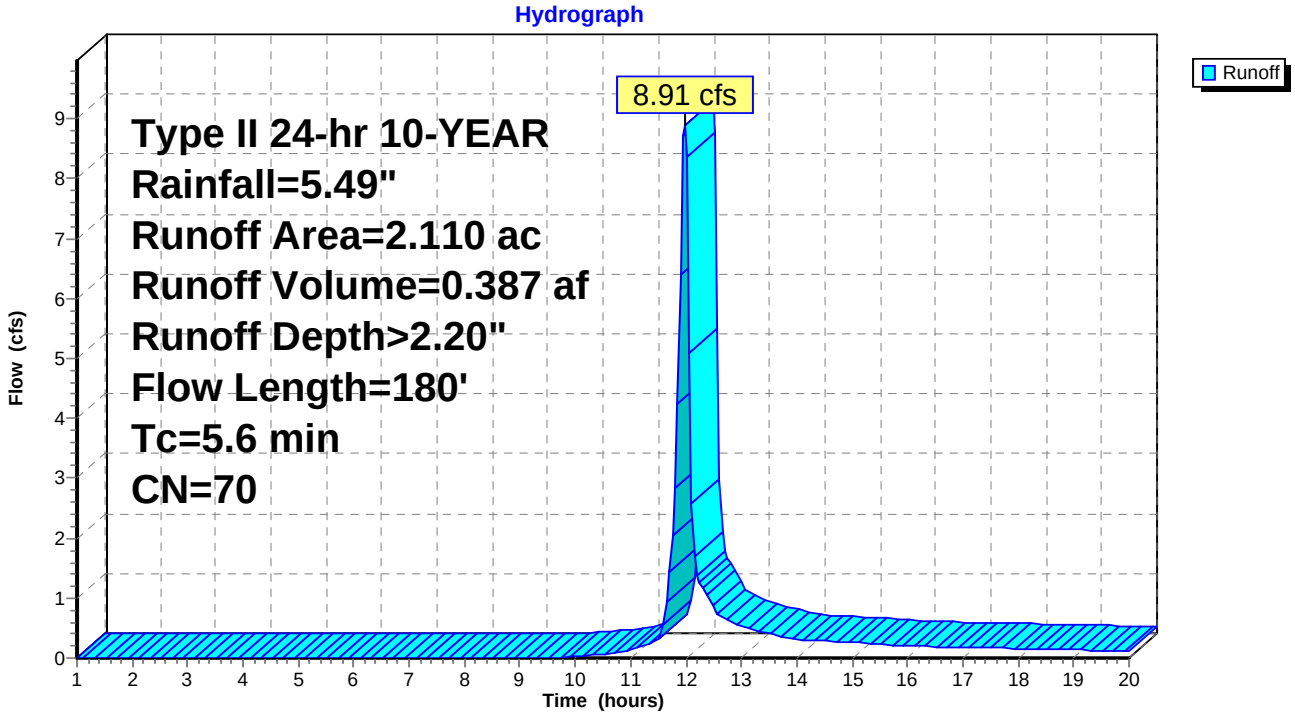
Runoff = 8.91 cfs @ 11.97 hrs, Volume= 0.387 af, Depth> 2.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-YEAR Rainfall=5.49"

Area (ac)	CN	Description
2.000	69	Pasture/grassland/range, Fair, HSG B
0.110	85	Gravel roads, HSG B
2.110	70	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.6	180	0.1660	0.5		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 16S: DA-1 (Direct Sheet Flow into the wetland on northeast side)



HydroCAD Analysis of Post-Development Condition
(2-Year Storm Event)

Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-6 Runoff Area=0.570 ac Runoff Depth>1.54"
Tc=5.0 min CN=79 Runoff=1.72 cfs 0.073 af

Subcatchment 2S: DA-5 Runoff Area=0.340 ac Runoff Depth>1.54"
Tc=5.0 min CN=79 Runoff=1.03 cfs 0.044 af

Subcatchment 3S: DA - 2C Runoff Area=0.370 ac Runoff Depth>1.75"
Tc=5.0 min CN=82 Runoff=1.26 cfs 0.054 af

Subcatchment 4S: DA-1B Runoff Area=2.700 ac Runoff Depth>1.61"
Tc=5.0 min CN=80 Runoff=8.50 cfs 0.362 af

Subcatchment 5S: DA-7 Runoff Area=1.000 ac Runoff Depth>1.04"
Tc=5.0 min CN=71 Runoff=2.05 cfs 0.087 af

Subcatchment 6S: DA - 2B Runoff Area=0.440 ac Runoff Depth>1.54"
Tc=5.0 min CN=79 Runoff=1.33 cfs 0.056 af

Subcatchment 8S: DA - 2A Runoff Area=1.320 ac Runoff Depth>1.68"
Tc=5.0 min CN=81 Runoff=4.33 cfs 0.185 af

Subcatchment 9S: DA-1A Runoff Area=0.770 ac Runoff Depth>1.28"
Tc=5.0 min CN=75 Runoff=1.94 cfs 0.082 af

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland a Runoff Area=2.800 ac Runoff Depth>0.93"
Flow Length=190' Tc=7.1 min CN=69 Runoff=4.78 cfs 0.217 af

Subcatchment 14S: DA-4 Runoff Area=1.090 ac Runoff Depth>1.15"
Tc=5.0 min CN=73 Runoff=2.49 cfs 0.105 af

Reach 3R: 18" RCP Pipe Peak Depth=0.87' Max Vel=3.5 fps Inflow=4.50 cfs 0.192 af
D=18.0" n=0.013 L=950.0' S=0.0032 '/' Capacity=5.90 cfs Outflow=3.64 cfs 0.190 af

Reach 4R: Water Quality Swale DC - 2B Peak Depth=0.55' Max Vel=1.9 fps Inflow=1.26 cfs 0.054 af
n=0.030 L=310.0' S=0.0097 '/' Capacity=16.80 cfs Outflow=1.15 cfs 0.054 af

Reach 5R: Warter Quality Swale DC-2A Peak Depth=0.44' Max Vel=2.8 fps Inflow=4.33 cfs 0.185 af
n=0.030 L=400.0' S=0.0150 '/' Capacity=102.94 cfs Outflow=3.93 cfs 0.184 af

Reach 6R: 18" Culvert Peak Depth=0.46' Max Vel=3.8 fps Inflow=1.80 cfs 0.082 af
D=18.0" n=0.013 L=220.0' S=0.0068 '/' Capacity=8.67 cfs Outflow=1.71 cfs 0.082 af

Reach 7R: Channel DC-1A Peak Depth=0.54' Max Vel=2.2 fps Inflow=1.94 cfs 0.082 af
n=0.030 L=170.0' S=0.0118 '/' Capacity=28.90 cfs Outflow=1.80 cfs 0.082 af

Reach 8R: 18" RCP Pipe Peak Depth=0.44' Max Vel=4.7 fps Inflow=2.05 cfs 0.087 af
D=18.0" n=0.013 L=45.0' S=0.0111 '/' Capacity=11.07 cfs Outflow=2.02 cfs 0.087 af

Pond 1P: Wet Detention Basin Peak Elev=210.92' Storage=19,199 cf Inflow=9.83 cfs 0.443 af
Primary=0.03 cfs 0.002 af Secondary=0.00 cfs 0.000 af Outflow=0.03 cfs 0.002 af

Pond 2P: Permanent Sediment Basin Peak Elev=209.09' Storage=8,332 cf Inflow=6.02 cfs 0.294 af
Primary=0.18 cfs 0.125 af Secondary=0.00 cfs 0.000 af Outflow=0.18 cfs 0.125 af

Pond ST-1: Temp. Sed. Trap-1 Peak Elev=201.84' Storage=691 cf Inflow=1.72 cfs 0.073 af
Primary=1.24 cfs 0.072 af Secondary=0.00 cfs 0.000 af Outflow=1.24 cfs 0.072 af

Pond ST-2: Temp. Sed. Trap-2 Peak Elev=200.68' Storage=326 cf Inflow=1.03 cfs 0.044 af
Primary=0.85 cfs 0.043 af Secondary=0.00 cfs 0.000 af Outflow=0.85 cfs 0.043 af

Total Runoff Area = 11.400 ac Runoff Volume = 1.264 af Average Runoff Depth = 1.33"

Subcatchment 1S: DA-6

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.72 cfs @ 11.96 hrs, Volume= 0.073 af, Depth> 1.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
0.570	79	<50% Grass cover, Poor, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: DA-5

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.03 cfs @ 11.96 hrs, Volume= 0.044 af, Depth> 1.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
0.340	79	<50% Grass cover, Poor, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: DA - 2C

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.26 cfs @ 11.96 hrs, Volume= 0.054 af, Depth> 1.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
0.240	79	<50% Grass cover, Poor, HSG B
0.110	85	Gravel roads, HSG B
0.020	98	Paved parking & roofs
0.370	82	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 4S: DA-1B

[49] Hint: Tc<2dt may require smaller dt

Runoff = 8.50 cfs @ 11.96 hrs, Volume= 0.362 af, Depth> 1.61"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
1.130	69	50-75% Grass cover, Fair, HSG B
1.120	85	Gravel roads, HSG B
0.450	98	Paved parking & roofs
2.700	80	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5S: DA-7

[49] Hint: Tc<2dt may require smaller dt

Runoff = 2.05 cfs @ 11.97 hrs, Volume= 0.087 af, Depth> 1.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
0.880	69	Pasture/grassland/range, Fair, HSG B
0.120	85	Gravel roads, HSG B
1.000	71	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 6S: DA - 2B

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.33 cfs @ 11.96 hrs, Volume= 0.056 af, Depth> 1.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
0.440	79	<50% Grass cover, Poor, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 8S: DA - 2A

[49] Hint: Tc<2dt may require smaller dt

Runoff = 4.33 cfs @ 11.96 hrs, Volume= 0.185 af, Depth> 1.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
1.020	79	50-75% Grass cover, Fair, HSG C
0.300	89	Gravel roads, HSG C
1.320	81	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9S: DA-1A

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.94 cfs @ 11.96 hrs, Volume= 0.082 af, Depth> 1.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
0.510	69	50-75% Grass cover, Fair, HSG B
0.240	85	Gravel roads, HSG B
0.020	98	Paved parking & roofs
0.770	75	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland at Northern Site)

Runoff = 4.78 cfs @ 11.99 hrs, Volume= 0.217 af, Depth> 0.93"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
2.800	69	Pasture/grassland/range, Fair, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	190	0.1000	0.4		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 14S: DA-4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 2.49 cfs @ 11.96 hrs, Volume= 0.105 af, Depth> 1.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
0.790	69	Pasture/grassland/range, Fair, HSG B
0.300	85	Gravel roads, HSG B
1.090	73	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Reach 3R: 18" RCP Pipe

[52] Hint: Inlet conditions not evaluated

Inflow Area = 2.090 ac, Inflow Depth > 1.10" for 2-YEAR event
Inflow = 4.50 cfs @ 11.97 hrs, Volume= 0.192 af
Outflow = 3.64 cfs @ 12.09 hrs, Volume= 0.190 af, Atten= 19%, Lag= 7.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.5 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 1.4 fps, Avg. Travel Time= 11.4 min

Peak Depth= 0.87' @ 12.01 hrs
Capacity at bank full= 5.90 cfs
Inlet Invert= 207.00', Outlet Invert= 204.00'
18.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 950.0' Slope= 0.0032 '/'

Reach 4R: Water Quality Swale DC - 2B

Inflow Area = 0.370 ac, Inflow Depth > 1.75" for 2-YEAR event
Inflow = 1.26 cfs @ 11.96 hrs, Volume= 0.054 af
Outflow = 1.15 cfs @ 12.04 hrs, Volume= 0.054 af, Atten= 9%, Lag= 4.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.9 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.7 fps, Avg. Travel Time= 6.9 min

Peak Depth= 0.55' @ 11.99 hrs
Capacity at bank full= 16.80 cfs
Inlet Invert= 214.00', Outlet Invert= 211.00'
0.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 310.0' Slope= 0.0097 '/'

Reach 5R: Warter Quality Swale DC-2A

Inflow Area = 1.320 ac, Inflow Depth > 1.68" for 2-YEAR event
Inflow = 4.33 cfs @ 11.96 hrs, Volume= 0.185 af
Outflow = 3.93 cfs @ 12.03 hrs, Volume= 0.184 af, Atten= 9%, Lag= 4.2 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.8 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 0.9 fps, Avg. Travel Time= 7.8 min

Peak Depth= 0.44' @ 11.99 hrs
Capacity at bank full= 102.94 cfs
Inlet Invert= 216.00', Outlet Invert= 210.00'
2.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 400.0' Slope= 0.0150 '/'

Reach 6R: 18" Culvert

[52] Hint: Inlet conditions not evaluated

Inflow Area = 0.770 ac, Inflow Depth > 1.27" for 2-YEAR event
Inflow = 1.80 cfs @ 12.00 hrs, Volume= 0.082 af
Outflow = 1.71 cfs @ 12.03 hrs, Volume= 0.082 af, Atten= 5%, Lag= 1.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.8 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.4 fps, Avg. Travel Time= 2.6 min

Peak Depth= 0.46' @ 12.01 hrs
Capacity at bank full= 8.67 cfs
Inlet Invert= 209.50', Outlet Invert= 208.00'
18.0" Diameter Pipe, n= 0.013 Corrugated PE, smooth interior
Length= 220.0' Slope= 0.0068 '/'

Reach 7R: Channel DC-1A

Inflow Area = 0.770 ac, Inflow Depth > 1.28" for 2-YEAR event
Inflow = 1.94 cfs @ 11.96 hrs, Volume= 0.082 af
Outflow = 1.80 cfs @ 12.00 hrs, Volume= 0.082 af, Atten= 7%, Lag= 2.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.2 fps, Min. Travel Time= 1.3 min
Avg. Velocity = 0.9 fps, Avg. Travel Time= 3.2 min

Peak Depth= 0.54' @ 11.98 hrs
Capacity at bank full= 28.90 cfs
Inlet Invert= 213.00', Outlet Invert= 211.00'
0.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 170.0' Slope= 0.0118 '/'

Reach 8R: 18" RCP Pipe

[52] Hint: Inlet conditions not evaluated

Inflow Area = 1.000 ac, Inflow Depth > 1.04" for 2-YEAR event
Inflow = 2.05 cfs @ 11.97 hrs, Volume= 0.087 af
Outflow = 2.02 cfs @ 11.97 hrs, Volume= 0.087 af, Atten= 2%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.7 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.8 fps, Avg. Travel Time= 0.4 min

Peak Depth= 0.44' @ 11.97 hrs
Capacity at bank full= 11.07 cfs
Inlet Invert= 215.50', Outlet Invert= 215.00'
18.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 45.0' Slope= 0.0111 '/'

Pond 1P: Wet Detention Basin

[63] Warning: Exceeded Reach 6R inflow depth by 1.35' @ 19.95 hrs

Inflow Area = 3.470 ac, Inflow Depth > 1.53" for 2-YEAR event
Inflow = 9.83 cfs @ 11.97 hrs, Volume= 0.443 af
Outflow = 0.03 cfs @ 20.00 hrs, Volume= 0.002 af, Atten= 100%, Lag= 482.1 min
Primary = 0.03 cfs @ 20.00 hrs, Volume= 0.002 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 210.92' @ 20.00 hrs Surf.Area= 8,020 sf Storage= 19,199 cf
Plug-Flow detention time= 589.3 min calculated for 0.002 af (0% of inflow)
Center-of-Mass det. time= 377.0 min (1,169.1 - 792.2)

Volume	Invert	Avail.Storage	Storage Description
#1	207.00'	40,711 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
207.00	1,898	0	0
208.00	3,673	2,786	2,786
210.50	6,966	13,299	16,084
212.00	10,770	13,302	29,386
213.00	11,880	11,325	40,711

Device	Routing	Invert	Outlet Devices
#1	Primary	207.00'	**18.0" x 80.0' long Barrel** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 202.00' S= 0.0625 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections
#2	Device 1	210.80'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	211.50'	**24.0" Horiz. Riser** Limited to weir flow C= 0.600
#4	Secondary	212.00'	**20.0' long x 10.0' breadth Emergency Spillway** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.03 cfs @ 20.00 hrs HW=210.92' (Free Discharge)
└**1=Barrel** (Passes 0.03 cfs of 15.14 cfs potential flow)
  └**2=Orifice/Grate** (Orifice Controls 0.03 cfs @ 1.2 fps)
  └**3=Riser** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=207.00' (Free Discharge)
└**4=Emergency Spillway** (Controls 0.00 cfs)

Pond 2P: Permanent Sediment Basin

Inflow Area = 2.130 ac, Inflow Depth > 1.66" for 2-YEAR event
Inflow = 6.02 cfs @ 12.01 hrs, Volume= 0.294 af
Outflow = 0.18 cfs @ 15.16 hrs, Volume= 0.125 af, Atten= 97%, Lag= 188.7 min
Primary = 0.18 cfs @ 15.16 hrs, Volume= 0.125 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 209.09' @ 15.16 hrs Surf.Area= 4,205 sf Storage= 8,332 cf
Plug-Flow detention time= 238.1 min calculated for 0.125 af (43% of inflow)
Center-of-Mass det. time= 154.4 min (946.3 - 791.9)

Volume	Invert	Avail.Storage	Storage Description
#1	206.00'	12,556 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
206.00	1,185	0	0
210.00	5,093	12,556	12,556

Device	Routing	Invert	Outlet Devices
#1	Primary	206.00'	**4.0" x 40.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 205.00' S= 0.0250 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior
#2	Secondary	209.30'	**10.0' long x 10.0' breadth Emergency Spillway** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#3	Device 1	206.00'	**2.0" Vert. Faircloth Skimmer** C= 0.600

Primary OutFlow Max=0.18 cfs @ 15.16 hrs HW=209.09' (Free Discharge)
└─**1=Culvert** (Passes 0.18 cfs of 0.36 cfs potential flow)
└─**3=Faircloth Skimmer** (Orifice Controls 0.18 cfs @ 8.4 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=206.00' (Free Discharge)
└─**2=Emergency Spillway** (Controls 0.00 cfs)

Pond ST-1: Temp. Sed. Trap-1

Inflow Area =	0.570 ac,	Inflow Depth >	1.54"	for 2-YEAR event
Inflow =	1.72 cfs @	11.96 hrs,	Volume=	0.073 af
Outflow =	1.24 cfs @	12.02 hrs,	Volume=	0.072 af, Atten= 28%, Lag= 3.8 min
Primary =	1.24 cfs @	12.02 hrs,	Volume=	0.072 af
Secondary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 201.84' @ 12.02 hrs Surf.Area= 601 sf Storage= 691 cf
Plug-Flow detention time= 15.3 min calculated for 0.072 af (99% of inflow)
Center-of-Mass det. time= 12.3 min (803.9 - 791.5)

Volume	Invert	Avail.Storage	Storage Description
#1	201.00'	2,881 cf	**Custom Stage Data (Prismatic)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
201.00	396	0	0
204.50	1,250	2,881	2,881

Device	Routing	Invert	Outlet Devices
#1	Primary	201.00'	**Rock Dam** Head (feet) 0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 Disch. (cfs) 0.000 0.390 1.640 3.860 7.140 11.610 17.360 24.500
#2	Secondary	204.50'	**143.0 deg x 10.0' long Sharp-Crested Vee/Trap Weir** C= 2.47

Primary OutFlow Max=1.20 cfs @ 12.02 hrs HW=201.82' (Free Discharge)
└─**1=Rock Dam** (Custom Controls 1.20 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=201.00' (Free Discharge)
└─**2=Sharp-Crested Vee/Trap Weir** (Controls 0.00 cfs)

Pond ST-2: Temp. Sed. Trap-2

Inflow Area = 0.340 ac, Inflow Depth > 1.54" for 2-YEAR event
Inflow = 1.03 cfs @ 11.96 hrs, Volume= 0.044 af
Outflow = 0.85 cfs @ 12.01 hrs, Volume= 0.043 af, Atten= 18%, Lag= 3.1 min
Primary = 0.85 cfs @ 12.01 hrs, Volume= 0.043 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 200.68' @ 12.01 hrs Surf.Area= 282 sf Storage= 326 cf
Plug-Flow detention time= 9.4 min calculated for 0.043 af (100% of inflow)
Center-of-Mass det. time= 7.7 min (799.2 - 791.5)

Volume	Invert	Avail.Storage	Storage Description
#1	200.00'	1,673 cf	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
200.00	156	0	0
203.50	800	1,673	1,673

Device	Routing	Invert	Outlet Devices
#1	Primary	200.00'	**Rock Dam** Head (feet) 0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 Disch. (cfs) 0.000 0.390 1.640 3.860 7.140 11.610 17.360 24.500
#2	Secondary	203.50'	**143.0 deg x 10.0' long Sharp-Crested Vee/Trap Weir** C= 2.47

Primary OutFlow Max=0.82 cfs @ 12.01 hrs HW=200.67' (Free Discharge)
↑—**1=Rock Dam** (Custom Controls 0.82 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=200.00' (Free Discharge)
↑—**2=Sharp-Crested Vee/Trap Weir** (Controls 0.00 cfs)

HydroCAD Analysis of Pre-Development Condition
(2-Year Storm Event)

Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland a Runoff Area=4.170 ac Runoff Depth>0.98"
Flow Length=200' Tc=6.3 min CN=70 Runoff=7.76 cfs 0.342 af

Subcatchment 14S: DA-4 (Direct Sheet Flow into the Wetland Runoff Area=2.380 ac Runoff Depth>0.98"
Flow Length=240' Tc=7.9 min CN=70 Runoff=4.18 cfs 0.195 af

Subcatchment 15S: DA-2 (Direct Sheet Flow into the wetland Runoff Area=1.160 ac Runoff Depth>1.10"
Flow Length=150' Tc=4.7 min CN=72 Runoff=2.55 cfs 0.106 af

Subcatchment 16S: DA-1 (Direct Sheet Flow into the wetland Runoff Area=2.110 ac Runoff Depth>0.98"
Flow Length=180' Tc=5.6 min CN=70 Runoff=4.00 cfs 0.173 af

Total Runoff Area = 9.820 ac Runoff Volume = 0.816 af Average Runoff Depth = 1.00"

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland at northwest site)

Runoff = 7.76 cfs @ 11.98 hrs, Volume= 0.342 af, Depth> 0.98"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
3.790	69	Pasture/grassland/range, Fair, HSG B
0.160	85	Gravel roads, HSG B
0.220	85	Gravel roads, HSG B
4.170	70	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	200	0.1500	0.5		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 14S: DA-4 (Direct Sheet Flow into the Wetland at Easterm Site)

Runoff = 4.18 cfs @ 12.00 hrs, Volume= 0.195 af, Depth> 0.98"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
2.190	69	Pasture/grassland/range, Fair, HSG B
0.150	85	Gravel roads, HSG B
0.040	98	Paved parking & roofs
2.380	70	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	240	0.1250	0.5		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 15S: DA-2 (Direct Sheet Flow into the wetland on northern side)

Runoff = 2.55 cfs @ 11.96 hrs, Volume= 0.106 af, Depth> 1.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
0.966	69	Pasture/grassland/range, Fair, HSG B
0.074	85	Gravel roads, HSG B
0.120	85	Recycling area
1.160	72	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	150	0.1800	0.5		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 16S: DA-1 (Direct Sheet Flow into the wetland on northeast side)

Runoff = 4.00 cfs @ 11.98 hrs, Volume= 0.173 af, Depth> 0.98"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YEAR Rainfall=3.64"

Area (ac)	CN	Description
2.000	69	Pasture/grassland/range, Fair, HSG B
0.110	85	Gravel roads, HSG B
2.110	70	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.6	180	0.1660	0.5		**Sheet Flow,** Range n= 0.130 P2= 3.70"

HydroCAD Analysis of Post-Development Condition
(1-Year Storm Event)

Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-6 Runoff Area=0.570 ac Runoff Depth>1.22"
Tc=5.0 min CN=79 Runoff=1.37 cfs 0.058 af

Subcatchment 2S: DA-5 Runoff Area=0.340 ac Runoff Depth>1.22"
Tc=5.0 min CN=79 Runoff=0.82 cfs 0.035 af

Subcatchment 3S: DA - 2C Runoff Area=0.370 ac Runoff Depth>1.41"
Tc=5.0 min CN=82 Runoff=1.02 cfs 0.044 af

Subcatchment 4S: DA-1B Runoff Area=2.700 ac Runoff Depth>1.28"
Tc=5.0 min CN=80 Runoff=6.82 cfs 0.289 af

Subcatchment 5S: DA-7 Runoff Area=1.000 ac Runoff Depth>0.79"
Tc=5.0 min CN=71 Runoff=1.53 cfs 0.065 af

Subcatchment 6S: DA - 2B Runoff Area=0.440 ac Runoff Depth>1.22"
Tc=5.0 min CN=79 Runoff=1.06 cfs 0.045 af

Subcatchment 8S: DA - 2A Runoff Area=1.320 ac Runoff Depth>1.35"
Tc=5.0 min CN=81 Runoff=3.50 cfs 0.148 af

Subcatchment 9S: DA-1A Runoff Area=0.770 ac Runoff Depth>0.99"
Tc=5.0 min CN=75 Runoff=1.50 cfs 0.064 af

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland a Runoff Area=2.800 ac Runoff Depth>0.69"
Flow Length=190' Tc=7.1 min CN=69 Runoff=3.49 cfs 0.162 af

Subcatchment 14S: DA-4 Runoff Area=1.090 ac Runoff Depth>0.88"
Tc=5.0 min CN=73 Runoff=1.89 cfs 0.080 af

Reach 3R: 18" RCP Pipe Peak Depth=0.73' Max Vel=3.3 fps Inflow=3.40 cfs 0.146 af
D=18.0" n=0.013 L=950.0' S=0.0032 '/' Capacity=5.90 cfs Outflow=2.70 cfs 0.144 af

Reach 4R: Water Quality Swale DC - 2B Peak Depth=0.51' Max Vel=1.8 fps Inflow=1.02 cfs 0.044 af
n=0.030 L=310.0' S=0.0097 '/' Capacity=16.80 cfs Outflow=0.93 cfs 0.043 af

Reach 5R: Warter Quality Swale DC-2A Peak Depth=0.39' Max Vel=2.6 fps Inflow=3.50 cfs 0.148 af
n=0.030 L=400.0' S=0.0150 '/' Capacity=102.94 cfs Outflow=3.18 cfs 0.147 af

Reach 6R: 18" Culvert Peak Depth=0.40' Max Vel=3.6 fps Inflow=1.39 cfs 0.063 af
D=18.0" n=0.013 L=220.0' S=0.0068 '/' Capacity=8.67 cfs Outflow=1.32 cfs 0.063 af

Reach 7R: Channel DC-1A Peak Depth=0.49' Max Vel=2.0 fps Inflow=1.50 cfs 0.064 af
n=0.030 L=170.0' S=0.0118 '/' Capacity=28.90 cfs Outflow=1.39 cfs 0.063 af

Reach 8R: 18" RCP Pipe Peak Depth=0.38' Max Vel=4.4 fps Inflow=1.53 cfs 0.065 af
D=18.0" n=0.013 L=45.0' S=0.0111 '/' Capacity=11.07 cfs Outflow=1.51 cfs 0.065 af

Pond 1P: Wet Detention Basin Peak Elev=210.39' Storage=15,320 cf Inflow=7.80 cfs 0.352 af
Primary=0.00 cfs 0.000 af Secondary=0.00 cfs 0.000 af Outflow=0.00 cfs 0.000 af

Pond 2P: Permanent Sediment Basin Peak Elev=208.61' Storage=6,417 cf Inflow=4.81 cfs 0.236 af
Primary=0.17 cfs 0.112 af Secondary=0.00 cfs 0.000 af Outflow=0.17 cfs 0.112 af

Pond ST-1: Temp. Sed. Trap-1 Peak Elev=201.71' Storage=584 cf Inflow=1.37 cfs 0.058 af
Primary=0.91 cfs 0.058 af Secondary=0.00 cfs 0.000 af Outflow=0.91 cfs 0.058 af

Pond ST-2: Temp. Sed. Trap-2 Peak Elev=200.60' Storage=285 cf Inflow=0.82 cfs 0.035 af
Primary=0.62 cfs 0.034 af Secondary=0.00 cfs 0.000 af Outflow=0.62 cfs 0.034 af

Total Runoff Area = 11.400 ac Runoff Volume = 0.989 af Average Runoff Depth = 1.04"

Subcatchment 1S: DA-6

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.37 cfs @ 11.96 hrs, Volume= 0.058 af, Depth> 1.22"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
0.570	79	<50% Grass cover, Poor, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: DA-5

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.82 cfs @ 11.96 hrs, Volume= 0.035 af, Depth> 1.22"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
0.340	79	<50% Grass cover, Poor, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: DA - 2C

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.02 cfs @ 11.96 hrs, Volume= 0.044 af, Depth> 1.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
0.240	79	<50% Grass cover, Poor, HSG B
0.110	85	Gravel roads, HSG B
0.020	98	Paved parking & roofs
0.370	82	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 4S: DA-1B

[49] Hint: Tc<2dt may require smaller dt

Runoff = 6.82 cfs @ 11.96 hrs, Volume= 0.289 af, Depth> 1.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
1.130	69	50-75% Grass cover, Fair, HSG B
1.120	85	Gravel roads, HSG B
0.450	98	Paved parking & roofs
2.700	80	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5S: DA-7

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.53 cfs @ 11.97 hrs, Volume= 0.065 af, Depth> 0.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
0.880	69	Pasture/grassland/range, Fair, HSG B
0.120	85	Gravel roads, HSG B
1.000	71	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 6S: DA - 2B

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.06 cfs @ 11.96 hrs, Volume= 0.045 af, Depth> 1.22"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
0.440	79	<50% Grass cover, Poor, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 8S: DA - 2A

[49] Hint: Tc<2dt may require smaller dt

Runoff = 3.50 cfs @ 11.96 hrs, Volume= 0.148 af, Depth> 1.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
1.020	79	50-75% Grass cover, Fair, HSG C
0.300	89	Gravel roads, HSG C
1.320	81	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9S: DA-1A

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.50 cfs @ 11.96 hrs, Volume= 0.064 af, Depth> 0.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
0.510	69	50-75% Grass cover, Fair, HSG B
0.240	85	Gravel roads, HSG B
0.020	98	Paved parking & roofs
0.770	75	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland at Northern Site)

Runoff = 3.49 cfs @ 12.00 hrs, Volume= 0.162 af, Depth> 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
2.800	69	Pasture/grassland/range, Fair, HSG B

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	190	0.1000	0.4		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 14S: DA-4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.89 cfs @ 11.97 hrs, Volume= 0.080 af, Depth> 0.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
0.790	69	Pasture/grassland/range, Fair, HSG B
0.300	85	Gravel roads, HSG B
1.090	73	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Reach 3R: 18" RCP Pipe

[52] Hint: Inlet conditions not evaluated

Inflow Area = 2.090 ac, Inflow Depth > 0.84" for 1-YEAR event
Inflow = 3.40 cfs @ 11.97 hrs, Volume= 0.146 af
Outflow = 2.70 cfs @ 12.10 hrs, Volume= 0.144 af, Atten= 20%, Lag= 7.8 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.3 fps, Min. Travel Time= 4.8 min
Avg. Velocity = 1.3 fps, Avg. Travel Time= 11.9 min

Peak Depth= 0.73' @ 12.02 hrs
Capacity at bank full= 5.90 cfs
Inlet Invert= 207.00', Outlet Invert= 204.00'
18.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 950.0' Slope= 0.0032 '/'

Reach 4R: Water Quality Swale DC - 2B

Inflow Area = 0.370 ac, Inflow Depth > 1.41" for 1-YEAR event
Inflow = 1.02 cfs @ 11.96 hrs, Volume= 0.044 af
Outflow = 0.93 cfs @ 12.04 hrs, Volume= 0.043 af, Atten= 9%, Lag= 4.9 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.8 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 0.7 fps, Avg. Travel Time= 7.1 min

Peak Depth= 0.51' @ 11.99 hrs
Capacity at bank full= 16.80 cfs
Inlet Invert= 214.00', Outlet Invert= 211.00'
0.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 310.0' Slope= 0.0097 '/'

Reach 5R: Warter Quality Swale DC-2A

Inflow Area = 1.320 ac, Inflow Depth > 1.35" for 1-YEAR event
Inflow = 3.50 cfs @ 11.96 hrs, Volume= 0.148 af
Outflow = 3.18 cfs @ 12.03 hrs, Volume= 0.147 af, Atten= 9%, Lag= 4.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.6 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 0.8 fps, Avg. Travel Time= 8.1 min

Peak Depth= 0.39' @ 11.99 hrs
Capacity at bank full= 102.94 cfs
Inlet Invert= 216.00', Outlet Invert= 210.00'
2.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 400.0' Slope= 0.0150 '/'

Reach 6R: 18" Culvert

[52] Hint: Inlet conditions not evaluated

Inflow Area = 0.770 ac, Inflow Depth > 0.99" for 1-YEAR event
Inflow = 1.39 cfs @ 12.00 hrs, Volume= 0.063 af
Outflow = 1.32 cfs @ 12.04 hrs, Volume= 0.063 af, Atten= 5%, Lag= 1.9 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.6 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.3 fps, Avg. Travel Time= 2.8 min

Peak Depth= 0.40' @ 12.02 hrs
Capacity at bank full= 8.67 cfs
Inlet Invert= 209.50', Outlet Invert= 208.00'
18.0" Diameter Pipe, n= 0.013 Corrugated PE, smooth interior
Length= 220.0' Slope= 0.0068 '/'

Reach 7R: Channel DC-1A

Inflow Area = 0.770 ac, Inflow Depth > 0.99" for 1-YEAR event
Inflow = 1.50 cfs @ 11.96 hrs, Volume= 0.064 af
Outflow = 1.39 cfs @ 12.00 hrs, Volume= 0.063 af, Atten= 8%, Lag= 2.4 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.0 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 0.9 fps, Avg. Travel Time= 3.3 min

Peak Depth= 0.49' @ 11.98 hrs
Capacity at bank full= 28.90 cfs
Inlet Invert= 213.00', Outlet Invert= 211.00'
0.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 170.0' Slope= 0.0118 '/'

Reach 8R: 18" RCP Pipe

[52] Hint: Inlet conditions not evaluated

Inflow Area = 1.000 ac, Inflow Depth > 0.79" for 1-YEAR event
Inflow = 1.53 cfs @ 11.97 hrs, Volume= 0.065 af
Outflow = 1.51 cfs @ 11.97 hrs, Volume= 0.065 af, Atten= 2%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.4 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.7 fps, Avg. Travel Time= 0.5 min

Peak Depth= 0.38' @ 11.97 hrs
Capacity at bank full= 11.07 cfs
Inlet Invert= 215.50', Outlet Invert= 215.00'
18.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 45.0' Slope= 0.0111 '/'

Pond 1P: Wet Detention Basin

[63] Warning: Exceeded Reach 6R inflow depth by 0.83' @ 19.95 hrs

Inflow Area = 3.470 ac, Inflow Depth > 1.22" for 1-YEAR event
Inflow = 7.80 cfs @ 11.97 hrs, Volume= 0.352 af
Outflow = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 210.39' @ 20.00 hrs Surf.Area= 6,820 sf Storage= 15,320 cf
Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	207.00'	40,711 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
207.00	1,898	0	0
208.00	3,673	2,786	2,786
210.50	6,966	13,299	16,084
212.00	10,770	13,302	29,386
213.00	11,880	11,325	40,711

Device	Routing	Invert	Outlet Devices
#1	Primary	207.00'	**18.0" x 80.0' long Barrel** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 202.00' S= 0.0625 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections
#2	Device 1	210.80'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	211.50'	**24.0" Horiz. Riser** Limited to weir flow C= 0.600
#4	Secondary	212.00'	**20.0' long x 10.0' breadth Emergency Spillway** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=207.00' (Free Discharge)
└**1=Barrel** (Controls 0.00 cfs)
└**2=Orifice/Grate** (Controls 0.00 cfs)
└**3=Riser** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=207.00' (Free Discharge)
└**4=Emergency Spillway** (Controls 0.00 cfs)

Pond 2P: Permanent Sediment Basin

Inflow Area = 2.130 ac, Inflow Depth > 1.33" for 1-YEAR event
Inflow = 4.81 cfs @ 12.02 hrs, Volume= 0.236 af
Outflow = 0.17 cfs @ 14.72 hrs, Volume= 0.112 af, Atten= 97%, Lag= 162.1 min
Primary = 0.17 cfs @ 14.72 hrs, Volume= 0.112 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 208.61' @ 14.72 hrs Surf.Area= 3,734 sf Storage= 6,417 cf
Plug-Flow detention time= 236.6 min calculated for 0.112 af (48% of inflow)
Center-of-Mass det. time= 153.1 min (950.0 - 796.8)

Volume	Invert	Avail.Storage	Storage Description
#1	206.00'	12,556 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
206.00	1,185	0	0
210.00	5,093	12,556	12,556

Device	Routing	Invert	Outlet Devices
#1	Primary	206.00'	**4.0" x 40.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 205.00' S= 0.0250 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior
#2	Secondary	209.30'	**10.0' long x 10.0' breadth Emergency Spillway** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#3	Device 1	206.00'	**2.0" Vert. Faircloth Skimmer** C= 0.600

Primary OutFlow Max=0.17 cfs @ 14.72 hrs HW=208.61' (Free Discharge)
└**1=Culvert** (Passes 0.17 cfs of 0.33 cfs potential flow)
└**3=Faircloth Skimmer** (Orifice Controls 0.17 cfs @ 7.7 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=206.00' (Free Discharge)
└**2=Emergency Spillway** (Controls 0.00 cfs)

Pond ST-1: Temp. Sed. Trap-1

Inflow Area = 0.570 ac, Inflow Depth > 1.22" for 1-YEAR event
Inflow = 1.37 cfs @ 11.96 hrs, Volume= 0.058 af
Outflow = 0.91 cfs @ 12.03 hrs, Volume= 0.058 af, Atten= 33%, Lag= 4.4 min
Primary = 0.91 cfs @ 12.03 hrs, Volume= 0.058 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 201.71' @ 12.03 hrs Surf.Area= 569 sf Storage= 584 cf
Plug-Flow detention time= 16.1 min calculated for 0.057 af (99% of inflow)
Center-of-Mass det. time= 13.0 min (809.3 - 796.4)

Volume	Invert	Avail.Storage	Storage Description
#1	201.00'	2,881 cf	**Custom Stage Data (Prismatic)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
201.00	396	0	0
204.50	1,250	2,881	2,881

Device	Routing	Invert	Outlet Devices
#1	Primary	201.00'	**Rock Dam** Head (feet) 0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 Disch. (cfs) 0.000 0.390 1.640 3.860 7.140 11.610 17.360 24.500
#2	Secondary	204.50'	**143.0 deg x 10.0' long Sharp-Crested Vee/Trap Weir** C= 2.47

Primary OutFlow Max=0.89 cfs @ 12.03 hrs HW=201.70' (Free Discharge)
└**1=Rock Dam** (Custom Controls 0.89 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=201.00' (Free Discharge)
└**2=Sharp-Crested Vee/Trap Weir** (Controls 0.00 cfs)

Pond ST-2: Temp. Sed. Trap-2

Inflow Area = 0.340 ac, Inflow Depth > 1.22" for 1-YEAR event
Inflow = 0.82 cfs @ 11.96 hrs, Volume= 0.035 af
Outflow = 0.62 cfs @ 12.02 hrs, Volume= 0.034 af, Atten= 24%, Lag= 3.6 min
Primary = 0.62 cfs @ 12.02 hrs, Volume= 0.034 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 200.60' @ 12.02 hrs Surf.Area= 266 sf Storage= 285 cf
Plug-Flow detention time= 9.8 min calculated for 0.034 af (99% of inflow)
Center-of-Mass det. time= 8.1 min (804.4 - 796.4)

Volume	Invert	Avail.Storage	Storage Description
#1	200.00'	1,673 cf	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
200.00	156	0	0
203.50	800	1,673	1,673

Device	Routing	Invert	Outlet Devices
#1	Primary	200.00'	**Rock Dam** Head (feet) 0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 Disch. (cfs) 0.000 0.390 1.640 3.860 7.140 11.610 17.360 24.500
#2	Secondary	203.50'	**143.0 deg x 10.0' long Sharp-Crested Vee/Trap Weir** C= 2.47

Primary OutFlow Max=0.59 cfs @ 12.02 hrs HW=200.58' (Free Discharge)
↑—**1=Rock Dam** (Custom Controls 0.59 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=200.00' (Free Discharge)
↑—**2=Sharp-Crested Vee/Trap Weir** (Controls 0.00 cfs)

HydroCAD Analysis of Pre-Development Condition
(1-Year Storm Event)

Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland a Runoff Area=4.170 ac Runoff Depth>0.74"
Flow Length=200' Tc=6.3 min CN=70 Runoff=5.75 cfs 0.257 af

Subcatchment 14S: DA-4 (Direct Sheet Flow into the Wetland Runoff Area=2.380 ac Runoff Depth>0.74"
Flow Length=240' Tc=7.9 min CN=70 Runoff=3.08 cfs 0.146 af

Subcatchment 15S: DA-2 (Direct Sheet Flow into the wetland Runoff Area=1.160 ac Runoff Depth>0.83"
Flow Length=150' Tc=4.7 min CN=72 Runoff=1.93 cfs 0.081 af

Subcatchment 16S: DA-1 (Direct Sheet Flow into the wetland Runoff Area=2.110 ac Runoff Depth>0.74"
Flow Length=180' Tc=5.6 min CN=70 Runoff=2.97 cfs 0.130 af

Total Runoff Area = 9.820 ac Runoff Volume = 0.614 af Average Runoff Depth = 0.75"

Subcatchment 11S: DA-3 (Direct Sheet flow into the wetland at northwest site)

Runoff = 5.75 cfs @ 11.99 hrs, Volume= 0.257 af, Depth> 0.74"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
3.790	69	Pasture/grassland/range, Fair, HSG B
0.160	85	Gravel roads, HSG B
0.220	85	Gravel roads, HSG B
4.170	70	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	200	0.1500	0.5		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 14S: DA-4 (Direct Sheet Flow into the Wetland at Easterm Site)

Runoff = 3.08 cfs @ 12.00 hrs, Volume= 0.146 af, Depth> 0.74"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
2.190	69	Pasture/grassland/range, Fair, HSG B
0.150	85	Gravel roads, HSG B
0.040	98	Paved parking & roofs
2.380	70	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	240	0.1250	0.5		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 15S: DA-2 (Direct Sheet Flow into the wetland on northern side)

Runoff = 1.93 cfs @ 11.96 hrs, Volume= 0.081 af, Depth> 0.83"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
0.966	69	Pasture/grassland/range, Fair, HSG B
0.074	85	Gravel roads, HSG B
0.120	85	Recycling area
1.160	72	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	150	0.1800	0.5		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Subcatchment 16S: DA-1 (Direct Sheet Flow into the wetland on northeast side)

Runoff = 2.97 cfs @ 11.98 hrs, Volume= 0.130 af, Depth> 0.74"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-YEAR Rainfall=3.20"

Area (ac)	CN	Description
2.000	69	Pasture/grassland/range, Fair, HSG B
0.110	85	Gravel roads, HSG B
2.110	70	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.6	180	0.1660	0.5		**Sheet Flow,** Range n= 0.130 P2= 3.70"

Sediment Basin Analysis

RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services
14 N. Boylan Avenue Tel: 919-828-0577
Raleigh, NC 27603 Fax: 919-828-3899

SHEET: /
JOB #: KING 07-3
DATE: 11/16/07
BY: BDJ
CHKD BY:

Thornton Road Transfer Station
Sediment Basin Analysis

Basin No.: Permanent Sediment Basin

DESIGN FOR WET (IF APPLICABLE) AND DRY STORAGE:

Areas Draining Into Basin:

Drainage Area	Area (acres)
A1. Landfill Slopes	2.1
A2. Other Areas	0.0
Total =	2.1 Acres

Basin Requirements:

Wet Storage:

Required Storage Capacity (ft^3/Ac.) =	0	**Enter "0" if Not Applicable.**
Required Storage Capacity (ft^3) =	0	
Required Depth of Wet Storage (ft) =	0.0	**Enter "0" if Not Applicable.**

Dry Storage:

Required Storage Capacity (ft^3/Ac.) =	1,800	
Required Storage Capacity (ft^3) =	3,834	
Multipier (X) for Desired Surface Area (Qp x X) =	0.01	
Peak Discharge into Basin (Qp) (cfs) =	11.4	**From HydroCAD - 10-Yr, 24-Hr. Storm**
Desired Surface Area (Ac) =	0.11	
Desired Surface Area (ft2) =	4,953	

Determine Stage-Storage Function:

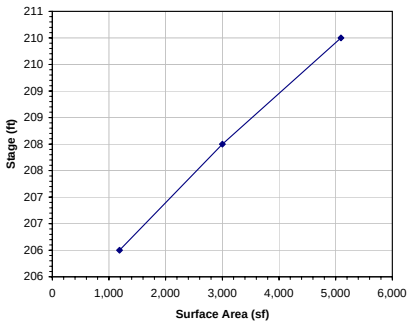
Contour	Area (ft^2)	Area (acres)	Incremental Volume (ft^3)	Cumulative Volume (ft^3)	Stage (ft)	ln S	ln Z	Z est
206	1,185	0.03		0	0			
208	3,000	0.07	4,185	4,185	2	8.34	0.69	2.00
210	5,093	0.12	8,093	12,278	4	9.42	1.39	4.00

Linear Regression Constants:

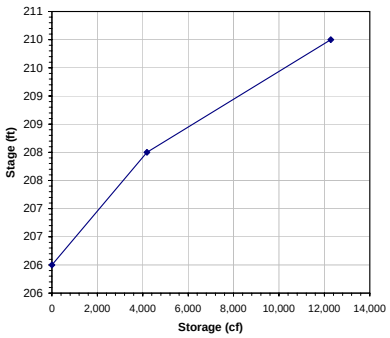
Ks =	1,426	Storage = 1426 z^1.55
b =	1.55	

***CAUTION: CHECK INPUT FOR REGRESSION ANALYSIS!**

Stage-Surface Area Relationship



Stage-Storage Relationship



Basin Design Elevations:

Elev. of Bottom of Basin =	206.0	

Cleanout:

Cleanout Requirement (% of Wet Storage) =	0	**Enter "0" if Not Applicable**
Cleanout Requirement (% of Total Storage) =	50	
Basin Cleanout Volume (ft^3) =	4,989	**Based on 50% of Total Storage Volume**
Basin Cleanout Elevation =	208.2	

Option-2 Faircloth Skimmer

Storage Volume (ft^3) =	3,834	
Required Orifice Diameter (in) =	2.0	**From Design Chart Based on 2 to 5 Day Drawdown**

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Basin Shape:

Length of Basin (ft) =	170	
Width of Basin (ft) =	50	
Desired Length to Width Ratio (X:1) =	3	
Actual Length to Width Ratio (X:1) =	3.4	**O.K.**

ROUTE DESIGN STORM: **Use HydroCAD or Other Method.**

Design Parameters:

Design Storm:	10-Yr, 24-Hr
Design Storm Rainfall (in) =	5.49
Rainfall Distribution:	Type II
Runoff Method:	SCS TR-20

Results:

Maximum Pool Elevation =	209.7	
Surface Area at Maximum Pool (ft^2) =	4,558	
Peak Discharge (cfs) =	6.4	

Check Settling Efficiency:

Particle Data:

Diam. (microns) =	40	
Specific Gravity =	2.65	
Settling Veloc. (ft/s) =	0.004140	
Reynolds No. (<0.5) =	0.044284	**O.K.**

Efficiency Data:

Desired Efficiency (%) =	80	
No. of Effective Cells =	2	
Settling Efficiency (%) =	84	**O.K.**

DESIGN OUTLET STRUCTURES:

Design Barrel Structures:

Outlets:

Outlet No. 1 (for Dewatering Dry Storage): Size: 2.0" Dia **Faircloth skimmer**
Invert Elevation: 206.0

Barrel Design:

Type of Barrel:	CPP
Diameter (in) =	4
Inv. In Elevation =	206.0
Inv. Out Elevation =	205.0
Length (ft) =	40.0
Slope (ft/ft) =	0.025

Emergency Spillway Calculations:

Crest Elev. (ft) =	209.3	
Required Freeboard (ft) =	0.7	
Top of Berm Elev. (ft) =	210.0	
Required Capacity (cfs) =	6.4	**From HydroCAD - 10-Yr, 24-Hr. Storm**
Driving Head (ft) =	0.39	**From HydroCAD - 10-Yr, 24-Hr. Storm**
Weir Coefficient =	3.0	
Length of Crest (ft) =	9	**Determine by Weir Equation***
Design Crest Length (ft) =	10	

SUMMARY DATA:

Basin No.: Permanent Sediment Basin

Elev. of Bottom of Basin =	206.0
Cleanout Elev. (ft) =	208.2
Emergency Spillway Elev. (ft) =	209.3
Top of Berm Elev. (ft) =	210.0
Top of Berm Width (ft) =	10
Barrel Diameter (in) =	4
Barrel Slope (%) =	2.5

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Engineering and Geological Services
14 N. Boylan Avenue Tel: 919-828-0577
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SHEET: /
JOB #: King 07-2
DATE: 2/28/08
BY: KBS
CHKD BY:

Shotwell Transfer Station
Wet Detention Basin Analysis **Basin No.: WDB-1**

DESIGN PERMANENT AND TEMPORARY WATER QUALITY POOLS:

Areas Draining Into Basin & % Impervious:

Drainage Area	Area (acres)	% Impervious
A1. Landfill Slopes	1.68	0
A2. Other Areas	1.80	100
Total =	3.48	Acres
Avg. % Impervious =	52	

Required Surface Area/Drainage Area Ratios*:

	Permanent Pool Depth (ft)			
	3.0	4.0	5.0	6.0
Ratio (%)	2.14	1.73	1.50	1.30

Based on 52 % Impervious Area

Source: NCDENR Stormwater BMP Manual Table 3.3-1 (Piedmont)

Required Surface Area of Permanent Pool:

	Permanent Pool Depth (ft)			
	3.0	4.0	5.0	6.0
Area (acres)	0.07	0.06	0.05	0.05
Area (ft^2)	3,244	2,622	2,274	1,971

Required Volume of Permanent and Temporary Water Quality Pools:

Water Quality Requirements - Runoff from Design Rainfall:

Rv (in/in) =	0.52
Design Rainfall (in) =	1.0
Required Volume (acre-feet) =	0.15
Required Water Quality Volume (ft^3) =	6,512

Land Quality Requirements - Required Storage/Acre:

Required Storage Capacity (ft^3/Ac.) =	1,800
Required Sediment Storage Volume (ft^3) =	6,264

Required Water Quality Volume (ft^3) = 6,512 **Water Quality Requirements Control**

SHEET:	/
JOB #:	King 07-2
DATE:	2/28/08
BY:	KBS
CHKD BY:	

Determine Stage-Storage Function:

Contour	Area (ft^2)	Area (acres)	Incremental Volume (ft^3)	Cumulative Volume (ft^3)	Stage (ft)	ln S	ln Z	Z est
207	1,898	0.04		0	0			
208	3,673	0.08	2,786	2,786	1	7.93	0.00	1.00
210.5	6,966	0.16	13,299	16,084	3.5	9.69	1.25	3.50
212	10,770	0.25	28,886	31,672	5	10.36	1.61	5.00
213	11,880	0.27	11,325	42,997	6	10.67	1.79	6.00

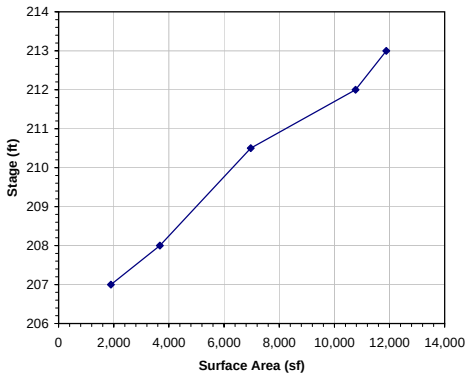
Linear Regression Constants:

Ks = 2,700 Storage = 2700 z^1.51

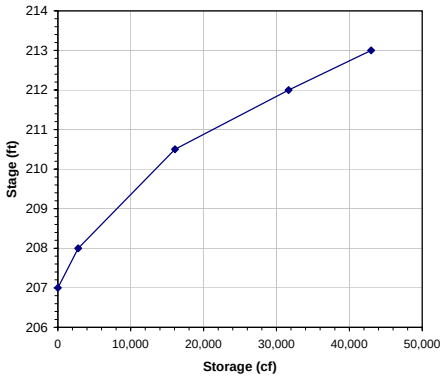
b = 1.51

***CAUTION: CHECK INPUT FOR REGRESSION ANALYSIS!**

Stage-Surface Area Relationship



Stage-Storage Relationship



Basin Design Elevations:

Elev. of Bottom of Basin =	207.0	
Elev. of Permanent Pool =	210.0	
Depth of Permanent Pool =	3.0	**O.K.**
Required Surface Area at Permanent Pool (ft^2) =	3,244	**From Table Above Based on Depth of Permanent Pool**
Actual Surface Area at Permanent Pool (ft^2) =	7,189	**O.K.**
Required Storage Volume of Permanent Pool (ft^3) =	6,512	**Equals Req'd. Water Quality Volume**
Storage Volume of Permanent Pool (ft^3) =	14,246	**O.K.**
Permanent Pool Cleanout Volume (ft^3) =	3,562	**= 25% of Permanent Pool Storage Volume**
Permanent Pool Cleanout Elevation =	208.2	
Req'd. Storage Volume at Temp. Water Quality Pool (ft^3) =	20,758	**Storage Volume of Permanent Pool + Req'd. Volume of Temp. Water Quality Pool**
Min. Elev. of Temporary Water Quality Pool =	210.8	
Selected Elev. of Temporary Water Quality Pool =	210.8	**OK**

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Dewatering of Temporary Water Quality Pool:

Average Head (ft) =	0.4	
Surface Area at Temporary Water Quality Pool (ft^2) =	8,117	
Coef. of Contraction =	0.6	
Min. Drawdown Period (hrs) =	48	
Max. Drawdown Period (hrs) =	120	
Max. Area of Dewatering Hole (ft^2) =	0.01	**Based on Min. Detention Time**
Max. Diameter of Dewatering Hole (in) =	1.5	
Min. Area of Dewatering Hole (ft^2) =	0.00	**Based on Max. Detention Time**
Min. Diameter of Dewatering Hole (in) =	1.0	
Selected Diameter of Dewatering Hole(s) (in) =	1.5	
Number of Dewatering Holes =	1	
Actual Area of Dewatering Hole(s) (ft^2) =	0.01	
Actual Drawdown Period (hrs) =	48	**O.K.**

Basin Drain Calculations:

Average Head (ft) =	1.9	
Surface Area at Temporary Water Quality Pool (ft^2) =	8,117	
Coef. of Contraction =	0.6	
Desired Drawdown Period (hrs) =	24	
Min. Area of Dewatering Hole (ft^2) =	0.05	**Based on Max. Detention Time**
Min. Diameter of Dewatering Hole (in) =	3.1	
Selected Diameter of Dewatering Hole (in) =	4	
Actual Area of Dewatering Hole (ft^2) =	0.09	
Actual Drawdown Period (hrs) =	15	**O.K.**

Forebay Calculations:

Required Volume of Forebay(s) (ft^3) = 1,302 **= 20% of Required Permanent Pool Storage Volume**

Forebay: **#1 - East**

Contour	Area (ft^2)	Area (acres)	Incremental Volume (ft^3)	Cumulative Volume (ft^3)	Stage (ft)	ln S	ln Z	Z est
708	425	0.01		0	0			
709	600	0.01	513	513	1	6.24	0.00	1.00
711	1,218	0.03	1,364	1,876	2.5	7.54	0.92	2.50

Linear Regression Constants:

Ks =	513	Storage = 2700 z^1.51
b =	1.42	

Elev. of Bottom of Forebay =	708.0	
Top Elevation of Forebay =	710.5	
Forebay Storage (ft^3) =	1,876	**O.K.**
Forebay Cleanout Volume (ft^3) =	938	**= 50% of Forebay Storage Volume**
Forebay Cleanout Elevation =	709.5	

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Basin Shape:

Length of Basin (ft) =	300	**Measured at Permanent Pool Elevation**
Width of Basin (ft) =	50	**Measured at Permanent Pool Elevation**
Desired Length to Width Ratio (X:1) =	3	
Actual Length to Width Ratio (X:1) =	6.0	**O.K.**

ROUTE DESIGN STORM: **Use HydroCAD or Other Method.**

Design Parameters:

Design Storm:	25-Yr, 24-Hr
Design Storm Rainfall (in) =	6.55
Rainfall Distribution:	Type II
Runoff Method:	SCS TR-20

Results:

Maximum Pool Elevation =	211.8
Surface Area at Maximum Pool (ft^2) =	9,153
Peak Discharge (cfs) =	4.0

Check Settling Efficiency:

Particle Data:

Diam. (microns) =	40	
Specific Gravity =	2.65	
Settling Veloc. (ft/s) =	0.004140	
Reynolds No. (<0.5) =	0.044284	**O.K.**

Efficiency Data:

Desired Efficiency (%) =	80	
No. of Effective Cells =	1	**Use of Forebay(s) Justifies Value of 2**
Settling Efficiency (%) =	90.5	**O.K.**

DESIGN OUTLET STRUCTURES:

Design Riser/Barrel Structures:

Riser Design:

Type of Riser:	CMP - Circular
Riser Base Elevation =	207.0
Riser Top Elevation =	211.5
Riser Height (ft) =	4.5

Outlets:

Outlet No. 1 (for Dewatering TWQ Pool):	Size:	4" Diam. Orifice	**From Above - Dewatering of TWQ Pool**
	Invert Elevation:	210.8	**May Vary For Multiple Holes**
Outlet No. 2 (Principal Spillway):	Size:	24.0	
	Invert Elevation:	211.5	

Riser Inside Diameter (ft) =	2.0
Approx. Circ. Riser Interior Volume (cf) =	14

Barrel Design:

Type of Barrel:	CMP
Diameter (in) =	18
Inv. In Elevation =	207.0
Inv. Out Elevation =	202.0
Length (ft) =	80.0
Slope (ft/ft) =	0.063

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Riser Base Calculations:

Design Uplift Force:

Factor of Safety =	1.25	
F (unadjusted) (lbs) =	1,103	
	0	
	0	
CMP Riser Buoyant Weight (lbs) =	0	
	0	
Buoyant Wt. of Riser Top (lbs) =	0	
Buoyant Wt. of Surrounding Soil Acting on Ext. Base (lbs) =	0	
Sliding Resistance of Surrounding Soil (lbs) =	0	
F (adjusted) (lbs) =	1,103	

Concrete Base:

Required Volume of Concrete (ft^3) =	12.6	
Length (ft) =	4.0	
Width (ft) =	4.0	
Thickness (ft) =	2.0	
Actual Volume of Concrete (ft^3) =	32.0	**O.K.**

Anti-Seepage Collar Calculations: (Alternatively - Design Filter Diaphragm)

Slope of Upstream Embankment (zH:1V) =	3	
Slope of Outlet Pipe (ft/ft) =	0.063	
Ls (ft) =	42	
Number of Collars:	2	
Length of Each Collar (ft) =	3.5	**From Design Chart Based on Ls and No. of Collars**
Width of Each Collar (ft) =	3.5	**From Design Chart Based on Ls and No. of Collars**
Collar Projection, P (ft) =	1	
Spacing of Subsequent Anti-Seep Collars (ft) =	14	**= 14P**

Emergency Spillway Calculations:

Crest Elev. (ft) =	212.0	
Required Freeboard (ft) =	2.0	
Top of Berm Elev. (ft) =	214.0	
Required Capacity (cfs) =	7.0	**From HydroCAD - 100-Yr, 24-Hr. Storm**
Driving Head (ft) =	0.3	**From HydroCAD - 100-Yr, 24-Hr. Storm**
Weir Coefficient =	3.0	
Length of Crest (ft) =	14.2	**Determine by Weir Equation***
Design Crest Length (ft) =	20	

*** Length = 20 ft minimum.**

SUMMARY DATA:

Basin No.: WDB-1

Elev. of Bottom of Basin =	207.0	
Cleanout Elev. (ft) =	208.2	
Elev. of Permanent Pool =	210.0	
Elev. of Temporary Water Quality Pool =	210.8	**See Above for Riser and Other Design Information.**
Emergency Spillway Elev. (ft) =	212.0	
Top of Berm Elev. (ft) =	214.0	
Top of Berm Width (ft) =	10	
Barrel Diameter (in) =	18	
Barrel Slope (%) =	6.3	

Sediment Trap Analysis

PROJECT Shotwell Transfer Station, Inc.

SUBJECT Sediment Trap/Rock Dam Analysis

SHEET 1 **OF** _____
JOB NO. King 07-1
DATE 1/24/08
COMPUTED BY KBS
CHECKED BY _____

Objective To design a sediment trap(s) and/or rock dam(s) to satisfy erosion and sediment control requirements and to handle the flow from the design storm.

References

Koerner, Robert M. (1999), Designing with Geosynthetics, 4th Ed., Prentice-Hall Inc., Englewood Cliffs, NJ, p. 463.

Malcom, H. Rooney (1989 & 2003 Supplement), Elements of Urban Stormwater Design, NC State Univ., Raleigh, NC.

North Carolina Division of Land Resources (2006), North Carolina Erosion & Sediment Control Planning & Design Manual, Raleigh, NC.

Analysis The following approach is used to properly size and evaluate each sediment trap/rock dam:

1. Design for Wet (If Applicable) and Dry Storage.
2. Perform Spillway Calculations.

Calculations

- Design for Wet (If Applicable) and Dry Storage:

  - Determine required wet (if applicable) and dry storage volumes based on applicable erosion and sedimentation control requirements.

  - If applicable, calculate the desired surface area at the measurement elevation. For some locations:

$$A = 0.01 Q_P$$

where: A = desired surface area (acres)
Q_P = peak discharge from design storm (cfs)
(NC - Use 10-yr 24-hr storm; GA - Use 2-yr 24-hr storm)

- Size Basin:

Rectangular Basin:

$$V = HLW - SH^2 L - SH^2 W + 2S^2 H^3 \qquad \text{(Koerner Eq. 5.17)}$$

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where: V = volume of basin
H = height at center
W = width at measurement elevation
L = length at measurement elevation
S = side slope ratio (i.e. 2 for 2:1 slopes)

Custom Size (or Refined Rectangular Basin):

- Set up a stage-storage relationship for the proposed basin as shown below. Based on this relationship and the required volume(s) and/or desired surface area, determine the required wet storage (if applicable) and dry storage elevations. Alternatively the elevation(s) can be determined from a graphical stage-storage relationship.

$$S = K_S Z^b \qquad \text{(Malcom Eq. III-7)}$$

where: S = storage volume (ft^3)
K_S, b = linear regression constants describing the stage-storage relationship
Z = stage referenced to the bottom elevation included in the analysis (ft)

- Set cleanout elevation.

- Set spillway (weir) elevation.

- Evaluate basin shape. Compare with the recommended length to width ratio. If this ratio is not achieved, the basin should be modified or baffles should be added as required.

- Spillway Calculations:

- Design crest length of spillway to handle flow from the design storm using the following equation. Determine peak flow from stormwater routing program.

$$Q_P = C_W L H^{3/2} \qquad \text{(Malcom Eq. I-6)}$$

where: Q_P = peak discharge from design storm (cfs)
C_w = weir coefficient (=3.0 for free overfall)
L = length of weir (ft)
H = driving head (ft) (= allowable headwater above crest of weir or calculated value from stormwater routing program)

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SHEET: /
JOB #: King 07-1
DATE: 3/3/08
BY: KBS
CHKD BY:

Shotwell Transfer Station, Inc.
Sediment Trap/Rock Dam Analysis **Trap/Rock Dam No.: ST-1**

DESIGN FOR WET (IF APPLICABLE) AND DRY STORAGE:

Areas Draining Into Basin:

Drainage Area	Area (acres)
A5	0.57
Total =	0.57 Acres

Basin Requirements:

Wet Storage:

Required Storage Capacity (ft^3/Ac.) =	0	**Enter "0" if Not Applicable.**
Required Storage Capacity (ft^3) =	0	
Required Depth of Wet Storage (ft) =	0.0	**Enter "0" if Not Applicable.**

Dry Storage:

Required Storage Capacity (ft^3/Ac.) =	1,800	**To Measurement Elevation**
Required Storage Capacity (ft^3) =	1,026	
Multipier (X) for Desired Surface Area (Qp x X) =	0.01	**At Measurement Elevation**
Peak Discharge into Basin (Qp) (cfs) =	3.0	**From HydroCAD - 10-Yr, 24-Hr. Storm**
Desired Surface Area (Ac) =	0.03	
Desired Surface Area (ft^2) =	1,307	

SIZE BASIN:

Rectangular Basin - Initial Sizing (If Used):

Depth or Height (ft) =	3.5	**Bottom of Basin to Measurement Elevation**
Length:Width Ratio =	2	(Min. = 2)
Side Slope Ratio =	2	(Max. = 2)

Length of Basin @ Measurement Elev. (ft) =	50 **(Iterate)**	Volume Reqd. (ft^3) =	1,026
Width of Basin @ Measurement Elev. (ft) =	25	Volume Actual (ft^3) =	2,881 **O.K.**
Length of Basin @ Base (ft) =	36	Surface Area Reqd. (ft^2) =	1,307
Width of Basin @ Base (ft) =	11	Surface Area Actual (ft^2) =	1,250 **O.K. Close to required area**

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Custom Size - or Refined Rectangular Basin:

Determine Stage-Storage Function:

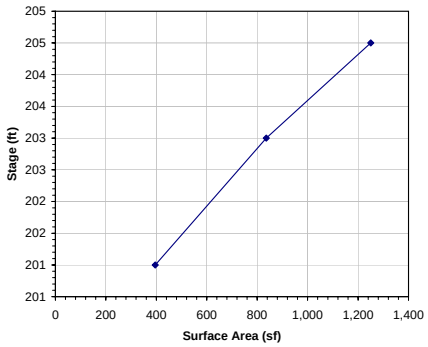
Contour	Area (ft^2)	Area (acres)	Incremental Volume (ft^3)	Cumulative Volume (ft^3)	Stage (ft)	ln S	ln Z	Z est
201	396	0.009		0	0			
203	836	0.019	1,232	1,232	2	7.12	0.69	2.00
204.5	1,250	0.029	1,565	2,797	3.5	7.94	1.25	3.50

Linear Regression Constants:

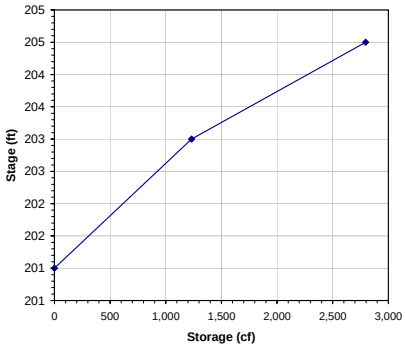
Ks = 446 Storage = 446 z^1.46
b = 1.46

***CAUTION: CHECK INPUT FOR REGRESSION ANALYSIS!**

Stage-Surface Area Relationship



Stage-Storage Relationship



Basin Design Elevations: ***Based on Custom Size**

Elev. of Bottom of Basin = 201.0

Wet Storage:

Required Storage Capacity (ft^3) = 0
Min. Elev. of Wet Storage (Permanent Pool) = 201.0
Selected Elev. of Wet Storage (Permanent Pool) = 201.0 **O.K.**
Actual Wet Storage Volume (ft^3) = 0 **O.K.**

Dry Storage:

Required Storage Capacity (ft^3) = 1,026 **= Required Dry Storage + Actual Wet Storage**
Min. Measurement Elev. = 202.8
Selected Measurement Elev. = 204.5 **O.K.**
Actual Total Storage Volume (ft^3) = 2,797 **O.K.**

Desired Surface Area (ft^3) = 1,307
Actual Surface Area at Spillway (Weir) (ft^2) = 1,170 **Increase Surface Area at Permanent Pool If Possible.** **O.K. Close to required area**

Cleanout:

Cleanout Requirement (% of Wet Storage) = 0 **Enter "0" if Not Applicable**
Cleanout Requirement (% of Total Storage) = 50
Basin Cleanout Volume (ft^3) = 1,398 **Based on 50% of Total Storage Volume**
Basin Cleanout Elevation = 203.2

Spillway (Weir) Elev.:

Spillway (Weir) Elev. - Measurement Elev. (ft) = 0 **Enter "0" if Measurement Elevation is at Weir**
Spillway (Weir) Elevation = 204.5

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Basin Shape:

Length of Basin (ft) =	60.0	**Measured at Crest of Weir**
Width of Basin (ft) =	30.0	**Measured at Crest of Weir**
Desired Length to Width Ratio (X:1) =	2	
Actual Length to Width Ratio (X:1) =	2	**O.K.**

SPILLWAY CALCULATIONS:

Crest Elev. (ft) =	204.5	
Required Freeboard (ft) =	1.5	
Top of Berm Elev. (ft) =	206.0	
Required Capacity (cfs) =	0.0	**From HydroCAD - 10-Yr, 24-Hr. Storm**
Driving Head (ft) =	0	
Weir Coefficient =	3.0	
Length of Crest (ft) =	0.0	**Determine by Weir Equation**
Design Crest Length (ft) =	4	

SUMMARY DATA:

Trap/Rock Dam No.: ST-1

Elev. of Bottom of Basin =	201.0
Cleanout Elev. (ft) =	203.2
Elev. of Wet Storage (Permanent Pool) =	NA
Elev. of Spillway (Weir) =	204.5
Top of Berm Elev. (ft) =	206.0
Top of Berm Width (ft) =	5

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SHEET: /
JOB #: King 07-1
DATE: 1/24/08
BY: KBS
CHKD BY:

Shotwell Transfer Station, Inc.
Sediment Trap/Rock Dam Analysis - Filter Flow **Trap/Rock Dam No.: ST-1**

Filter Flow (For Use in HydroCAD):

Permeability of Stone (k) (ft/sec) =	0.50	(Approx. Half of typical permeability of No. 57 Stone to account for clogging)
Base of Stone Elevation (ft) =	201	
Length of Stone at Base (ft) =	6	
Crest Elevation (ft) =	204.5	
Length of Stone at Crest (ft) =	10	

Elevation (ft)	Avg. Gradient (ft/ft)	Top Length of Stone (ft^3)	Area of Stone (ft^3)	Filter Flow (cfs)
201.00	0.00	6.00	0.00	0.00
201.50	0.25	6.57	3.14	0.39
202.00	0.50	7.14	6.57	1.64
202.50	0.75	7.71	10.29	3.86
203.00	1.00	8.29	14.29	7.14
203.50	1.25	8.86	18.57	11.61
204.00	1.50	9.43	23.14	17.36
204.50	1.75	10.00	28.00	24.50

Notes: Gradient = Average Head
Filter Flow is based on Darcy's Law (Flow = kiA)

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SHEET: /
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DATE: 1/24/08
BY: KBS
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Shotwell Transfer Station, Inc.
Sediment Trap/Rock Dam Analysis **Trap/Rock Dam No.: ST-2**

DESIGN FOR WET (IF APPLICABLE) AND DRY STORAGE:

Areas Draining Into Basin:

Drainage Area	Area (acres)
A5	0.34
Total =	0.34 Acres

Basin Requirements:

Wet Storage:

Required Storage Capacity (ft^3/Ac.) =	0	**Enter "0" if Not Applicable.**
Required Storage Capacity (ft^3) =	0	
Required Depth of Wet Storage (ft) =	0.0	**Enter "0" if Not Applicable.**

Dry Storage:

Required Storage Capacity (ft^3/Ac.) =	1,800	**To Measurement Elevation**
Required Storage Capacity (ft^3) =	612	
Multipier (X) for Desired Surface Area (Qp x X) =	0.01	**At Measurement Elevation**
Peak Discharge into Basin (Qp) (cfs) =	1.9	**From HydroCAD - 10-Yr, 24-Hr. Storm**
Desired Surface Area (Ac) =	0.02	
Desired Surface Area (ft^2) =	828	

SIZE BASIN:

Rectangular Basin - Initial Sizing (If Used):

Depth or Height (ft) =	3.5	**Bottom of Basin to Measurement Elevation**
Length:Width Ratio =	2	(Min. = 2)
Side Slope Ratio =	2	(Max. = 2)

Length of Basin @ Measurement Elev. (ft) =	40	**(Iterate)**	Volume Reqd. (ft^3) =	612
Width of Basin @ Measurement Elev. (ft) =	20		Volume Actual (ft^3) =	1,673 **O.K.**
Length of Basin @ Base (ft) =	26		Surface Area Reqd. (ft^2) =	828
Width of Basin @ Base (ft) =	6		Surface Area Actual (ft^2) =	800 **O.K. Very Close to required Area**

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Custom Size - or Refined Rectangular Basin:

Determine Stage-Storage Function:

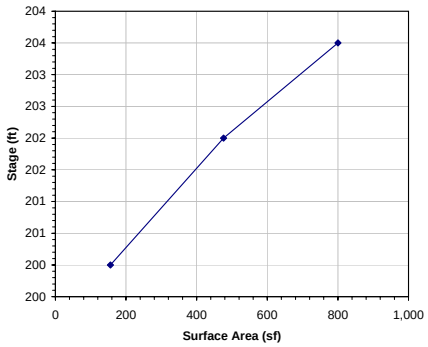
Contour	Area (ft^2)	Area (acres)	Incremental Volume (ft^3)	Cumulative Volume (ft^3)	Stage (ft)	ln S	ln Z	Z est
200	156	0.004		0	0			
202	476	0.011	632	632	2	6.45	0.69	2.00
203.5	800	0.018	957	1,589	3.5	7.37	1.25	3.50

Linear Regression Constants:

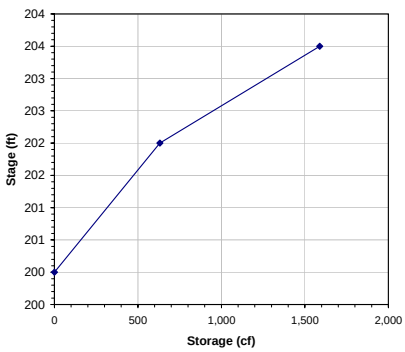
Ks = 202 Storage = 202 z^1.65
b = 1.65

***CAUTION: CHECK INPUT FOR REGRESSION ANALYSIS!**

Stage-Surface Area Relationship



Stage-Storage Relationship



Basin Design Elevations: ***Based on Custom Size**

Elev. of Bottom of Basin = 200.0

Wet Storage:

Required Storage Capacity (ft^3) = 0
Min. Elev. of Wet Storage (Permanent Pool) = 200.0
Selected Elev. of Wet Storage (Permanent Pool) = 200.0 **O.K.**
Actual Wet Storage Volume (ft^3) = 0 **O.K.**

Dry Storage:

Required Storage Capacity (ft^3) = 612 **= Required Dry Storage + Actual Wet Storage**
Min. Measurement Elev. = 202.0
Selected Measurement Elev. = 203.5 **O.K.**
Actual Total Storage Volume (ft^3) = 1,589 **O.K.**

Desired Surface Area (ft^3) = 828
Actual Surface Area at Spillway (Weir) (ft^2) = 748

Cleanout:

Cleanout Requirement (% of Wet Storage) = 0 **Enter "0" if Not Applicable**
Cleanout Requirement (% of Total Storage) = 50
Basin Cleanout Volume (ft^3) = 795 **Based on 50% of Total Storage Volume**
Basin Cleanout Elevation = 202.3

Spillway (Weir) Elev.:

Spillway (Weir) Elev. - Measurement Elev. (ft) = 0 **Enter "0" if Measurement Elevation is at Weir**
Spillway (Weir) Elevation = 203.5

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Basin Shape:

Length of Basin (ft) =	40.0	**Measured at Crest of Weir**
Width of Basin (ft) =	20.0	**Measured at Crest of Weir**
Desired Length to Width Ratio (X:1) =	2	
Actual Length to Width Ratio (X:1) =	2	**O.K.**

SPILLWAY CALCULATIONS:

Crest Elev. (ft) =	203.5	
Required Freeboard (ft) =	1.5	
Top of Berm Elev. (ft) =	205.0	
Required Capacity (cfs) =	0.0	**From HydroCAD - 10-Yr, 24-Hr. Storm**
Driving Head (ft) =	0	
Weir Coefficient =	3.0	
Length of Crest (ft) =	0.0	**Determine by Weir Equation**
Design Crest Length (ft) =	4	

SUMMARY DATA:

Trap/Rock Dam No.: ST-2

Elev. of Bottom of Basin =	200.0
Cleanout Elev. (ft) =	202.3
Elev. of Wet Storage (Permanent Pool) =	NA
Elev. of Spillway (Weir) =	203.5
Top of Berm Elev. (ft) =	205.0
Top of Berm Width (ft) =	5

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SHEET: /
JOB #: King 07-1
DATE: 1/24/08
BY: KBS
CHKD BY:

Shotwell Transfer Station, Inc.
Sediment Trap/Rock Dam Analysis - Filter Flow

Filter Flow (For Use in HydroCAD):

Permeability of Stone (k) (ft/sec) =	0.50	(Approx. Half of typical permeability of No. 57 Stone to account for clogging)
Base of Stone Elevation (ft) =	200	
Length of Stone at Base (ft) =	6	
Crest Elevation (ft) =	203.5	
Length of Stone at Crest (ft) =	10	

Elevation (ft)	Avg. Gradient (ft/ft)	Top Length of Stone (ft^3)	Area of Stone (ft^3)	Filter Flow (cfs)
200.00	0.00	6.00	0.00	0.00
200.50	0.25	6.57	3.14	0.39
201.00	0.50	7.14	6.57	1.64
201.50	0.75	7.71	10.29	3.86
202.00	1.00	8.29	14.29	7.14
202.50	1.25	8.86	18.57	11.61
203.00	1.50	9.43	23.14	17.36
203.50	1.75	10.00	28.00	24.50

Notes: Gradient = Average Head
Filter Flow is based on Darcy's Law (Flow = kiA)

Drainage Channel Analysis

PROJECT Shotwell Transfer Station, LLC

SUBJECT Drainage Channel Analysis

SHEET 1 **OF**
JOB NO. King 07-1
DATE 12/29/07
COMPUTED BY KBS
CHECKED BY

Objective To design drainage channels, ditches, etc. to handle stormwater flow from the design storm(s). The main design criteria will be to ensure that all drainage channels, ditches, etc. will be able to accommodate the peak discharge from the design storm without overtopping and without exceeding the allowable shear stress and/or velocity of the selected channel lining.

References Federal Highway Administration (2001), Urban Drainage Design Manual, Hydraulic Engineering Circular No. 22, FHWA NHI-01-021, Second Ed., U.S. Dept. of Transportation, Washington, D.C.

North Carolina Division of Land Resources (2006), North Carolina Erosion & Sediment Control Planning & Design Manual, Raleigh, NC.

Malcom, H. Rooney (1989 & 2003 Supplement), Elements of Urban Stormwater Design, NC State Univ., Raleigh, NC.

Pennsylvania DEP Bureau of Watershed Protection (2000), Erosion and Sediment Pollution Control Program Manual.

Analysis The following approach is used in the design of drainage channels:

1. Determine the peak discharge from the design storm(s) (from HydroCAD or spreadsheet methods). For permanent linings (Grass, TRM, rip rap, gabions, etc.) use the peak discharge from the 10-Yr 24-Hr storm unless otherwise specified. For grass lined channels, a smaller design storm (2-Yr 24-Hr - unless otherwise specified) is used to evaluate temporary linings.
2. Input other design parameters (bottom width; side slopes; minimum freeboard, min./max. slopes; and channel lining).
3. Based on the design parameters calculate normal depth of flow, velocity, Froude number, and maximum shear stress for both max./min. slopes. Also determine the critical slope and corresponding normal depth.
4. Compare the velocity and/or shear stress to allowable values (the maximum slope values will control). If values are exceeded, revise design parameters as required.
5. Based on normal depth values and required freeboard (generally use the greater of 6 inches or 25% of the flow depth), determine the minimum channel depth and top width for both max./min. slopes (the minimum slope values will control).
6. If the channel has a significant curved reach, evaluate the shear stress and superelevation of the water surface in the bend.

DRAINAGE CHANNEL.WPD

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Calculations

- Manning's Equation:

$$Q = \frac{1.49 A R^{2/3} S^{1/2}}{n} = AV \qquad \text{(HEC-22 Eq. 5-5)}$$

where:
- Q = discharge (cfs)
- n = Manning's roughness coefficient (See Below)
- A = cross sectional area of flow (ft^2)
- R = hydraulic radius (ft) = A/P
- P = wetted perimeter
- S = slope of channel (ft/ft)
- V = average channel velocity (ft/sec)

- Maximum Shear Stress (Tractive Force Method):

$$\tau_d = \gamma d S \qquad \text{(HEC-22 Eq. 5-13)}$$

where:
- τ_d = maximum shear stress on channel lining (lb/ft^2)
- γ = unit weight of water (62.4 lb/ft^3)
- d = maximum depth of flow (ft)
- S = channel slope (ft/ft)

- Froude Number:

$$Fr = \frac{v}{\sqrt{\frac{gA}{T}}}$$

where:
- Fr = Froude number (dimensionless)
- v = flow velocity (ft/sec)
- g = acceleration of gravity (32.2 ft/sec^2)
- A = cross-sectional area of flow (ft^2)
- T = top width of flow (ft)

Note that A/T = the hydraulic depth (D). For $Fr > 1.0$, flow is supercritical; $Fr < 1.0$, flow is subcritical; $Fr = 1.0$, flow is critical.

Critical Slope:

The critical slope (S_c) is the slope at which Fr = 1.0. When the slope is between $0.7S_c$ and $1.3S_c$, unstable flow may occur as small flow disturbances can initiate a change in the flow state. If slopes are within this range, consider additional freeboard.

- Manning's Roughness Coefficient (n):

Grass:

$$n = \frac{R^{1/6}}{\left[K + 19.97\log\left(R^{1.4}S^{0.4}\right)\right]}$$ (HEC-22 Eq. 5-6 - 5-10)

where: R = hydraulic radius (ft)
K = vegetative coefficient (depending on retardance class)
= 15.8 (Class A)
= 23.0 (Class B)
= 30.2 (Class C)
= 34.6 (Class D)
= 37.7 (Class E)
S = slope of channel (ft/ft)

Rip Rap:

$$n = \frac{y^{1/6}}{21.6\log\left(\frac{y}{d_{50}}\right) + 14}$$ (PA DEP Manual Fig. 3)

where: y = depth of flow (ft)
d_{50} = median size of rip rap (ft)

- Curved Channels (Where Applicable):

Shear Stress in Bend:

$$\tau_b = K_b \tau_d$$ (HEC-22 Eq. 5-15)

where:
τ_d = bend shear stress (lb/ft^2)
K_b = function of R_c/B (use HEC-22 Chart 21)
τ_d = maximum shear stress on channel lining (lb/ft^2)
R_c = radius to the centerline of the channel (ft)
B = bottom width of channel (ft)

Superelevation at Outside of Bend:

$$\Delta d = 0.5\frac{V^2 T}{gR_c}$$ (HEC-22 Eq. 5-11 modified)

where:
Δd = superelevation of water surface between the outer channel bank and the centerline of the channel (avg. water surface before bend) (ft)
V = average channel velocity (ft/sec)
T = top width of flow (ft)
g = acceleration of gravity (32.2 ft/sec^2)
R_c = radius to the centerline of the channel (ft)

- Allowable Shear Stress/Velocity:

Grass-Lined Channels:

For grass-lined channels, an allowable velocity approach is applicable for slopes flatter than 10%. For slopes of 10% and steeper appropriate permanent linings should be used. For use in the evaluation of curved channels, the following allowable shear stress values (lb/ft^2) can be assumed based on retardance class:

Class A: 3.70
Class B: 2.10
Class C: 1.00
Class D: 0.60
Class E: 0.35

Rip Rap-Lined Channels:

For rip rap-lined channels, an allowable velocity approach is applicable for slopes flatter than 10% (see attached table). For slopes of 10% or steeper, use the following equation:

$$\tau_{allow} = 4 \times d_{50} \qquad \text{(HEC-22 Eq. 5-17)}$$

where: τ_{allow} = allowable shear stress (lb/ft^2)
d_{50} = median size of rip rap (ft)

Reno Mattress or Gabion-Lined Channels:

For Reno mattress or gabion-lined channels, use allowable velocity for slopes flatter than 10% and allowable shear stress for slopes of 10% or steeper (see attached table).

Riprap Gradation, Filter Blanket Requirements, Maximum Velocities

	Graded Rock Size (in)			Filter Blanket Requirements**		
NSA No.	Max.	d_{50}*	Min.	Size NSA No.	Placement Thickness	V_{max} (ft/sec
R-1	1.5	.75	No. 8	FS-1	N/A	2.5
R-2	3	1.5	1	FS-1	N/A	4.5
R-3	6	3	2	FS-1	3	6.5
R-4	12	6	3	FS-2	4	9.0
R-5	18	9	5	FS-2	6	11.5
R-6	24	12	7	FS-3	8	13.0
R-7	30	15	12	FS-3	10	14.5

* The d_{50} stone size is the size exceeded by 50% of the total weight of the tonnage shipped (i.e. 50% by weight shall consist of pieces larger than the d_{50} stone size").

** This is a general standard. Soil conditions at each site should be analyzed to determine actual filter size. A suitable woven or non-woven geotextile underlayment, used according to manufacturer's recommendations, may be substituted for the filter stone.

Ref: PA DEP Manual Table 9

Maximum Permissible Velocities for Reno Mattress & Gabions

Type	n	Thickness Inches	Rock Fill Gradation (in)	Permissible* Velocity (fps)	Permissible** Shear Stress (lb/ft^2)
Reno Mattress	.025 - .030	6	3 - 6	6.0	8.35
	.025 - .030	6 - 10	3 - 6	12.0	8.35
	.025 - .030	10 - 12	3 - 6	15.0	8.35
	.025 - .030	12 - 18	4 - 6	18.0	8.35
Gabion	.027	>18	5 - 9	22.0	8.35

* Permissible velocities may be increased by the introduction of sand mastic grout. Refer to manufacturer's recommendations/specifications for permissible velocities and for recommendations regarding filters or geotextile fabric underlayment when using Reno mattresses or gabions for channel linings.
**Based on vegetation completely grown.

Ref: PA DEP Manual Table 13

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SHEET: /
JOB #: KING 07-1
DATE: 11/21/07
BY: KBS
CHKD BY:

Thornton Road Transfer Station
Drainage Channel Analysis (Grass Lined)

Channel No. DC-1A

Design Parameters:

PEAK DISCHARGE, $Q2$ = 1.8 ft^3/s Source: HydroCAD 2-Yr 24-Hr
PEAK DISCHARGE, $Q125$ = 4.9 ft^3/s Source: HydroCAD 25-Yr 24-Hr

Bottom Width, B = 0.0 ft
Left Side Slope, z_1 = 3.0 horizontal :1 vertical
Right Side Slope, z_2 = 3.0 horizontal :1 vertical
Minimum Freeboard = 0.5 ft

Permanent Grass Lining:
Grass Retardance = D
K = 34.6
V_{allow} = 4.5 ft/sec
τ_{allow} = 0.60 lb/ft^2

Temporary Lining:
Temporary Lining Used (Y/N) = Y
RECP Product Name = NA Green - Curlex I, or equal
Manning's Coefficient, n = 0.035
τ_{allow} = 1.55 lb/ft^2

Maximum Channel Slope, S_{max} = 0.023 ft/ft
Minimum Channel Slope, S_{min} = 0.020 ft/ft

Bare Ground (If Temporary Liner Not Used):
Manning's Coefficient, n = 0.020
V_{allow} = 2.0 ft/sec

Normal Depth

Depth of Flow (Norm. Depth) Y_n ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Average Velocity V_n ft/s	Flow Rate Q ft^3/s	Froude Number F_r (Normal) #	Maximum Shear Stress τ_d lb/ft^2	Allowable Velocity (V) or Sh. Stress (S) Used?	Factor of Safety V_{allow}/V_n or τ_{allow}/τ_d	Comment
Q2													
Maximum Slope:													
0.50	0.035	0.74	3.13	0.23	2.97	0.25	2.46	1.8	0.87	**0.7**	S	2.2	**O.K.**
Minimum Slope:													
0.51	0.035	0.77	3.19	0.24	3.03	0.25	2.32	1.8	0.81	**0.6**	S	2.5	**O.K.**
Q25													
Maximum Slope:													
0.96	0.074	2.74	6.04	0.45	5.73	0.48	1.80	4.9	0.46	**1.4**	V	2.5	**O.K.**
Minimum Slope:													
0.98	0.075	2.85	6.17	0.46	5.85	0.49	1.68	4.8	0.42	**1.2**	V	2.7	**O.K.**

Critical Depth

Depth of Flow (Crit. Depth) Y_c ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Section Factor $Z=AD^{1/2}$ $ft^{2.5}$	Flow Rate Q ft^3/s	Average Velocity V_c ft/s	Froude Number F_r (Critical) #	Uniform-Flow Critical Slope S_c ft/ft	Comment
Q2												
0.47	0.035	0.65	2.94	0.22	2.79	0.23	0.31	1.8	2.74	1.00	0.031	**Slopes Near Sc - Check Freeboard.**
Q25												
0.70	0.064	1.45	4.40	0.33	4.17	0.35	0.85	4.8	3.35	1.00	0.091	**Flow is Stable.**

Determination of Minimum Channel Depth & Top Width (Based on Q25)

Maximum Slope		Minimum Slope	
Minimum Channel Depth ft	Minimum Top Width T ft	Minimum Channel Depth ft	Minimum Top Width T ft
1.46	8.73	**1.48**	**8.85**

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SHEET: /
JOB #: KING 07-1
DATE: 11/21/07
BY: KBS
CHKD BY:

Thornton Road Transfer Station
Drainage Channel Analysis (Grass Lined)

Channel No. Water Quality Swale DC-2A

Design Parameters:

PEAK DISCHARGE, $Q2$ = 3.9 ft^3/s Source: HydroCAD 2-Yr 24-Hr
PEAK DISCHARGE, $Q25$ = 9.2 ft^3/s Source: HydroCAD 25-Yr 24-Hr

Bottom Width, B = 2.0 ft
Left Side Slope, z_1 = 3.0 horizontal :1 vertical
Right Side Slope, z_2 = 3.0 horizontal :1 vertical
Minimum Freeboard = 0.5 ft

Permanent Grass Lining:
Grass Retardance = D
K = 34.6
V_{allow} = 4.5 ft/sec
τ_{allow} = 0.60 lb/ft^2

Temporary Lining:
Temporary Lining Used (Y/N) = Y
RECP Product Name = NA Green - Curlex I, or equal
Manning's Coefficient, n = 0.035
τ_{allow} = 1.55 lb/ft^2

Maximum Channel Slope, S_{max} = 0.015 ft/ft
Minimum Channel Slope, S_{min} = 0.008 ft/ft

Bare Ground (If Temporary Liner Not Used):
Manning's Coefficient, n = 0.020
V_{allow} = 2.0 ft/sec

Normal Depth

Depth of Flow (Norm. Depth) Y_n ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Average Velocity V_n ft/s	Flow Rate Q ft^3/s	Froude Number F_r (Normal) #	Maximum Shear Stress τ_d lb/ft^2	Allowable Velocity (V) or Sh. Stress (S) Used?	Factor of Safety V_{allow}/V_n or τ_{allow}/τ_d	Comment
Q2													
Maximum Slope:													
0.48	0.035	1.63	5.00	0.33	4.85	0.34	2.46	4.0	0.75	**0.4**	S	3.5	**O.K.**
Minimum Slope:													
0.56	0.035	2.03	5.51	0.37	5.33	0.38	1.96	4.0	0.56	**0.3**	S	5.6	**O.K.**
Q25													
Maximum Slope:													
0.99	0.067	4.88	8.23	0.59	7.91	0.62	1.92	9.4	0.43	**0.9**	V	2.3	**O.K.**
Minimum Slope:													
1.16	0.071	6.31	9.30	0.68	8.93	0.71	1.45	9.1	0.30	**0.6**	V	3.1	**O.K.**

Critical Depth

Depth of Flow (Crit. Depth) Y_c ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Section Factor $Z=AD^{1/2}$ $ft^{2.5}$	Flow Rate Q ft^3/s	Average Velocity V_c ft/s	Froude Number F_r (Critical) #	Uniform-Flow Critical Slope S_c ft/ft	Comment
Q2												
0.41	0.035	1.30	4.56	0.29	4.43	0.29	0.71	4.0	3.08	1.00	0.028	**Flow is Stable.**
Q25												
0.64	0.059	2.48	6.02	0.41	5.81	0.43	1.62	9.2	3.71	1.00	0.070	**Flow is Stable.**

Determination of Minimum Channel Depth & Top Width (Based on Q25)

Maximum Slope		Minimum Slope	
Minimum Channel Depth ft	Minimum Top Width T ft	Minimum Channel Depth ft	Minimum Top Width T ft
1.49	10.91	**1.66**	**11.93**

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SHEET: /
JOB #: KING 07-1
DATE: 11/21/07
BY: KBS
CHKD BY:

Thornton Road Transfer Station
Drainage Channel Analysis (Grass Lined)

Channel No. Water Quality Swale DC-2B

Design Parameters:

PEAK DISCHARGE, $Q2$ = 1.2 ft^3/s Source: HydroCAD 2-Yr 24-Hr
PEAK DISCHARGE, $Q25$ = 2.6 ft^3/s Source: HydroCAD 25-Yr 24-Hr

Bottom Width, B = 0.0 ft
Left Side Slope, z_1 = 3.0 horizontal :1 vertical
Right Side Slope, z_2 = 3.0 horizontal :1 vertical
Minimum Freeboard = 0.25 ft

Permanent Grass Lining:
Grass Retardance = D
K = 34.6
V_{allow} = 4.5 ft/sec
τ_{allow} = 0.60 lb/ft^2

Temporary Lining:
Temporary Lining Used (Y/N) = N
RECP Product Name = NA Green - Curlex I, or equal
Manning's Coefficient, n = 0.035
τ_{allow} = 1.55 lb/ft^2

Maximum Channel Slope, S_{max} = 0.010 ft/ft
Minimum Channel Slope, S_{min} = 0.007 ft/ft

Bare Ground (If Temporary Liner Not Used):
Manning's Coefficient, n = 0.020
V_{allow} = 2.0 ft/sec

Normal Depth

Depth of Flow (Norm. Depth) Y_n ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Average Velocity V_n ft/s	Flow Rate Q ft^3/s	Froude Number F_r (Normal) #	Maximum Shear Stress τ_d lb/ft^2	Allowable Velocity (V) or Sh. Stress (S) Used?	Factor of Safety V_{allow}/V_n or τ_{allow}/τ_d	Comment
Q2													
Maximum Slope:													
0.49	0.035	0.71	3.07	0.23	2.91	0.24	1.60	1.1	0.57	**0.3**	V	1.3	**O.K.**
Minimum Slope:													
0.53	0.035	0.83	3.32	0.25	3.15	0.26	1.36	1.1	0.47	**0.2**	V	1.5	**O.K.**
Q25													
Maximum Slope:													
0.97	0.096	2.79	6.10	0.46	5.79	0.48	0.93	2.6	0.23	**0.6**	V	4.9	**O.K.**
Minimum Slope:													
1.07	0.100	3.40	6.74	0.51	6.39	0.53	0.76	2.6	0.18	**0.4**	V	5.9	**O.K.**

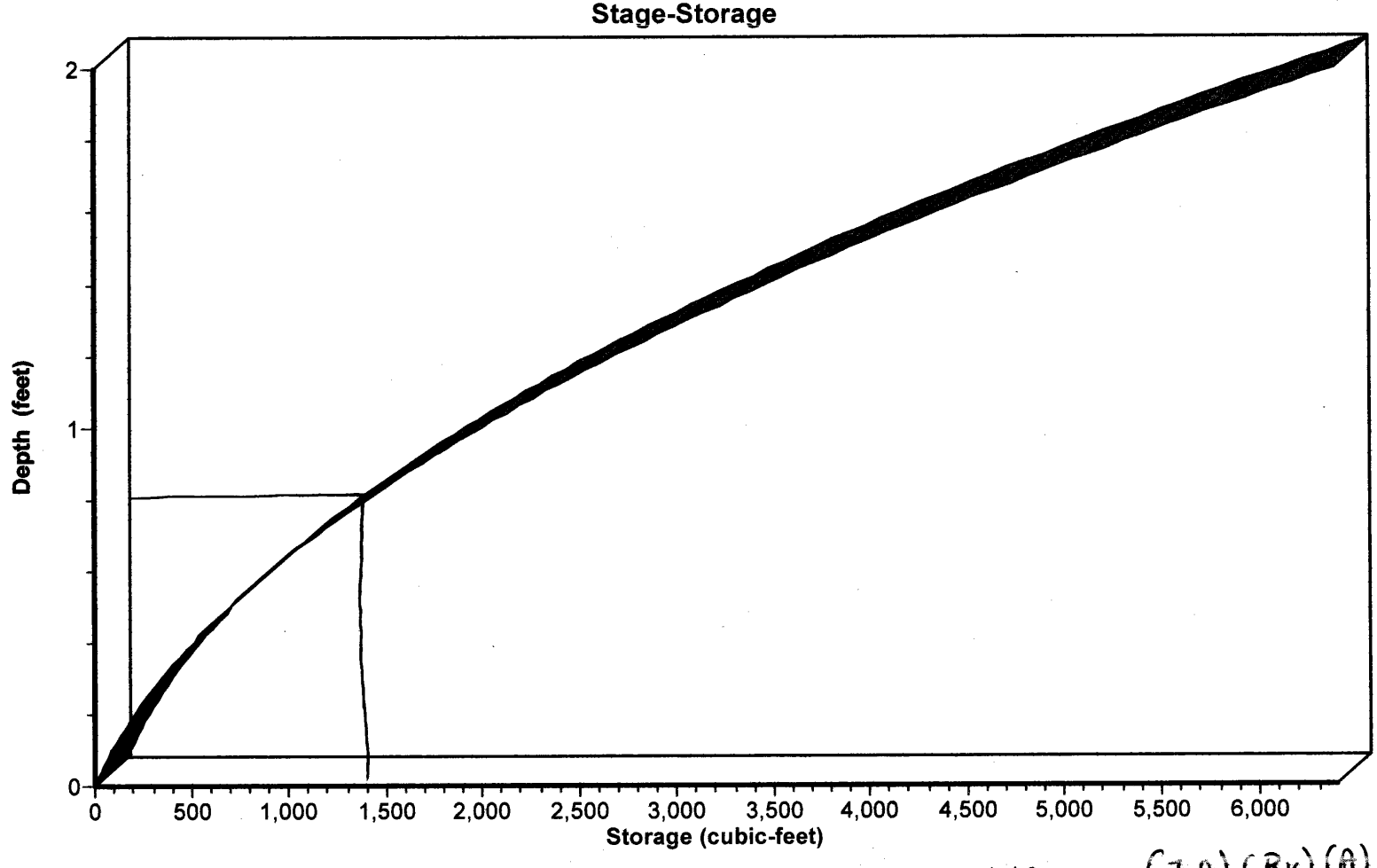
Critical Depth

Depth of Flow (Crit. Depth) Y_c ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Section Factor $Z=AD^{1/2}$ $ft^{2.5}$	Flow Rate Q ft^3/s	Average Velocity V_c ft/s	Froude Number F_r (Critical) #	Uniform-Flow Critical Slope S_c ft/ft	Comment
Q2												
0.40	0.035	0.47	2.50	0.19	2.37	0.20	0.21	1.2	2.52	1.00	0.033	**Flow is Stable.**
Q25												
0.55	0.074	0.89	3.45	0.26	3.27	0.27	0.47	2.6	2.96	1.00	0.130	**Flow is Stable.**

Determination of Minimum Channel Depth & Top Width (Based on Q25)

Maximum Slope		Minimum Slope	
Minimum Channel Depth ft	Minimum Top Width T ft	Minimum Channel Depth ft	Minimum Top Width T ft
1.22	7.29	**1.32**	**7.89**

Reach 5R: Warter Quality Swale DC-2A



Total storage volume, 6400 CF >

WQ_V = 1490 CF

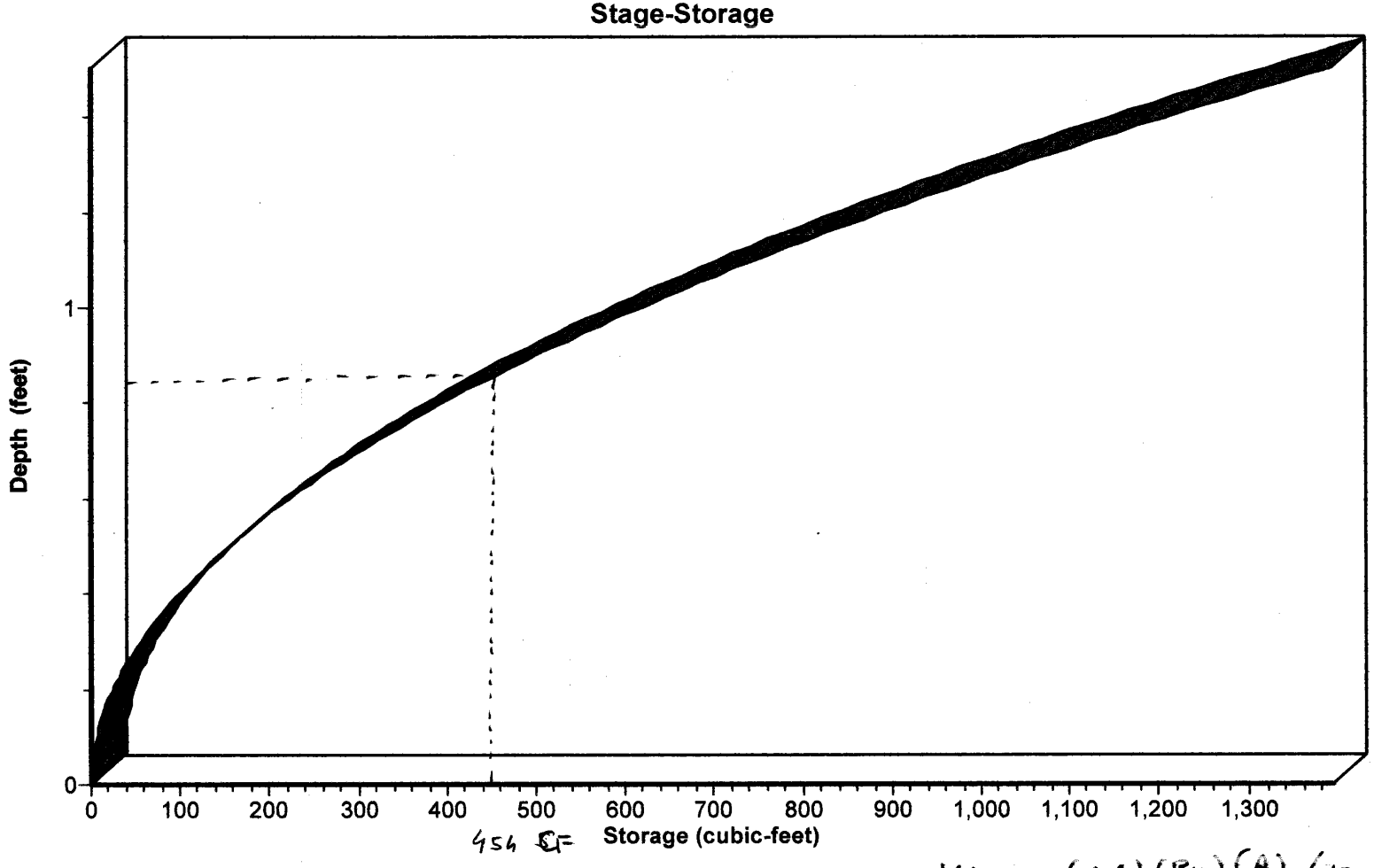
∴ OK

Find Water Quality Volume for DC-2A → $WQ_V = (1.0)(R_V)(A)/12$

$= (1.0)\frac{((0.05 + 0.009(24))}{12}(1.32 Ac)$

= 0.034 Ac. ft = 1490 CF

Reach 4R: Water Quality Swale DC - 2B



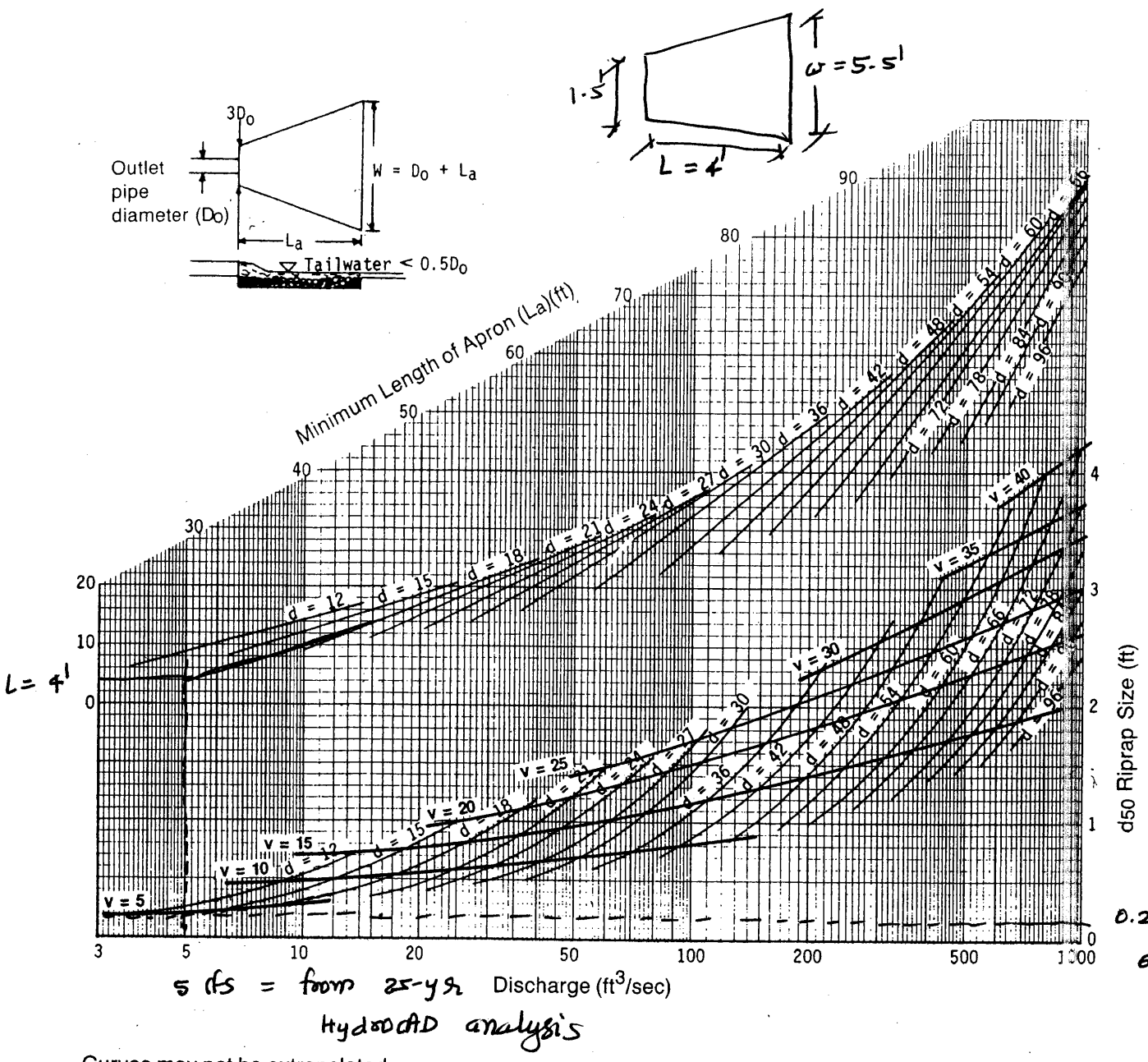
Total storage volume
1380 CF >
WQ_V volume
454 CF
∴ OK

Find Water Quality Volume for DC-2B →

$$WQ_V = (1.0)(R_V)(A)/12$$
$$= \frac{(1.0)((0.05 + 0.009(32))(0.37)}{12}$$
$$= 0.010 \text{ Ac-ft} \approx 454 \text{ CF}$$

Outlet Protection Analysis

Riprap Outlet Protection at the end of C-3 to Basin-1

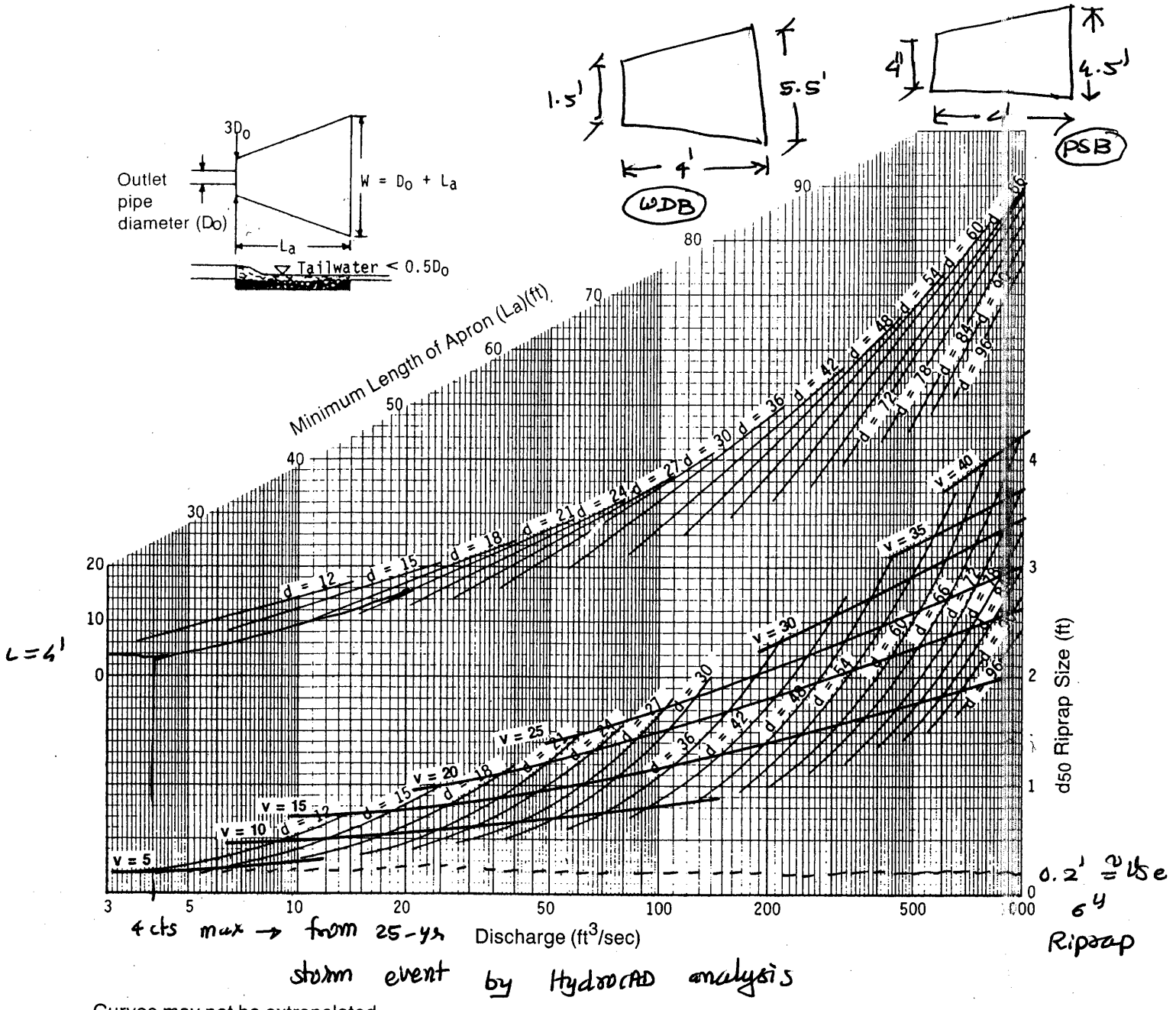


Curves may not be extrapolated.

Figure 8.06a Design of outlet protection protection from a round pipe flowing full, minimum tailwater condition (T_w < 0.5 diameter)

Riprap outlet protection at the end of (1) Permanent Sediment Basin (PSB) Appendices

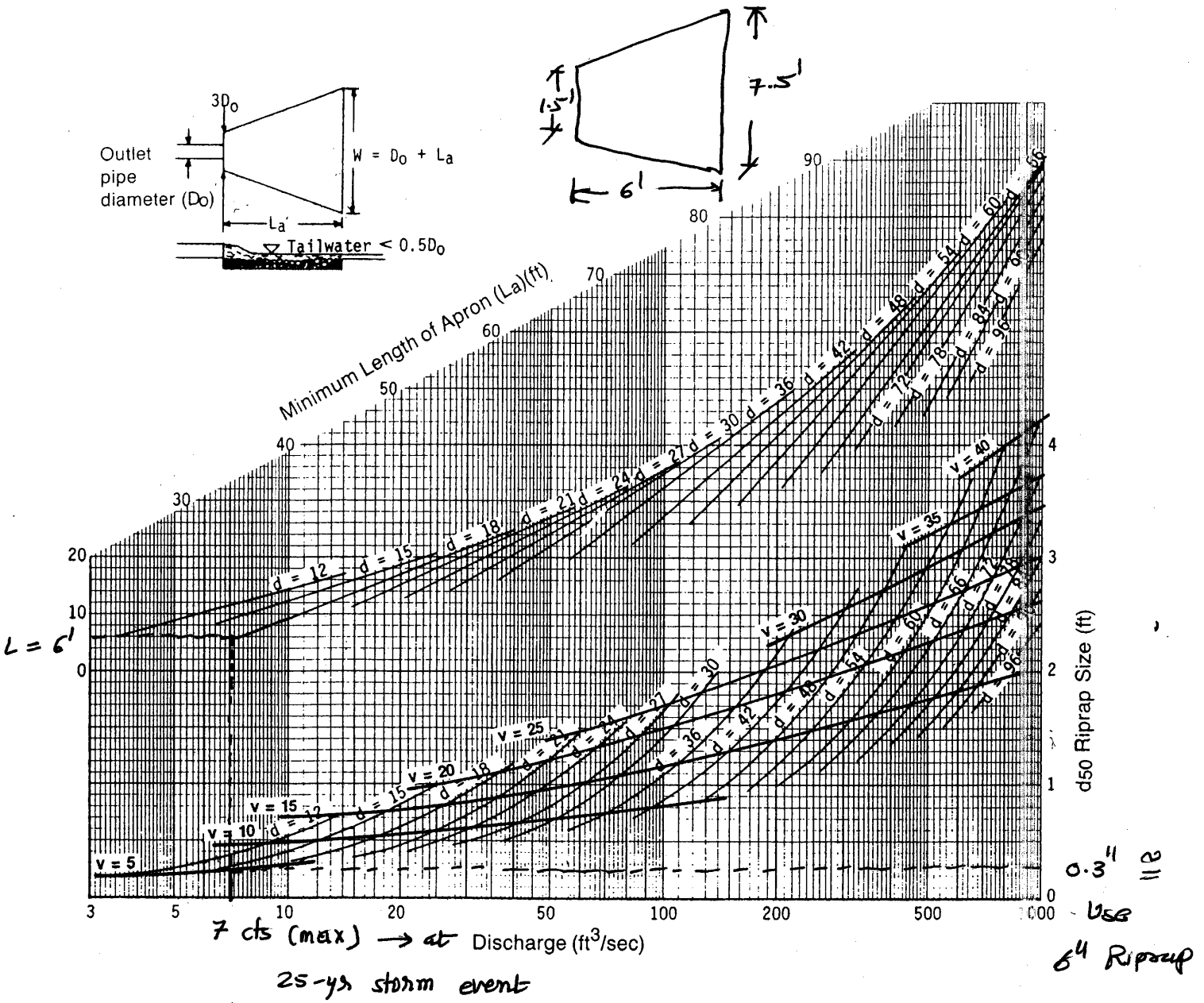
(2) wet Detention Basin (WDB)



Curves may not be extrapolated.

Figure 8.06a Design of outlet protection protection from a round pipe flowing full, minimum tailwater condition (T_w < 0.5 diameter)

Riprap Outlet Protection at C-1 & C-2



Curves may not be extrapolated.

Figure 8.06a Design of outlet protection protection from a round pipe flowing full, minimum tailwater condition (T_w < 0.5 diameter)

Appendix B

Nitrogen Loading Calculations

Total Nitrogen Loading Calcuations :

Total Nitrogen Loading Calcuations are evaluated for three conditions: (1) Pre-Development Condition (2) Post-Development Condition and (3) Nitrogen Reduction due to BMPs, as per Wake County Stormwater Manual.

1. Pre-Development Condition:

Type of Landfill Cover	Area (Acres)	TN exporn coefficient (lbs/ac/yr)	TN export from use (lbs/yr)
(a)	(b)	(c)	(d) = (b)x(c)
Permanently protected undisturbed open space	0.0	0.6	0.00
Permanently protected managed space	8.98	1.2	10.78
Impervious surfaces	0.87	21.2	18.44
Total	**9.85**		**29.22**

Total N loading for pre-development condition per acre = **2.97** **lbs/ac/yr**

2. Post-Development Condition:

Type of Landfill Cover	Area (Acres)	TN exporn coefficient (lbs/ac/yr)	TN export from use (lbs/yr)
(a)	(b)	(c)	(d) = (b)x(c)
Permanently protected undisturbed open space	0	0.6	0.00
Permanently protected managed space	7.17	1.2	8.60
Impervious surfaces	2.68	21.2	56.82
Total	**9.85**		**65.42**

Total N loading for post-development condition per acre = **6.64** **lbs/ac/yr**

3. Nitrogen Reduction due to BMPs:

There are two compliance points where nitrogen will be reduced due to BMPs.
For each compliance point, find the nitrogen reduction efficiency

A) Compliance Point - DC-2A & DC-2B

Type of Landfill Cover	Area (Acres)	TN exporn coefficient (lbs/ac/yr)	TN export from use (lbs/yr)
(a)	(b)	(c)	(d) = (b)x(c)
Permanently protected undisturbed open space	0.0	0.6	0.00
Permanently protected managed space	1.26	1.2	1.51
Impervious surfaces	0.4	21.2	9.12
Total	**1.69**		**10.63**

Consider two BMPs are in series : (1) water quality grass swale DC-2A & (2) Water quality grass swale DC-2B.

Nitrogen reduction efficiency of grass swale = 30 %

Total efficiency E, will be find as the following formula:
E = 30% + 30% + ((30x30)/100) = 60% - 9% = 51 %

Total N loading for post-development condition due to BMP impact = (10.63*0.51) = 5.42 lbs/yr

A) Compliance Point - Wet Detention Pond

Type of Landfill Cover	Area (Acres)	TN exporn coefficient (lbs/ac/yr)	TN export from use (lbs/yr)
(a)	(b)	(c)	(d) = (b)x(c)
Permanently protected undisturbed open space	0.0	0.6	0.00
Permanently protected managed space	1.64	1.2	1.97
Impervious surfaces	1.8	21.2	38.80
Total	**3.47**		**40.76**

Total N loading for post-development condition due to BMP impact = (40.76*0.25) = 10.19 lbs/yr

Total Nitrogen loading due to BMP impacts:

	Post-BMP TN Loading (lb//yr)
Total for the site	65.42
DC-2A	-5.42
pond-2	-10.19
Total Load after treatment	**49.81**

N loading for post-development condition after BMP impact = (49.81 lbs/yr) / (9.85 ac) = 5.05 lbs/ac/yr

Appendix C

Erosion and Sedimentation Control Technical Specification

SHOTWELL TRANSFER STATION, INC.
CITY OF RALEIGH, NORTH CAROLINA

TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

SECTION 02110

SITE PREPARATION

Site Preparation: Site Preparation includes clearing, grubbing, and stripping operations which precede the proposed construction.

A. DESCRIPTION

1. General:

a. The Contractor shall furnish all labor, material, and equipment to complete Site Preparation in accordance with the Contract Drawings and these Specifications.

b. Principal items of work include:

1. Notifying all authorities owning utility lines running to or on the property. Protect and maintain all utility lines to remain and cap those that are not required in accordance with instructions of the Utility Companies, and all other authorities having jurisdiction.

2. Clearing the site within the clearing limits, including removal of grass, brush, shrubs, trees, loose debris, and other encumbrances except for trees to remain.

3. Boxing and protecting all areas to be preserved.

4. Removing all topsoil from designated areas and stockpiling on site where directed by the Engineer for future use.

5. Disposing from the site all debris resulting from work under this Section.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Excavation	02222
Embankment	02223

B. MATERIALS Not Used.

C. SUBMITTALS Not Used.

D. CONSTRUCTION

1. Clearing of the Site:

a. Clearing limits, as shown on the Contract Drawings, shall be established by the Contractor's Surveyor. Once established, the clearing limits shall be inspected and approved by the Engineer prior to clearing the affected areas.

b. Before removal of topsoil, and start of excavation and grading operations, the areas within the clearing limits shown on the Contract Drawings shall be cleared and grubbed.

c. Clearing shall consist of cutting, removal, and satisfactory disposal of all trees, fallen timber, brush, bushes, rubbish, fencing, and other perishable and objectionable material.

Should it become necessary to remove a tree, bush, brush, or other plants outside the clearing limits, the Contractor shall do so only after permission has been granted by the Engineer.

d. Excavation resulting from the removal of trees, roots, and the like shall be filled with suitable material, as approved by the Engineer, and thoroughly compacted per the requirements contained in Section 02223, Embankment, of these Specifications.

e. In temporary construction easement locations, only those trees and shrubs shall be removed which are in actual interference with excavation or grading work under this Contract, and removal shall be subject to approval by the Engineer. However, the Engineer reserves the right to order additional trees and shrubs removed at no additional cost to the Owner, if such, in his opinion, they are too close to the work to be maintained or have become damaged due to the Contractor's operations.

f. Unless otherwise shown or specified, the Contractor shall clear and grub a strip at least 15 feet wide along all permanent fence lines installed under this Contract.

2. Stripping and Stockpiling Existing Topsoil:

   a. Existing topsoil and sod on the site within areas designated on the Contract Drawings shall be stripped to whatever depth it may occur, and stored in locations directed by the Engineer.

   b. The topsoil shall be free of stones, roots, brush, rubbish, or other unsuitable materials before stockpiling.

   c. Care shall be taken not to contaminate the stockpiled topsoil with any unsuitable materials.

3. Grubbing:

   a. Grubbing shall consist of the removal and disposal of all stumps, roots, logs, sticks, and other perishable materials to a depth of at least 6 inches below ground surfaces.

   b. Large stumps located in areas to be excavated may be removed during grading operations, subject to the approval of the Engineer.

4. Disposal of Cleared and Grubbed Material:

   All trees, stumps, roots, and bushes shall be disposed of by burning (Only if allowed by the Owner and local zoning) or shall be removed from the site and disposed of by the Contractor. The Contractor shall receive written authorization from the Owner prior to burning. Any material other than plant growth shall not be burned. On-site and off-site disposal areas are subject to approval by the Engineer. Ashes and residue from burning operations shall be removed from the site and disposed of by the Contractor. The Contractor shall also obtain all of the required permits for his burning operations, as applicable.

END OF SECTION

SECTION 02222

EXCAVATION

Excavation: Excavation includes excavating, sealing, hauling, scraping, undercutting, removal of accumulated surface water or ground water, stockpiling, and all necessary and incidental items as required for bringing the landfill and related structures to the specified lines and grades.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment required to complete Excavation of the project area in accordance with the Contract Drawings and these Specifications, except as noted below:

a. Clearing and grubbing and removal of topsoil is addressed in Section 02110, Site Preparation, of these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Site Preparation	02110
Embankment	02223
Erosion and Sedimentation Control	02270
Roadway Work	02500

3. Definitions:

a. Excavation: shall consist of the removal and satisfactory disposal and/or stockpiling of materials located with the limits of construction including widening cuts and shaping of slopes necessary for the preparation of roadbeds, landfill slope areas, cutting of any ditches, channels, waterways, entrances, and other work incidental thereto.

b. Borrow: shall consist of approved on-site material required for the construction of embankments/fills or for other portions of the work.

c. Select Borrow: shall consist of approved off-site material required for the construction of embankments/fills, roadway subgrade, backfilling, or for

other portions of the work as shown on Contract Drawings or in these Specifications. The Contractor shall make his own arrangements for obtaining select borrow and pay all costs involved.

d. Unsuitable Material: is any in-place or excavated material which contains undesirable materials, or is in a state which is not appropriate; in the opinion of the CQA Engineer, for the intended use or support of planned structures, embankment, or excavation. This may include but not be limited to organic material, waste/refuse, soft, or wet material not meeting required specifications, etc.

e. Unsuitable Materials Excavation (Overexcavation): shall consist of the removal and satisfactory disposal of all unsuitable material located within the limits of construction. Where excavation to the finished grade section shown results in a subgrade or slopes of unsuitable material, the Contractor shall overexcavate such material to below the grade shown on the Contract Drawings or as directed by the Engineer and CQA Engineer.

B. MATERIALS

Excavation shall include the removal of all soil, weathered rock, boulders, conduits, pipe, and all other obstacles encountered and shown on the Contract Drawings or specified herein.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer before approval is given to proceed:

1. Plans of open cut excavations showing side slopes and limits of the excavation at grade.

2. List of disposal site(s) for waste and unsuitable materials.

3. Descriptive information on Excavation equipment to be used.

D. CONSTRUCTION

1. The Contractor shall conduct Excavation activities in such a manner that erosion of disturbed areas and off site sedimentation is absolutely minimized as outlined in Section 02270, Erosion and Sedimentation Control, of these Specifications.

2. The Contractor shall excavate to the lines and grades shown on the Contract Drawings and stockpile all suitable excavated materials. As the excavation is made, the materials will be examined and identified to the CQA Engineer.

The Contractor will perform all surveys necessary to establish and verify lines and grades for all Excavation, including pipe excavations, soil overexcavation, and anchor trenches.

3. Stockpiling:

The Contractor shall stockpile the materials in appropriate stockpiles as approved by the CQA Engineer. The Contractor shall use equipment and methods as necessary to maintain the moisture content of soils stockpiled (excluding topsoil) at or near their optimum moisture content.

Stockpiles shall be properly sloped and the surfaces sealed by the Contractor at the end of each working day, or during the day in the event of heavy rain, to the satisfaction of the Engineer.

4. The Contractor shall protect all existing facilities and structures including, but not limited to, existing utilities, monitoring wells, signs, grade stakes, etc. during the grading and stockpiling operations.

5. All excavations shall be made in the dry and in such a manner and to such widths as will give ample room for properly constructing and inspecting the structures and/or piping they are to contain and for such sheeting, timbering, pumping, and drainage as may be required.

6. Excavation slopes shall be flat enough to avoid sloughs and slides that will cause disturbance of the subgrade or damage of adjacent areas. Slides and overbreaks which occur due to negligence, carelessness, or improper construction techniques on the part of the Contractor shall be removed and disposed of by the Contractor as directed by the Engineer at no additional cost to the Owner.

7. The intersection of slopes with natural ground surfaces, including the beginning and ending of cut slopes, shall be uniformly rounded. All protruding roots and other vegetation shall be removed from slopes.

8. The bottom of all excavations for structures and pipes shall be examined by the CQA Engineer for bearing value and the presence of unsuitable material. If, in the opinion of the CQA Engineer, additional Excavation is required due to the low bearing value of the subgrade material, or if the in-place materials are soft, yielding, pumping and wet, the Contractor shall remove such material to the required width and depth and replace it with thoroughly compacted structural fill, or material directed by the CQA Engineer. No payment will be made for subgrade disturbance caused by inadequate Dewatering or improper construction methods.

9. Any areas excavated below design subgrade elevations by the Contractor, unless directed by the CQA Engineer, shall be brought back to design elevations at no

cost to the Owner. The Contractor shall place and compact such material in accordance with Section 02223, Embankment, of these Specifications.

10. The Contractor shall dispose of excess or unsuitable excavation materials on-site at location(s) approved by the Owner.

11. The Contractor shall properly level-off bottoms of all excavations. Proof-rolling shall be conducted with appropriate equipment.

12. Upon reaching subgrade elevations shown in excavation areas, the Contractor shall scarify subgrade soils to a minimum depth of 6" and obtain the CQA Engineer's approval of quality. If unsuitable materials are encountered at the subgrade elevation, perform additional excavations as approved by the CQA Engineer to remove unsuitable materials.

13. Overexcavation and Backfill:

Where subgrade materials are determined to be unsuitable, such materials shall be removed by the Contractor to the lengths, widths and depths approved by the CQA Engineer and backfilled with suitable material in accordance with Section 02223, Embankment, of these Specifications unless further excavation or earthwork is required. No additional payment will be made for such excavation and backfill 1 foot or less than the finished subgrade. Unsuitable material excavation greater than 1 foot beneath the finished subgrade shall be made on a unit price basis for excavation and backfill, only as approved by the Engineer and CQA Engineer prior to the work. Unit price for overexcavation and backfill greater than 1 foot in depth shall include disposal of unsuitable materials.

15. All cuts shall be brought to the grade and cross section shown on the Contract Drawings, or established by the Engineer, prior to final inspection.

16. The Contractor shall protect finished lines and grades of completed excavation against excessive erosion, damage from trafficking, or other causes and shall repair any damage at no additional cost to the Owner.

17. Trench Excavation:

a. All pipe Excavation and trenching shall be done in strict accordance with these Specifications, all applicable parts of the OSHA Regulations, 29 CFR 1926, Subpart P, and other applicable regulations. In the event of any conflicts in this information, safe working conditions as established by the appropriate OSHA guidelines shall govern.

b. The minimum trench widths shall be as indicated on the Contract Drawings. Enlargements of the trench shall be made as needed to give ample space for operations at pipe joints. The width of the trench shall be

limited to the maximum dimensions shown on the Contract Drawings, except where a wider trench is needed for the installation of and work within sheeting and bracing.

c. Except where otherwise specified, excavation slopes shall be flat enough to avoid slides which will cause disturbance of the subgrade, damage to adjacent areas, or endanger the lives or safety of persons in the vicinity.

d. Hand excavation shall be employed wherever, in the opinion of the Engineer, it is necessary for the protection of existing utilities, poles, trees, pavements, obstructions, or structures.

e. No greater length of trench in any location shall be left open, in advance of pipe laying, than shall be authorized or directed by the Engineer and, in general, such length shall be limited to approximately one hundred (100) feet.

f. Pipe Bedding: All pipe bedding shall be as shown on the Contract Drawings, unless otherwise specified herein.

18. Sheeting and Bracing:

a. The Contractor shall furnish, place, and maintain such sheeting and bracing which may be required to support sides of Excavation or to protect pipes and structures from possible damage and to provide safe working conditions in accordance with current OSHA requirements. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports put in at the sole expense of the Contractor. The Contractor shall be responsible for the adequacy of all sheeting and bracing used and for all damage resulting from sheeting and bracing failure or from placing, maintaining, and removing it.

b. The Contractor shall exercise caution in the installation and removal of sheeting to insure that excessive or unusual loadings are not transmitted to any new or existing structure. The Contractor shall promptly repair at his expense any and all damage that can be reasonably attributed to sheeting installation or removal.

c. All sheeting and bracing shall be removed upon completion of the work.

19. If grading operations are suspended for any reason whatsoever, partially completed cut and fill slopes shall be brought to the required slope and the work of seeding and mulching or other required erosion and sedimentation control operations shall be performed at the Contractor's sole expense.

END OF SECTION

SECTION 02223

EMBANKMENT

Embankment: Embankment is the on-site compacted fill that provides the foundation and the berms for the containment area, the subgrade for some access roadways and structures, and backfill around structures and piping.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete Embankment including borrowing, hauling, screening, discing, drying, compaction, control of surface and subsurface water, final grading, sealing, and all necessary and incidental items as detailed or required to complete the Embankment, all in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Excavation	02222
Erosion and Sedimentation Control	02270
Roadway Work	02500

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these Specifications.

ASTM D 698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
ASTM D 2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

ASTM D 2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D 2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
ASTM D 2937	Standard Test Method for Density of Soil in Place by the Drive Cylinder Method.
ASTM D 2974	Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
ASTM D 4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
ASTM D 4959	Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method.
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. Definitions:

a Embankment: Shall include construction of all site earthwork including roadways, subgrade, perimeter berm embankments, including preparation of the areas upon which materials are to be placed. Embankment may also be referred to as structural and/or controlled fill. All Embankment materials may be either (off-site) Select Borrow or (on-site) Borrow unless otherwise noted on Contract Drawings or specified by the Engineer.

b. Prepared Subgrade: The ground surface after clearing, grubbing, stripping, excavation, scarification, and/or compaction, and/or proof rolling to the satisfaction of the CQA Engineer.

c. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes. Well-graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters. Well-graded is used to define a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

d. Unclassified Fill: The nature of materials to be used is not identified or described herein but must be approved by the Engineer prior to use.

B. MATERIALS

1. Embankment materials shall consist of clean well-graded natural soil classified as SW, SM, SM-SC, SC, ML, CL-ML, or CL (ASTM D 2488) containing no topsoil or other deleterious material. Other material classifications may be approved by the Engineer.

2. Stones or rock fragments shall not exceed one half the maximum lift thickness as compacted in any dimension. Isolated rocks shall be a maximum of 24-inches in any dimension.

3. Embankment materials shall have a 12% maximum loss on ignition (ASTM D 2974).

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer before approval is given to proceed:

1. Descriptive information on compaction equipment to be used for construction of Embankment.

2. Descriptive information on the location and source of any off-site borrow material to be used for Embankment, where applicable. Information shall include Standard Proctor curves (ASTM D698) for each borrow material.

D. CONSTRUCTION

1. The Contractor shall conduct Embankment activities in such a manner that erosion of disturbed areas and off-site sedimentation is absolutely minimized as outlined in Section 02270, Erosion and Sedimentation Control, of these Specifications.

2. All placement and compaction of Embankment shall be performed only when the CQA Engineer is informed by the Contractor of intent to perform such work.

3. Embankment shall be placed and compacted to the lines and grades shown on the Contract Drawings. Placement of Embankment outside the construction limits shall occur only as directed and approved by the Engineer.

The Contractor will perform all surveys necessary to establish and verify lines and grades for all Embankment.

4. The Contractor shall protect all existing facilities including, but not limited to, utilities and monitoring wells.

5. Subgrade Preparation:

   a. The CQA Engineer shall inspect the exposed subgrade prior to placement of Embankment to assure that all rocks, topsoil, vegetation, roots, debris, or other deleterious materials have been removed.

   b. Prior to placement of Embankment, the exposed subgrade shall be proofrolled using a static smooth-drum roller, loaded tandem axle dump truck, or other suitable equipment in the presence of the CQA Engineer. Any soft or unsuitable materials revealed before or during the in-place compaction shall be removed as directed by the CQA Engineer and replaced with suitable Embankment.

6. Surfaces on which Embankment is to be placed, shall be scarified or stepped in a manner which will permit bonding of the Embankment with the existing surface.

7. The Contractor shall be responsible for preparing the materials for the Embankment, including but not limited to, in-place drying or wetting of the soil necessary to achieve the compaction criteria of these Specifications.

8. Embankment materials shall be placed in a manner permitting drainage and in continuous, approximately horizontal layers.

9. Compaction Requirements:

   a. The Contractor shall compact Embankment in accordance with the requirements shown in Table 1 of this section. If Embankment does not meet the specified requirements, the Contractor shall rework the material, as may be necessary and continue compaction to achieve these requirements, or remove and replace the material to achieve the specified requirements, at Contractor's expense.

   b. Each lift shall be compacted prior to placement of succeeding lifts. In confined areas, mechanical equipment, suitable for small areas and capable of achieving the density requirements, shall be required.

   c. Lift compaction shall be performed with an appropriately heavy, properly ballasted, penetrating-foot or smooth-drum vibratory compactor depending on soil type. Compaction equipment shall be subject to approval by the CQA Engineer.

10. Embankment that becomes excessively eroded, soft, or otherwise unsuitable shall be removed or repaired by the Contractor as directed by the CQA Engineer, at no cost to the Owner.

11. The exposed surface of Embankment shall be rolled with a smooth-drum roller at the end of each work day to protect from adverse weather conditions.

12. Where Embankment is to be placed and compacted on slopes that are steeper than 3:1, the subgrade shall be benched to a minimum depth of 6 inches and the Embankment shall be placed in horizontal lifts.

13. Backfilling for Structures and Piping:

    a. All structures, including manholes and pipes shall be backfilled with Embankment as shown in the Contract Drawings and as described in these Specifications.

    b. Where sheeting is used, the Contractor shall take all reasonable measures to prevent loss of support beneath and adjacent to pipes and existing structures when sheeting is removed. If significant volumes of soil cannot be prevented from clinging to the extracted sheets, the voids shall be continuously backfilled as rapidly as possible. The Contractor shall thereafter limit the depth below subgrade that sheeting will be driven in similar soil conditions or employ other appropriate means to prevent loss of support.

    c. When backfilling around structures, do not backfill until concrete has sufficiently cured (as determined by the CQA Engineer) and is properly supported. Place backfill in a manner to avoid displacement or damage of structures.

TABLE 1: REQUIRED EMBANKMENT PROPERTIES

ITEM	Required % Standard Proctor (ASTM D698)[2]	Required Moisture Content[3]	Maximum Lift Thickness (Compacted) (inches)
Embankment	95	As Required for Compaction	8
Embankment Beneath Structures and Roads[1]	98		8
Backfill Around Structures	95		8
Backfill in Pipe Trenches	95		6
Unclassified Fill	N/A	N/A	N/A

Notes:

1. Embankment beneath structures shall be considered to include a zone 10 feet out from the foundation of the structure extending down to the natural ground on a 45° slope. Embankment beneath roads shall be considered to include all embankment placed within 2 vertical feet of the final wearing surface and shall also include shoulders.
2. Determine field density using ASTM D 6938, ASTM D 1556, ASTM D 2167, or ASTM D 2937.
3. Determine field moisture content using ASTM D 6938, ASTM D 2216, ASTM D 4643, or ASTM D 4959.
4. The Engineer may allow exceptions to the above criteria for areas outside of the containment area which are not subject to significant long-term loads.

END OF SECTION

SECTION 02270

EROSION AND SEDIMENTATION CONTROL

Erosion and Sedimentation Control: Erosion and Sedimentation Control is a system of construction practices and engineered structures which act to minimize surface water induced erosion of disturbed areas and resulting sedimentation off-site.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of and maintain Erosion and Sedimentation Control facilities and other construction in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Geotextiles	02240
Rolled Erosion Control Products	02275
Storm Water Systems	02720
Revegetation	02930

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 3786 Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method.

ASTM D 4355 Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).

ASTM D 4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

B. MATERIALS

1. Permanent Sediment Basins:

Permanent sediment basins shall be constructed as shown on the Contract Drawings.

2. Permanent Ditches, Swales, and Drainage Channels:

Permanent ditches, swales, and drainage channels shall be constructed as shown on the Contract Drawings.

3. Silt Fence:

Silt fences shall be constructed as shown on the Contract Drawings and as needed, based on the Contractor's discretion and Engineer's approval. The silt fence is a permeable barrier erected within and downgradient of small disturbed areas to capture sediment from sheet flow. It is made of filter fabric buried at the bottom, stretched, and supported by posts and wire mesh backing. Silt fence shall conform to the following properties:

a. Posts: Posts shall be 3 feet long "U" or "T"-type steel posts.

b. Filter Fabric: Filter fabric shall be a woven geotextile made specifically for sediment control. Filter fabric shall conform to the properties listed in Table 1 of this section.

4. Geotextiles:

Geotextiles shall conform to the requirements of Section 02240, Geotextiles, of these Specifications.

5. Temporary Sediment Traps:

Temporary sediment traps shall be constructed as shown on the Contract Drawings.

6. Pipes:

Pipes shall be constructed as shown on the Contract Drawings.

7. Rip Rap:

Rip Rap shall conform to the requirements of Section 02271, Rip Rap, of these Specifications.

8. Rolled Erosion Control Products (RECPs):

Rolled Erosion Control Products (RECPs) shall conform to the requirements of Section 02275, Rolled Erosion Control Products, of these Specifications.

9. Other Work:

In addition to the erosion control measures shown on the Contract Drawings, the Contractor shall provide adequate means to prevent any sediment from entering any storm drains, drop inlets, ditches, streams, or bodies of water downstream of any area disturbed by construction. Excavation materials shall be placed upstream of any trench or other excavation to prevent sedimentation of off-site areas. In areas where a natural buffer area exists between the work area and the closest stream or water course, this area shall not be disturbed. All paved areas shall be scraped and swept as necessary to prevent the accumulation of dirt and debris. Work associated with this provision shall be considered incidental to the project and no separate payment will be made.

10. Temporary and Permanent Ground Cover:

The Contractor shall provide temporary or permanent ground cover (or other acceptable measure(s)) adequate to restrain erosion on erodible slopes or other areas within twenty-one (21) calendar days following completion of any phase of grading.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Submit a certification and summary of all required test results, prior to installation, that all Erosion and Sedimentation Control materials manufactured for the project have been produced in accordance with these Specifications.

2. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

D. CONSTRUCTION

1. Establishment of Erosion Control Devices:

a. All erosion control structures will be constructed according to the Contract Drawings and these Specifications.

b. Due to the nature of the work required by this Contract, it is anticipated that the location and nature of the erosion control devices may need to be adjusted on several occasions to reflect the current phase of construction.

c. Erosion control devices shall be established prior to the work in a given area. Where such practice is not feasible, the erosion control device(s) shall be established immediately following completion of the clearing operation.

d. The construction schedule adopted by the Contractor will impact the placement and need for specific devices required for the control of erosion. The Contractor shall develop and implement such additional techniques as may be required to minimize erosion and off-site sedimentation.

e. The location and extent of erosion control devices shall be revised at each phase of construction that results in a change in either the quantity or direction of surface runoff from construction areas. All deviations from the control provisions shown on the Contract Drawings shall have the prior approval of the Engineer.

2. Maintenance of Erosion Control Devices:

a. The Contractor shall furnish the labor, material, and equipment required for maintenance of all erosion control devices. Maintenance shall be scheduled as required for a particular device to maintain the removal efficiency and intent of the device.

b. All erosion control devices shall be inspected immediately after each significant rainfall event, and appropriate maintenance conducted.

c. Maintenance shall include, but not be limited to:

(1) The removal and satisfactory disposal of trapped or deposited sediments from basins, traps, barriers, filters, and/or drainage features/devices;

(2) Replacement of filter fabrics used for silt fences upon loss of specified efficiency; and

(3) Replacement of any other components which are damaged or cannot serve the intended use.

d. The Contractor shall accept and maintain any existing sediments that are included in existing sediment traps or sediment basins that accept or will accept stormwater flow and or silt accumulation from all areas within the Contractor's limits of construction.

e. Sediments removed from erosion control devices shall be disposed of in locations that will not result in off-site sedimentation as approved by the Engineer.

f. All erosion control structures shall be maintained to the satisfaction of the Engineer until the site has been stabilized.

3. Finish Grading:

All disturbed areas shall be uniformly graded to the lines, grades, and elevations shown on the Contract Drawings. Finished surfaces shall be reasonably smooth, compacted, and free from irregular surface changes. Unless otherwise specified, the degree of finish shall be that ordinarily obtainable from either blade or scraper operations. Areas shall be finished to a smoothness suitable for application of topsoil.

4. Seeding:

Seeding shall conform to the requirements of Section 02930, Revegetation, of these Specifications.

5. Cleanup:

a. The Contractor shall remove from the site all subsoil excavated from his work and all other debris including, but not limited to, branches, paper, and rubbish in all landscape areas, and remove temporary barricades as the work proceeds.

b. All areas shall be kept in a neat, orderly condition at all times. Prior to final acceptance, the Contractor shall clean up the entire landscaped area to the satisfaction of the Engineer.

TABLE 1: REQUIRED SILT FENCE FILTER FABRIC PROPERTIES

PROPERTY	TEST METHOD	UNITS	VALUE[1]
Grab Tensile Strength[2]	ASTM D 4632	lbs	100 x 100
Grab Elongation	ASTM D 4632	%	15 (Max.)
Trapezoidal Tear Strength[2]	ASTM D 4533	lbs	50 x 50
Burst Strength	ASTM D 3786	psi	265
Puncture Resistance	ASTM D 4833	lbs	55
Ultraviolet Resistance (500 hrs)	ASTM D 4355	%	80
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Sieve	20 (Max.)/40 (Min.)
Permittivity	ASTM D 4491	sec^{-1}	0.20

Notes:
1. Minimum Average Roll Value (MARV).
2. Values for machine and cross machine direction (MD x XD), respectively.

END OF SECTION

SECTION 02271

RIP RAP

Rip Rap: This section includes all rip rap aprons and channel protection.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of Rip Rap for protection of earthen slopes against erosion as indicated, including all necessary and incidental items, in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Erosion and Sedimentation Control	02270

3. Reference Standards:

The latest revision of the following standards of the North Carolina Department of Transportation (NCDOT) are hereby made a part of these Specifications.

NCDOT Standard Specifications for Roads and Structures.

B. MATERIALS

1. Rip Rap: Rip Rap shall be of the size indicated on the Contract Drawings and shall conform to NCDOT Section 1042, Rip Rap Materials.

2. Geotextiles: Geotextiles shall conform to the requirements outlined in Section 02240, Geotextiles, of these Specifications.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Submit a certification and summary of all required test results prior to installation, that all Rip Rap has been produced in accordance with these Specifications.

2. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

D. CONSTRUCTION

1. Surface Preparation:

   a. Trim and dress all areas to conform to the Contract Drawings as indicated with tolerance of 2 inches from theoretical slope lines and grades.

   b. Bring areas that are below allowable minimum tolerance limit to grade by filling with compacted Embankment material similar to adjacent material.

   c. Geotextiles shall be placed as shown on the Contract Drawings and in accordance with Section 02240, Geotextiles, of these Specifications.

   d. Do not place any stone material on the prepared surface prior to inspection and approval to proceed from the Engineer.

2. Placing Rip Rap:

   Rip Rap shall be placed in accordance with NCDOT Section 868, Rip Rap.

END OF SECTION

SECTION 02275

ROLLED EROSION CONTROL PRODUCTS

Rolled Erosion Control Products: Rolled Erosion Control Products (RECPs) include erosion control blankets (ECB) placed in channels and on slopes.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of all RECPs in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Erosion and Sedimentation Control	02270
Revegetation	02930

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 4355 Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).

ASTM D 6475 Standard Test Method for Measuring Mass per Unit Area of Erosion Control Blankets.

ASTM D 6524 Standard Test Method for Measuring the Resiliency of Turf Reinforcement Mats.

ASTM D 6525 Standard Test Method for Measuring Nominal Thickness of Permanent Erosion Control Products.

ASTM D 6566	Standard Test Method for Measuring Mass per Unit Area of Turf Reinforcement Mats.
ASTM D 6818	Standard Test Method for Ultimate Tensile Properties of Turf Reinforcement Mats.

B. MATERIALS

1. General:

The materials supplied under these Specifications shall consist of new, first-quality products designed and manufactured specifically for the purpose of this work, which shall have been satisfactorily demonstrated, by prior use, to be suitable and durable for such purposes.

Labels on each RECP shall identify the length, width, product name, and name of Manufacturer.

2. Erosion Control Blanket (ECB) (Single Net):

ECB (single net) shall consist of a machine-produced mat of straw or wood excelsior fiber covered on the top side with a photodegradable extruded plastic or woven biodegradable netting and sewn together with degradable thread. ECB (single net) shall also conform to the properties listed in Table 1 of this section. ECB (single net) shall be S75, as manufactured by North American Green, CURLEX I, as manufactured by American Excelsior Company, LANDLOK S1, as manufactured by Propex Fabrics, or approved equal.

3. Anchors: Anchors for RECPs shall consist of machine made staples of No. 8 gauge new steel wire formed into a "U" shape. The size when formed shall be not less that 8 inches in length with a throat of not less than 1 inch in width. Longer anchors may be required for loose soils. Other anchors, such as metal pins or plastic pegs, may also be used if approved in advance by the Engineer.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for each RECP attesting that each RECP meets the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample of each RECP to be used. The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.

2. Shipping, Handling, and Storage Instructions: The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.

3. Installation Guidelines/Instructions: The Manufacturer's guidelines/instructions for installation shall be submitted for review.

4. Furnish copies of delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

D. CONSTRUCTION

1. Shipping, Handling, and Storage:

All RECPs shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. Installation - General:

a. Placing of RECPs shall be done immediately following seeding. Seeding shall be performed in accordance with Section 02930, Revegetation, of these Specifications.

b. RECPs shall be placed to the lines and grades shown on the Contract Drawings. The earth surface shall be smooth and free from stones, clods, or debris which will prevent the contact of the RECP with the soil. Care shall be taken to preserve the required line, grade, and cross section of the area.

c. RECPs shall be unrolled in the direction of the flow of water and shall be applied without stretching so that it will lie smoothly but loosely on the soil surface.

d. At the time of installation, RECPs shall be rejected, if they have defects, rips, holes, flaws, evidence of deterioration, or other damage.

e. The Engineer may require adjustments in the installation requirements to fit individual conditions.

3. Installation - Channels:

RECPs installed in channels shall be unrolled parallel to the direction of water flow. The first roll shall be centered longitudinally in the channel and anchored with staples. Subsequent rolls shall be installed outward to the edges of the channel and be lapped to allow installation of a common row of anchors. RECP ends shall be overlapped with the upstream ends on top ("shingled"). Refer to the

Contract Drawings and/or the Manufacturer's installation guidelines/instructions for installation details.

4. Maintenance:

Maintenance of RECPs shall be in accordance with Section 02270, Erosion and Sedimentation Control, of these Specifications.

TABLE 1: REQUIRED ROLLED EROSION CONTROL PRODUCT PROPERTIES

PROPERTY	TEST METHOD	UNITS	VALUE[1]
Erosion Control Blanket (ECB) (Single Net)			
Mass per Unit Area	ASTM D 6475	lbs/yd^2	0.5 ± 10% (Straw) 0.7 ± 10% (Excelsior)
Tensile Strength[2]	ASTM D 6818	lbs/ft	50 x 65
Tensile Elongation	ASTM D 6818	%	20
Maximum Permissible Shear Stress (Un-Vegetated)	-----	lb/ft^2	1.55
Functional Longevity	-----	months	12

Notes:

1. Typical for ECB; Minimum Average Roll Value (MARV) for TRM and HPTRM.
2. Values for machine and cross machine direction (MD x XD), respectively.

END OF SECTION

SECTION 02500

ROADWAY WORK

Roadway Work: Roadway Work refers to the construction of gravel road surfaces, the repair and reconstruction of existing roads.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment required to complete construction of all Roadway Work including gravel roads, and repair of existing gravel roads in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Excavation	02222
Embankment	02223

3. Reference Standards:

The latest revision of the following standards of the North Carolina Department of Transportation (NCDOT) are hereby made a part of these Specifications:

NCDOT Standard Specifications for Roads and Structures.

B. MATERIALS

1. Geotextiles:

Geotextiles shall conform to the requirements outlined in Section 02240, Geotextiles, of these Specifications.

2. Aggregate Base Course (ABC):

All work, including materials, associated with ABC shall be in accordance with NCDOT Section 520, Aggregate Base Course, except that Articles 520-7 (Contractor Furnished Laboratory), 520-12 (Method of Measurement), and 520-13 (Basis of Payment) shall be deleted. Type "A" or "B" aggregate will be acceptable for this project.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Submit a certification and summary of all required test results, prior to installation, that all materials for Roadway Work have been produced in accordance with these Specifications.

2. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

D. CONSTRUCTION

1. General:

All Roadway Work including the replacement of portions of the existing roads shall be to the limits, grades, thicknesses, and types as shown on the Contract Drawings. Patches for pipe crossings and areas damaged during the construction work shall be asphalt or gravel, depending upon the material encountered, unless otherwise indicated.

2. Earthwork:

The earthwork for all Roadway Work shall be completed in accordance with Section 02222, Excavation, and Section 02223, Embankment, of these Specifications and as shown on the Contract Drawings.

3. Geotextiles:

Geotextiles shall be placed as shown on the Contract Drawings and in accordance with Section 02240, Geotextiles, of these Specifications. If overlapped seams are used, overlaps shall be a minimum of 12 inches.

4. Aggregate Base Course:

ABC shall be constructed in accordance with NCDOT Section 520.

5. Underground Utility Lines:

Where an underground utility line is beneath the Roadway Work, backfilling shall be carried out with special care, and the final consolidation shall be accomplished by a vibratory roller. Construction of Roadway Work over the trench shall be deferred as long as practicable.

END OF SECTION

SECTION 02612

CORRUGATED POLYETHYLENE (CPE) PIPE

Corrugated Polyethylene (CPE) Pipe: CPE Pipe is used in the storm water system.

A. DESCRIPTION

1. General:

The Contractor shall furnish labor, material, and equipment to complete installation of CPE Pipe in accordance with the Contract Drawings and these Specifications.

2. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) and the American Association of State Highway and Transportation Officials (AASHTO) are hereby made a part of these specifications.

ASTM D 2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
ASTM D 2412	Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
ASTM D 3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
AASHTO M 252	Specification for Corrugated Polyethylene Drainage Tubing, 3 to 10 Inch Diameter.
AASHTO M 294	Specification for Corrugated Polyethylene Pipe, 12 to 36 Inch Diameter.

3. Quality Assurance:

Quality Assurance during placement of CPE Pipe will be provided by the Owner.

B. MATERIALS

1. All CPE Pipe shall be manufactured from new materials conforming with the requirements of cell class 324420C (4 to 10 inch diameter) Or 335420C (12 inch and greater diameter) as defined and described in ASTM D 3350.

2. All CPE Pipe shall be of the size indicated on the Contract Drawings and have smooth interior walls (AASHTO "Type S") and outer corrugated walls with either annular or spiral corrugations.

3. All CPE Pipe shall meet the requirements of AASHTO M 252 (3 to 10 inch diameter) or AASHTO M 294 (12 to 36 inch diameter).

4. The minimum parallel plate stiffness values when tested in accordance with ASTM D 2412 shall be as follows:

Pipe Diameter (inches)	Pipe Stiffness (psi)
4	50
6	50
8	50
10	50
12	50
15	42
18	40
24	34

5. Visible defects, such as cracks, creases, crazing, non-uniformly pigmented areas, or undispersed raw materials shall not be acceptable and will result in rejection of the pipe by the CQA Engineer.

6. Pipe Perforations: The perforations of the perforated CPE Pipe shall be as shown on the Contract Drawings.

7. CPE Pipe fittings and couplings shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints. Only fittings and couplings supplied or recommended by the pipe manufacturer shall be used.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Submit a certification and summary of all required test results, prior to installation, that all CPE Pipe manufactured for the project has been produced in accordance with these Specifications.

2. Submit a copy of the CPE Pipe Manufacturer's recommendations for shipping, handling, and storage of pipe.

3. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

D. CONSTRUCTION

1. Shipping , Handling, and Storage:

All CPE Pipe shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. CPE Pipe Installation:

a. The Contractor shall install CPE Pipe to the lines and grades shown on the Contract Drawings. Line and grade of piping shall be maintained with laser or approved equivalent. The Contractor shall give the CQA Engineer sufficient notice so that he may observe field location and installation activities.

b. Perforated CPE Pipe shall be placed during construction as shown on the Contract Drawings.

3. Cleaning:

All CPE Pipe shall be cleaned of any accumulation of silt, debris, or foreign matter of any kind and shall be kept clear of such accumulation until final acceptance of the work.

END OF SECTION

SECTION 02778

LLDPE GEOMEMBRANE

LLDPE Geomembrane (LLDPE-GM): The LLDPE Geomembrane serves as the primary hydraulic barrier in the Basin 1 & 2. It is of great importance that the LLDPE-GM be free from defects and installed free from damage.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of LLDPE-GM including all necessary and incidental items as detailed or required to complete the installation in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Excavation	02222
Embankment	02223

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) and the Geosynthetic Research Institute (GRI) are hereby made a part of these Specifications.

ASTM D 792	Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ASTM D 1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.

ASTM D 5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
ASTM D 5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
ASTM D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
ASTM D 5820	Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.
ASTM D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
ASTM D 6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
ASTM D 6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Flexible Polyethylene and Nonreinforced Polypropylene Geomembranes.
GRI GM9	Cold Weather Seaming of Geomembranes.
GRI GM12	Asperity Measurement of Textured Geomembranes Using a Depth Gage.
GRI GM17	Standard Specification for Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.
GRI GM19	Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

4. Quality Control:

Not Used.

5. Quality Assurance:

Quality Assurance during installation of LLDPE-GM will be provided by the Owner.

6. Manufacturers Qualifications:

The Manufacturer shall have previously demonstrated his ability to produce the required LLDPE-GM by having successfully manufactured a minimum of 5,000,000 ft^2 of LLDPE-GM for hydraulic containment purposes.

7. Installer Qualifications:

a. Installation of the LLDPE-GM shall be performed by an Installer that has installed a minimum of 5,000,000 ft^2 of LLDPE-GM (or similar material) within the past five (5) years in similar landfill installations.

b. All Installation Supervisors assigned to the Project shall have previously managed the installation of at least 2,000,000 ft^2 of LLDPE-GM (or similar material) using the same techniques to be used on site.

c. All seaming equipment operators shall have demonstrated performance on previous geomembrane installations and/or documented training.

8. Warranties:

a. General: Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for repair and/or relocation and replacement of the LLDPE-GM.

b. Workmanship: The Contractor shall furnish the Owner a warranty from the Installer of the LLDPE-GM which warrants their workmanship to be free of defects on a prorata basis for five (5) years after the final acceptance of the Work. This warranty shall include but not be limited to all field seams, anchor trenches, attachments to appurtenances, and penetration seals, as applicable.

c. Manufacturer's Warranty: The Contractor shall furnish the Owner a warranty from the LLDPE-GM Manufacturer for the materials used. The material warranty shall be for defects or failures related to manufacture on a prorata basis for five (5) years after the date of shipment.

B. MATERIALS

1. General:

The materials supplied under these Specifications shall consist of new, first-quality products designed and manufactured specifically for the purpose of this work, which shall have been satisfactorily demonstrated, by prior use, to be suitable and durable for such purposes. The LLDPE-GM and LLDPE-GM Manufacturer shall be approved by the Engineer.

The LLDPE-GM shall be supplied in rolls which shall have a minimum width of 22 feet. The roll length shall be maximized to provide the largest manageable sheet for the fewest seams. Labels on the roll shall identify the thickness, length, width, lot and roll numbers, and name of Manufacturer.

2. LLDPE-GM Materials:

a. Textured LLDPE-GM shall be 40 mils thick. Resin and sheet properties of LLDPE-GM shall meet or exceed the requirements of GRI GM17.

b. Materials classified as Very Flexible Polyethylene (VFPE) which otherwise meet the requirements of this section are also acceptable.

3. Extrusion Resin/Typical Extrudate:

Extrusion resin/typical extrudate used for extrusion seaming of LLDPE-GM shall be linear low density polyethylene (LLDPE). Physical properties shall be the same as the LLDPE-GM sheet. The extrudate's additives shall be thoroughly dispersed throughout the rod or bead. The extrudate shall be free of contamination by moisture or foreign matter and shall be recommended for use with the associated sheet material.

4. Texturing:

Textured LLDPE-GM, where required, shall be fabricated using coextrusion or impingement methods. Texturing shall not be created by lamination, structuring, or embossing. Texturing applied to LLDPE-GM using impingement methods shall be bonded securely to the parent LLDPE-GM. All texturing shall be uniform in appearance and coverage on the finished sheet. Textured LLDPE-GM shall be textured on both sides of the sheet.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Pre-Installation Requirements:

Prior to LLDPE-GM installation, the Contractor shall submit the following:

a. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for the LLDPE-GM attesting that the LLDPE-GM meets the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample of the LLDPE-GM to be used. The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.

b. Qualifications:

(1) Submit list of equipment and personnel proposed for the Project. Include equipment type and quantities. Include personnel experience on similar projects.

(2) Submit resume and references of Installation Supervisor to be assigned to the Project, including data and duration of employment and pertinent experience information.

(3) Submit resumes and references of installation personnel who will perform seaming operations, including dates and durations of employment and pertinent experience information.

c. Shipping, Handling, and Storage Instructions: The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.

d. Delivery Date: Submit notification of the scheduled delivery dates for the materials.

e. Installation Procedures and Drawings:

Submit installation procedures and (shop) drawings for carrying out the work.

(1) Installation procedures to be addressed shall include but not be limited to material installation, repair, and protection to be provided in the event of rain or strong winds.

(2) Shop drawings shall have LLDPE-GM sheet layout with proposed size, number, position, and sequence of placing all panels, and indicating the location of all field seams. Shop drawings shall also show complete details and/or methods for anchoring the LLDPE-

GM, making field seams, and making seals around pipes and structures penetrating the LLDPE-GM (if applicable).

Following review, these procedures and drawings shall be used for installation of the LLDPE-GM. Any deviations from these procedures and drawings must be approved by the Engineer and CQA Engineer.

f. Quality Control Certificates: For LLDPE-GM delivered to the site, quality control certificates, signed by the Manufacturer's quality assurance manager shall be provided which represent every roll of LLDPE-GM. Each certificate shall have the roll identification number(s), test methods, frequency, and test results. At a minimum, the test results and frequency of testing shall meet or exceed the requirements of GRI GM17.

g. Contractor Quality Control Test Results: The Contractor shall provide the results of required testing.

h. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

2. Post-Installation Requirements:

Upon completion of the LLDPE-GM installation, the Contractor shall submit the following:

a. Certificate stating that the LLDPE-GM has been installed in accordance with the Drawings, Specifications, and the Manufacturer's recommendations.

b. Completed Manufacturer's and workmanship warranties.

c. Record Information: Record information shall include but not be limited to:

(1) CQC Documentation: Includes trial seam logs, panel placement logs, panel seaming logs, non-destructive seam testing report forms, field destructive seam testing report forms, and repair logs.

(2) As-Built Drawing: Includes the requirements listed in Paragraph D.8 (Surveying) of this Specification.

Finalization of payment for LLDPE-GM installation shall not be made until the above submittals have been reviewed by the CQA Engineer.

4. LLDPE-GM Placement:

a. Weather Conditions:

LLDPE-GM placement shall not proceed at an ambient temperature below 32° F or above 100° F unless otherwise authorized, in writing, by the Engineer. Installation of LLDPE-GM at temperatures below 32° F, if authorized by the Engineer, shall follow GRI GM9. LLDPE-GM placement shall not be performed during precipitation, excessive moisture, in an area of ponded water, or in excessive winds. Any portion of LLDPE-GM or subgrade damaged due to weather conditions shall be repaired at the Contractor's cost.

b. Method of Placement:

(1) Each panel of the LLDPE-GM shall be installed in accordance with the approved shop drawings prepared by the Contractor. The layout shall be designed to keep field seaming of the LLDPE-GM to a minimum and consistent with proper methods of LLDPE-GM installation.

(2) Panels shall be oriented perpendicular to the line of the slope crest (i.e., down and not across slope).

(3) The LLDPE-GM shall be placed smooth and free of excessive wrinkles.

(4) LLDPE-GM rolls shall be placed using proper spreader and rolling bars with cloth slings. If a sheet must be displaced a distance greater than its width, a slip sheet shall be used.

(5) The CQA Engineer shall inspect each panel, after placement and prior to seaming, for damage and/or defects. Defective or damaged panels shall be replaced or repaired, as approved by the CQA Engineer and as described in this section.

(6) The Installer shall avoid dragging the LLDPE-GM on rough soil subgrades.

(7) All LLDPE-GM shall be anchored as shown on the Contract Drawings and consistent with Manufacturer's recommendations.

(8) Personnel working on the LLDPE-GM shall not smoke, wear damaging shoes, or involve themselves in any activity that may damage the LLDPE-GM, in the opinion of the CQA Engineer.

(9) The LLDPE-GM shall be properly weighted to avoid uplift due to wind.

(10) Vehicular traffic across the LLDPE-GM shall not be allowed, except that four-wheel (or greater) all-terrain vehicles (ATVs) with low ground pressure may be allowed if approved in advance by the Engineer. The Contractor shall submit proposed equipment and procedures for use of ATVs to the CQA Engineer as part of his submittals. If ATVs are allowed by the Engineer, each ATV shall be operated such that no sudden stops, starts, or turns are made.

(11) All damage shall be recorded and located on the record drawings.

(12) The LLDPE-GM shall be kept free of debris, unnecessary tools, and materials. In general, the LLDPE-GM area shall remain neat in appearance.

c. Pipe Penetrations:

All pipe penetrations through the LLDPE-GM shall be as shown in the Contract Drawings. Alternative penetration details may be approved by the Engineer and CQA Engineer.

5. Field Seams:

a. Individual panels of LLDPE-GM shall be laid out and overlapped by a minimum of 4 inches prior to seaming. The area to be seamed shall be cleaned and prepared in accordance with the Manufacturer's recommendations.

b. Dual or single track hot wedge methods shall be used for straight seams.

c. Extrusion fillet methods shall be used to seam cross seam tees, patches, repairs, and penetration boots. All extrudate shall be free of dirt, dry, and protected from damage. To limit overgrinding, the amount of grinding exposed after an extrusion seam is completed shall be less than ¼ inch.

d. The seaming equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the LLDPE-GM so as to ensure that changes in environmental conditions will not affect the integrity of the seam.

e. All seams shall have a seam number that corresponds with the panel layout numbers. The numbering system shall be used in the development of the

D. CONSTRUCTION

1. Shipping, Handling, and Storage:

The LLDPE-GM shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. Failing CQA Material Control Tests:

LLDPE-GM that is rejected upon testing shall be removed from the project site and replaced at Contractor's cost. Sampling and CQA testing of LLDPE-GM supplied as replacement for rejected material shall be performed by the CQA Engineer at Contractor's cost.

3. Subgrade Preparation:

a. The surface of the subgrade shall be smooth, uniform, free from sudden changes in grade (such as vehicular ruts), rocks or stones greater than ½ inch in size, debris, and deleterious materials. During actual placing and seaming of the LLDPE-GM, the subgrade shall be kept free of all standing water. If the subgrade below the LLDPE-GM becomes excessively wet and unstable as determined by the CQA Engineer, it shall be dried and recompacted, and replaced if needed.

b. Before an individual panel of LLDPE-GM is installed; the Contractor and Installer shall verify in writing and submit to the CQA Engineer:

(1) Lines and grades are in conformance with the Drawings and Specifications.

(2) The surface area to be lined has been rolled and compacted, free of irregularities and abrupt changes in grade.

c. The Contractor shall not proceed with LLDPE-GM installation until a complete report on all Compacted Soil Barrier (if required) CQA testing has been submitted and approved by the CQA Engineer. If the Contractor proceeds with LLDPE-GM installation prior to completion of these tests, the Contractor will do so at his own risk. If any tests fail, the Contractor shall be required to remove LLDPE-GM and reconstruct the Compacted Soil Barrier to specification requirements. All costs associated with such actions (including the costs of additional testing) shall be paid for entirely by the Contractor.

record drawings. Seam numbers shall be derived from the combination of the two panel numbers that are to be seamed together.

f. Where horizontal seams are required on sloped surfaces, the panels shall be placed such that the "upstream" panel forms the upper panel and overlaps the "downstream" panel in order to minimize infiltration potential. All seams constructed on slopes of 6H:1V or steeper shall be vertical seams, except where slope lengths exceed standard roll lengths and elsewhere as approved in advance by the Engineer. Where approved, end seams on slopes of 6H:1V or steeper shall be staggered a minimum of 5 feet and shall be made at an angle of approximately 45 degrees.

g. All panels placed on slopes of 6H:1V or steeper shall extend a minimum of 5 feet beyond the grade break with a slope flatter than 6H:1V.

h. All seams shall extend to the full extent of the anchor trench (where applicable).

i. Unless otherwise approved by the Engineer, all “T” seams (i.e., the result of three panels placed together) shall be staggered a minimum of 3 feet along either seam and shall be covered with a patch.

j. No junctions of four or more panels shall be allowed unless approved by the Engineer.

k. If extrusion seaming equipment is stopped for longer than one minute, it shall be purged to remove heat-degraded extrudate. All purged extrudate shall be placed on a sacrificial sheet and disposed of.

l. To prevent moisture buildup during seaming, it may be necessary to place a movable protective layer of plastic directly below each overlap of LLDPE-GM that is to be seamed.

m. If required, a firm substrate shall be provided by using a flat board or similar hard surface directly under the seam overlap to achieve proper support.

n. All seams (including repairs) shall meet or exceed the requirements of GRI GM19 and Table 1 of this section.

o. No overlying material shall be placed over the LLDPE-GM until approved by the CQA Engineer.

6. Anchor Trench:

a. The anchor trench shall be constructed as shown on the Contract Drawings and as specified herein. The anchor trench shall be maintained by the Contractor.

b. Slightly rounded corners shall be provided in the trench to avoid sharp bends in the LLDPE-GM.

c. The anchor trench shall be adequately drained to prevent water ponding and softening to adjacent soils. The anchor trench shall be backfilled with controlled fill material and compacted to 90% standard Proctor dry density (ASTM D 698).

d. If the anchor trench is located in a clay susceptible to desiccation, the amount of trench open at any time shall be limited to one day of LLDPE-GM installation capacity.

7. Repair Procedures:

a. Any portion of the LLDPE-GM exhibiting signs of defect or failing a nondestructive or a destructive test, shall be repaired by the Geomembrane Installer. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be made by the CQA Engineer. The procedures available include:

(1) Patching - Apply a new piece of LLDPE-GM sheet over, and at least 6-inches beyond the limits of a defect. The patch shall be extrusion seamed to the underlying LLDPE-GM. This method should be used to repair holes, tears, destructive test locations, undispersed raw materials, contamination by foreign matter, dents, pinholes, and pressure test holes.

(2) Capping - Apply a new strip of LLDPE-GM along the length of a delineated faulty seam. The cap strip shall extend at least 6-inches beyond the limit of the seam and the edges shall be extrusion seamed to the underlying LLDPE-GM. This method should be used to repair lengths of extrusion or hot wedge seams.

(3) Replacement - The faulty seam is removed and replaced.

b. In addition, the following provisions shall be satisfied:

(1) Surfaces of the LLDPE-GM which are to be repaired shall be abraded no more than one hour prior to the repair;

(2) All surfaces must be clean and dry at the time of the repair;

(3) All seaming equipment used in repairing procedures must be approved;

(4) The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the CQA Engineer;

(5) Extrusion seaming of flaps of dual track hot wedge seams is not acceptable. A patch or cap strip shall be used; and

(6) Patches or caps shall extend at least 6-inches beyond the edge of the defect, and all patch corners shall be rounded.

8. Surveying:

a. After completion of a segment of LLDPE-GM, the Contractor shall survey LLDPE-GM to obtain the following information:

(1) Location and numbering of all panels/seams.

(2) Location of all repairs/patches;

(3) Location of all destructive test locations; and

(4) Location of all pipe penetrations and other appurtenances (if applicable).

b. No overlying materials shall be placed before survey information is obtained.

c. The Contractor shall provide the CQA Engineer with updated survey information when requested by the CQA Engineer to verify that the required information is being obtained.

9. Cover Placement:

Placement of materials over LLDPE-GM shall be performed in a manner as to ensure that LLDPE-GM and the underlying geosynthetics are not damaged; minimal slippage of LLDPE-GM on the underlying geosynthetics occurs; no excess tensile stresses occur in the LLDPE-GM; and that no portion of the LLDPE-GM develops excessive wrinkles or crimp. Wrinkles that exceed approximately 6 inches in height and cannot be eliminated by amended placement and covering methods or LLDPE-GM that becomes crimped shall be cut and repaired by the Geosynthetics Installer in a method approved by the Engineer.

TABLE 1: REQUIRED SEAM STRENGTH PROPERTIES

PROPERTY	TEST METHOD	VALUE	
		Hot Wedge Seams	**Extrusion Fillet Seams**
40 mil			
Shear Strength[1]	ASTM D 6392	60 lbs/inch	
Shear Elongation at Break[2]		50%	
Peel Strength[1]		50 lbs/inch	44 lbs/inch
Peel Separation (Incursion)		$\leq$ 25%	
Locus-of-Break		See Note 3	

Notes:

1. Values listed for shear and peel strengths are for 4 out of 5 test specimens; the 5th specimen can be as low as 80% of the listed values.
2. Omit elongation measurements when performing field tests.
3. Regarding the locus-of-break patterns of the different seaming methods in shear and peel, the following are unacceptable break codes per their description in ASTM D 6392 (in this regard, SIP is an acceptable break code):

   Hot Wedge: AD and AD-BRK with > 25% Separation
   Extrusion Fillet: AD1, AD2, and AD-WLD (unless strength is achieved).

END OF SECTION

SECTION 02930

REVEGETATION

Revegetation: Revegetation includes permanent Revegetation of all site areas disturbed by the Contractor whether inside the Contract Limits or not.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete Revegetation in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Embankment	02223
Vegetative Soil Layer	02258
Erosion and Sedimentation Control	02270
Rolled Erosion Control Products	02275

3. Warranty:

The Contractor shall be responsible for the satisfactory establishment and growth of a permanent stand of vegetation for a period of one year following the final seeding as judged by the Engineer. During this period, the Contractor shall be responsible for the maintenance items described in Paragraph D.4 (Maintenance) of this Specification.

B. MATERIALS

1. Limestone: Unless otherwise defined by specific soil tests, supply agricultural grade ground limestone conforming to the current "Rules, Regulations, and Standards of the Fertilizer Board of Control."

2. Fertilizer: Unless otherwise defined by specific soil tests, supply commercial fertilizer of 10-20-10 analysis, meeting applicable requirements of State and Federal law. Do not use cyanamic compounds of hydrated lime. Deliver fertilizer in original containers labeled with content analysis.

3. Grass Seed: Supply fresh, clean, new-crop seed as specified in Table 1 of this section. Do not use seed which is wet, moldy, or otherwise damaged. Deliver seed in standard sealed containers labeled with producer's name and seed analysis, and in accord with US Department of Agriculture Rules and Regulations under Federal Seed Act.

4. Mulch: Supply clean, seed-free, threshed straw of oats, wheat, barley, rye, beans, or other locally available mulch material.

   a. Do not use mulch containing a quantity of matured, noxious weed seeds or other species that will be detrimental to seeding, or provide a menace to surrounding land.

   b. Do not use mulch material which is fresh or excessively brittle, or which is decomposed and will smother or retard growth of grass.

5. Binder: Supply emulsified asphalt or synthetic binder.

6. Water: Supply potable, free of substances harmful to growth.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Results of soil tests performed and proposed modifications, if any, to the specified requirements.

2. Certificates for each grass seed mixture, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed. Certify that each container of seed delivered is fully labeled in accordance with Federal Seed Act and equals or exceeds specification requirements.

3. Copies of invoices for fertilizer, showing grade furnished and total quantity applied.

D. CONSTRUCTION

1. The Contractor shall establish a smooth, healthy, uniform, close stand of grass from the specified seed. Prior to Revegetation, the Contractor shall adequately test the soils to be revegetated to ensure the adequacy of the specified requirements. Any modifications to these requirements deemed necessary after the review of soil test results, shall be at the Contractor's sole expense. The Engineer will perform the observations to determine when successful Revegetation is achieved.

2. Soil Preparation:

a. Limit preparation to areas which will be planted soon after preparation.

b. Loosen surface to minimum depth of four (4) inches.

c. Remove stones, sticks, roots, rubbish and other extraneous matter over three (3) inches in any dimension.

d. Spread lime uniformly over designated areas at the rate specified in Table 1 of this section.

e. After application of lime, prior to applying fertilizer, loosen areas to be seeded with double disc or other suitable device if soil has become hard or compacted. Correct any surface irregularities in order to prevent pocket or low areas which will allow water to stand.

f. Distribute fertilizer uniformly over areas to be seeded at the rate specified in Table 1 of this section.

(1) Use suitable distributor.

(2) Incorporate fertilizer into soil to depth of a least two (2) inches.

(3) Remove stones or other substances which will interfere with turf development or subsequent mowing.

g. Grade seeded areas to smooth, even surface with loose, uniformly fine texture.

(1) Roll and rake, remove ridges and fill depressions, as required to meet finish grades.

(2) Fine grade just prior to planting.

3. Seeding:

a. Use approved mechanical power driven drills or seeders, mechanical hand seeders, or other approved equipment.

b. Distribute seed evenly over entire area at the rate specified in Table 1 of this section.

c. Stop work when work extends beyond most favorable planting season for species designated, or when satisfactory results cannot be obtained because of drought, high winds, excessive moisture, or other factors.

d. Resume work only when favorable condition develops, or as directed by the Engineer.

e. Lightly rake seed into soil followed by light rolling or cultipacking.

f. Immediately protect seeded areas against erosion by mulching or placing Rolled Erosion Control Products in accordance with Section 02275 of these Specifications, where applicable.

(1) Spread mulch in a continuous blanket at the rate specified in Table 1 of this section.

(2) Immediately following spreading mulch, secure with evenly distributed binder at the rate specified in Table 1 of this section.

4. Maintenance:

The Contractor shall be responsible for maintaining all seeded areas through the end of his warranty period. The Contractor shall provide, at his expense, protection of all seeded areas against damage at all times until acceptance of the work. Maintenance shall include, but not be limited to, the following items

a. Regrade and revegetate all eroded areas until adequately stabilized by grass.

b. Remulch with new mulch in areas where mulch has been disturbed by wind or maintenance operations sufficiently to nullify its purpose. Anchor as required to prevent displacement.

c. Replant bare areas using same materials specified.

TABLE 1: SEEDING SCHEDULE

MATERIAL	SEED TYPE	APPLICATION RATE[1]
Lime	-----	4,000 lbs/acre
Fertilizer	10-10-10 Analysis	1,000 lbs/acre
Seed		
Permanent:	Kentucky 31 Tall Fescue	120 lbs/acre
	Pensacola Bahiagrass	50 lbs/acre
	Sericea Lespedeza[3]	40 lbs/acre
	Kobe Lespedeza	10 lbs/acre
	Seasonal Nurse Crop[2]	See Note 2
Temporary:	Seasonal Nurse Crop[2]	See Note 2
Mulch	-----	4,000 - 5,000 lbs/acre
Binder	Asphalt Emulsion	300 gallons/acre

Notes:

1. Application rates and/or chemical analysis shall be confirmed or established by a soil test.

2. Use seasonal nurse crop in accordance with seeding dates as stated below:

April 15 - August 15	10 lbs/acre German Millet or 15 lbs/acre Sudangrass
August 16 - April 14	25 lbs/acre Rye (grain).

3. From September 1 - March 1, use unscarified Sericea seed.

END OF SECTION

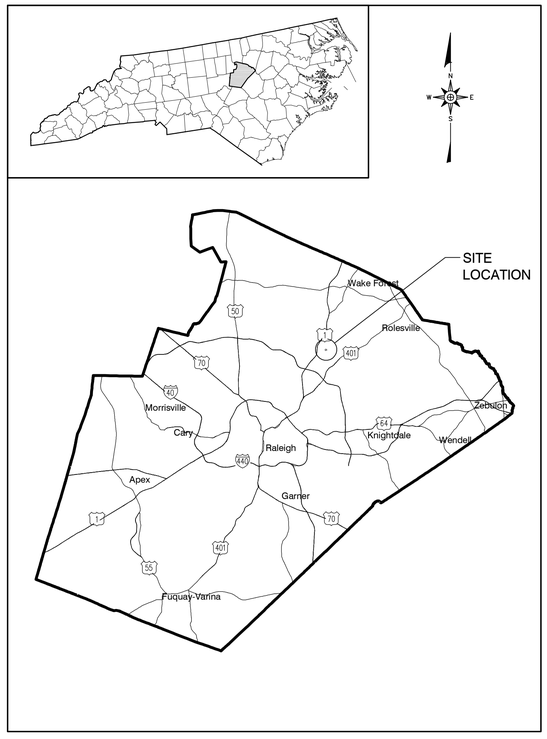
Appendix D

Erosion and Sedimentation Control Plans & Details

SHOTWELL TRANSFER STATION, INC.
WAKE COUNTY, NORTH CAROLINA

THORNTON ROAD MIXED WASTE TRANSFER & RECYCLING CENTER PERMIT DRAWINGS CITY OF RALEIGH GRADING PERMIT

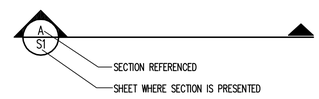
FEBRUARY 2008



SITE LOCATION MAP
NOT TO SCALE

SHEET NO.	DRAWING NO.	DRAWING TITLE
1		TITLE – COVER SHEET
2	S1	EXISTING SITE CONDITIONS
3	S2	INITIAL GRADING AND DRAINAGE PLAN
4	S3	FINAL SITE GRADING AND DRAINAGE PLAN
5	EC1	EROSION AND SEDIMENTATION CONTROL DETAILS (SHEET 1 OF 2)
6	EC2	EROSION AND SEDIMENTATION CONTROL DETAILS (SHEET 2 OF 3)
7	EC3	EROSION AND SEDIMENTATION CONTROL DETAILS (SHEET 3 OF 3)

STANDARD SECTION LOCATION (SHEET AND DETAIL)



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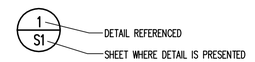
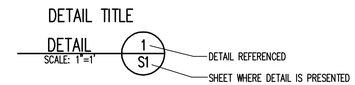
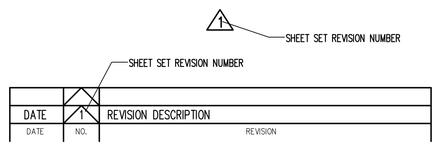


STANDARD DETAIL TITLE AND CALLOUT



STANDARD REVISION CALLOUT (SHEET AND DETAIL)



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fax: 919-828-3899

FILE NAME
KING-D0008

REVISION
NO.
DATE

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50' NEUSE RIVER BUFFER
30' UNDISTURBED NEUSE RIVER BUFFER
FEMA FLOOD ZONE
(SEE REFERENCE 2)
WETLANDS
PROPERTY LINE
(SEE REFERENCE 6)
R-4
I-1
RECYCLING AREA
(TO BE RELOCATED)
WETLANDS
CITY OF RALEIGH SANITARY SEWER
(SEE REFERENCE 3)
ZONING LINE
CLOSED LCID LANDFILL
(SEE REFERENCE 7)
SIGN
T&T
SALVAGE
MW-9
50' ZONE BUFFER
THORNTON ROAD
EXISTING SCALES AND SCALEHOUSE
(TO BE REMOVED)
EXISTING PIPE (TYP.)
OVERHEAD UTILITY LINE
UTILITY POLE
THORNTON ROAD
TBM

N
W
E
S

LEGEND

- 800 — EXISTING 10' CONTOUR (SEE REFERENCE 1)
- EXISTING 2' CONTOUR
- PROPERTY LINE (SEE REFERENCE 6)
- FEMA FLOOD ZONE "X" (SEE REFERENCE 2)
- FEMA FLOOD ZONE "AE" (SEE REFERENCE 2)
- NEUSE RIVER BUFFER
- NEUSE RIVER BUFFER (DISTURBABLE LIMITS)
- SURVEYED WETLANDS (SEE REFERENCE 5)
- ZONING LINE
- MONITORING WELL

REFERENCES

1. EXISTING TOPOGRAPHY SURVEYED BY STOCKS ENGINEERING, P.A., DATED OCTOBER 2007.
2. FLOOD ZONE LIMITS FROM FLOOD INSURANCE RATE MAP (FIRM) NUMBER 3720173800J, PANEL 1738, EFFECTIVE DATE MAY 2, 2006.
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4. ZONING LINES FROM SURVEY BY MURPHY GEOMATICS, PRESENTED IN DRAWING ENTITLED "RECOMBINATION PLAT FOR THORNTON II" DATED AUGUST 2006.
5. WETLAND DELINEATION FROM DRAWING ENTITLED "WEBTHOR PRELIMARY WETLAND DELINEATION", PREPARED BY MURPHY GEOMATICS, DATED OCTOBER 29, 2007.
6. SITE PROPERTY LINE FROM DRAWING ENTITLED "RECOMBINATION PLAT FOR DYNASTY HOLDINGS, LLC" PREPARED BY MURPHY GEOMATICS, DATED NOVEMBER 2007.

PERMIT ISSUE
NOT FOR CONSTRUCTION

0 50' 100' 150'

REVISION | NO. | DATE

RICHARDSON SMITH GARDNER & ASSOCIATES
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ph: 919-828-0577 fax: 919-828-3899
www.rsgengineers.com

SEAL

SEAL

PROJECT TITLE:
THORNTON ROAD
MIXED WASTE TRANSFER &
RECYCLING CENTER
SHOTWELL TRANSFER STATION, INC.

DRAWING TITLE:
EXISTING SITE CONDITIONS

DESIGNED BY:	DRAWN BY:
S.A.S.	J.A.L.
CHECKED BY:	PROJECT NO.: KING 07-1
SCALE: AS SHOWN	DATE: FEB. 2008
FILE NAME: KING-D0005	
SHEET NO.: 2	DRAWING NO.: S1

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EROSION AND SEDIMENTATION CONTROL NOTES/CONSTRUCTION SEQUENCE:

1. SCHEDULE A PRECONSTRUCTION CONFERENCE WITH THE ENVIRONMENTAL ENGINEER. OBTAIN A LAND-DISTURBING PERMIT.
2. INSTALL THE INITIAL STORMWATER MEASURES AS PER THE FOLLOWING SEQUENCE AS SHOWN IN THE DRAWING.
   A. SILT FENCE
   B. SEDIMENT TRAPS ST-1 & ST-2. CLEAR THE AREA ONLY AS NECESSARY TO INSTALL THESE DEVICES.
   C. WET DETENTION BASIN (INSTALL THIS BASIN UP TO AN EXISTING ROAD AS SHOWN IN THE FIGURE).
3. INSTALL THE FINAL GRADING STORMWATER MEASURES AS PER THE FOLLOWING SEQUENCE AS SHOWN IN THE DRAWING.
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   B. CHANNEL DC-1A & GRASS SWALES DC-2A & DC-2B
   C. SCALE HOUSE AND ACCESS ROAD
4. CALL FOR AN ONSITE INSPECTION BY THE ENVIRONMENTAL ENGINEER TO OBTAIN A CERTIFICATION OF COMPLIANCE PRIOR TO LAND DISTURBANCE ACTIVITIES COMMENCE.
5. VEGETATIVE STABILIZATION OF DISTURBED AREAS WILL BE IN ACCORDANCE WITH THE FOLLOWING REQUIREMENTS:
   TEMPORARY OR PERMANENT GROUND COVER (OR OTHER ACCEPTABLE MEASURE(S)) ADEQUATE TO RESTRAIN EROSION ON ERODIBLE SLOPES OR OTHER AREAS WILL BE STABILIZED WITHIN FIFTEEN (15) WORKING DAYS OR TWENTY-ON (21) CALENDAR DAYS FOLLOWING COMPLETION OF ANY PHASE OF GRADING.
6. ALL EROSION AND SEDIMENTATION CONTROL MEASURES WILL BE INSPECTED AT LEAST ONCE EVERY SEVEN CALENDAR DAYS AND WITHIN 24 HOURS AFTER ANY STORM EVENT OF GREATER THAN 0.5 INCHES OF RAIN PER 24 HOUR PERIOD. A RAIN GAUGE WILL BE MAINTAINED ON THE SITE AND A RECORD OF THE RAINFALL AMOUNTS AND DATES WILL BE KEPT PROPERLY.
7. DURING INSPECTIONS, ANY STORMWATER DISCHARGES FROM THE SITE WILL BE OBSERVED FOR STORMWATER DISCHARGE CHARACTERISTICS TO EVALUATE THE EFFECTIVENESS OF THE EROSION AND SEDIMENTATION CONTROL MEASURES INCORPORATING BEST MANAGEMENT PRACTICES (BMPS). ANY OFFSITE SEDIMENTATION SHOULD BE REPORTED TO WAKE COUNTY AND CORRECTIVE ACTION WILL BE TAKEN IMMEDIATELY TO CONTROL THE DISCHARGE OF SEDIMENTS.
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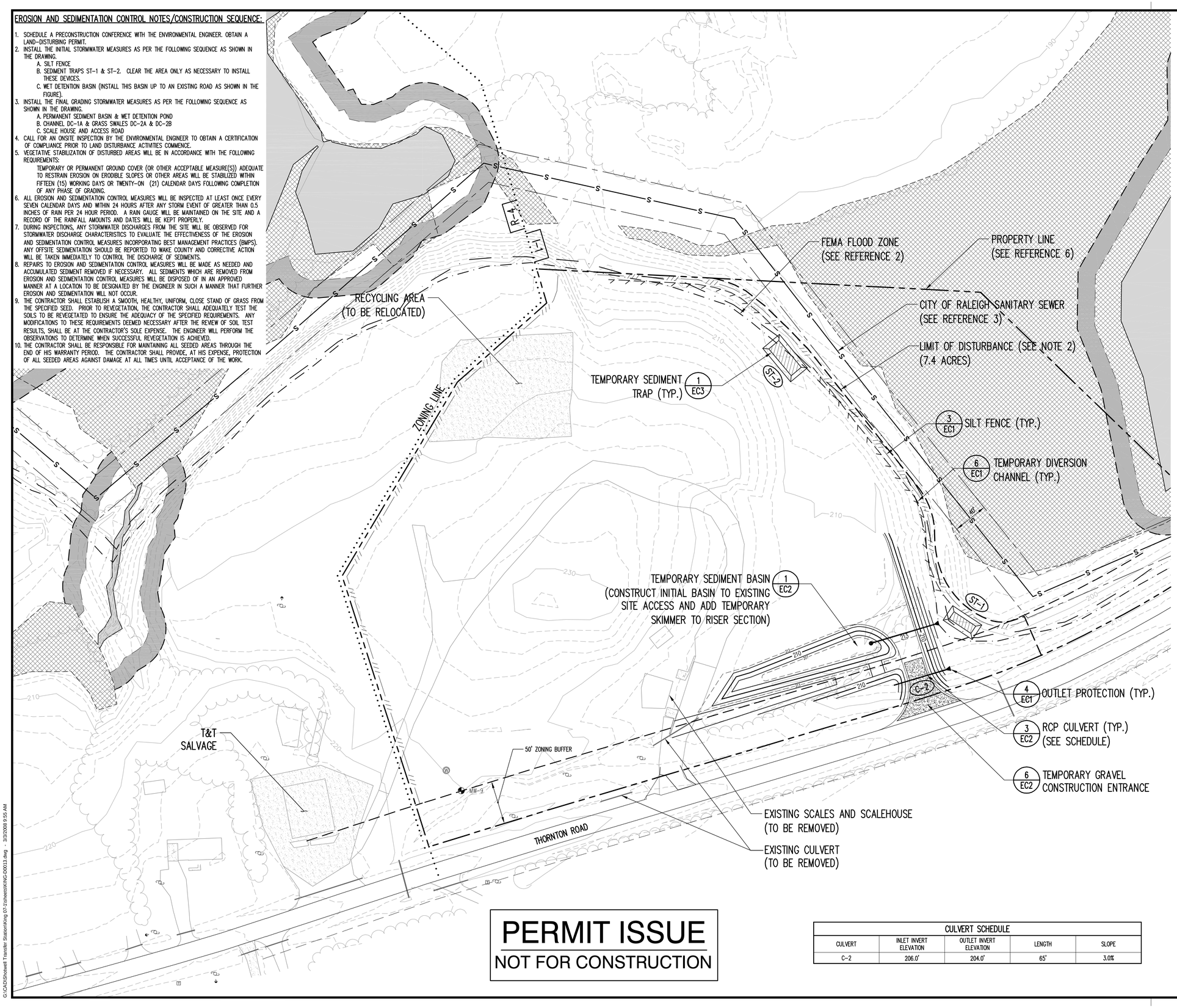

LEGEND

- EXISTING 10' CONTOUR (SEE REFERENCE 1)
- EXISTING 2' CONTOUR
- PROPOSED 10' CONTOUR
- PROPOSED 2' CONTOUR
- PROPOSED 1' CONTOUR (SEE NOTE 1)
- DIVERSION CHANNEL
- PIPE (WITH OUTLET PROTECTION)
- SILT FENCE
- SEDIMENT TRAP
- PROPERTY LINE
- LIMIT OF DISTURBANCE (SEE NOTE 2)
- FEMA FLOOD ZONE "X" (SEE REFERENCE 2)
- FEMA FLOOD ZONE "AE" (SEE REFERENCE 2)
- NEUSE RIVER BUFFER
- NEUSE RIVER BUFFER (DISTURBABLE LIMITS)
- SURVEYED WETLANDS (SEE REFERENCE 5)
- FACILITY BOUNDARY
- ZONING LINE
- MONITORING WELL

NOTES

1. PROPOSED CONTOURS AT 1' INTERVAL SHOWN FOR CLARITY ONLY IN AREAS NEEDED.
2. IN DISTURBED AREAS WEST OF THIS BOUNDARY, LIMIT OF DISTURBANCE IS COINCIDENT WITH THE PROPERTY LINE.

REFERENCES

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0 50' 100' 150'

CULVERT SCHEDULE

CULVERT	INLET INVERT ELEVATION	OUTLET INVERT ELEVATION	LENGTH	SLOPE
C-2	206.0'	204.0'	65'	3.0%

PERMIT ISSUE
NOT FOR CONSTRUCTION

NO.	REVISION	DATE

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14 N. Boylan Ave. Raleigh, N.C. 27603
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www.rsgengineers.com

SEAL

SEAL

PROJECT TITLE:
THORNTON ROAD
MIXED WASTE TRANSFER &
RECYCLING CENTER
SHOTWELL TRANSFER STATION, INC.

DRAWING TITLE:
INITIAL GRADING AND DRAINAGE PLAN

DESIGNED BY:	DRAWN BY:
S.A.S.	J.A.L.
CHECKED BY:	PROJECT NO.:
	KING 07-1
SCALE:	DATE:
AS SHOWN	FEB. 2008
FILE NAME	
KING-D0013	
SHEET NO.	DRAWING NO.
3	S2

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EROSION AND SEDIMENTATION CONTROL NOTES/CONSTRUCTION SEQUENCE:

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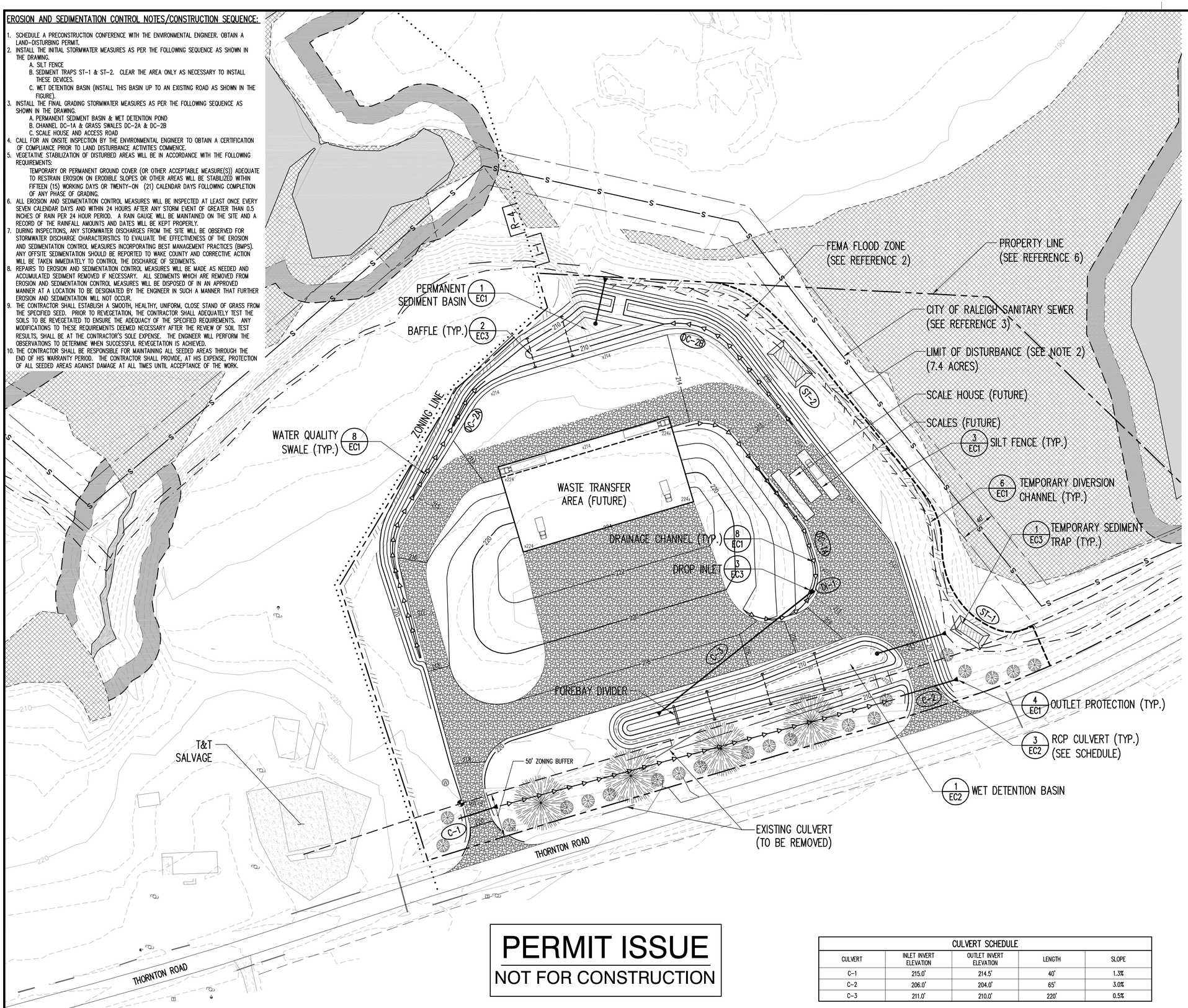

LEGEND

- EXISTING 10' CONTOUR (SEE REFERENCE 1)
- EXISTING 2' CONTOUR
- PROPOSED 10' CONTOUR
- PROPOSED 2' CONTOUR
- PROPOSED 1' CONTOUR (SEE NOTE 1)
- DRAINAGE CHANNEL
- DIVERSION CHANNEL
- PIPE (WITH OUTLET PROTECTION)
- SILT FENCE
- SEDIMENT TRAP
- PROPERTY LINE
- LIMITS OF DISTURBANCE (SEE NOTE 2)
- FEMA FLOOD ZONE "X" (SEE REFERENCE 2)
- FEMA FLOOD ZONE "AE" (SEE REFERENCE 2)
- NEUSE RIVER BUFFER
- NEUSE RIVER BUFFER (DISTURBABLE LIMITS)
- SURVEYED WETLANDS (SEE REFERENCE 5)
- ZONING LINE
- MONITORING WELL
- BUSH
- TREE

NOTES

1. PROPOSED CONTOURS AT 1' INTERVAL SHOWN FOR CLARITY ONLY IN AREAS NEEDED.
2. IN DISTURBED AREAS WEST OF THIS BOUNDARY, LIMIT OF DISTURBANCE IS COINCIDENT WITH THE PROPERTY LINE.

REFERENCES

1. EXISTING TOPOGRAPHY SURVEYED BY STOCKS ENGINEERING, P.A., DATED OCTOBER 2007.
2. FLOOD ZONE LIMITS FROM FLOOD INSURANCE RATE MAP (FIRM) NUMBER 3720173800J, PANEL 1738, EFFECTIVE DATE MAY 2, 2006.
3. CITY OF RALEIGH SINITARY SEWER LOCATIONS PROVIDED BY STOCKS ENGINEERING, P.A., DATED OCTOBER 2007.
4. ZONING LINES FROM SURVEY BY MURPHY GEOMATICS, PRESENTED IN DRAWING ENTITLED "RECOMBINATION PLAT FOR THORNTON II" DATED AUGUST 2006.
5. WETLAND DELINEATION FROM DRAWING ENTITLED "WEBTHOR PRELIMARY WETLAND DELINEATION", PREPARED BY MURPHY GEOMATICS, DATED OCTOBER 29, 2007.
6. SITE PROPERTY LINE FROM DRAWING ENTITLED "RECOMBINATION PLAT FOR DYNASTY HOLDINGS, LLC" PREPARED BY MURPHY GEOMATICS, DATED NOVEMBER 2007.

0 50' 100' 150'

CULVERT SCHEDULE

CULVERT	INLET INVERT ELEVATION	OUTLET INVERT ELEVATION	LENGTH	SLOPE
C-1	215.0'	214.5'	40'	1.3%
C-2	206.0'	204.0'	65'	3.0%
C-3	211.0'	210.0'	220'	0.5%

PERMIT ISSUE
NOT FOR CONSTRUCTION

NO.	DATE	REVISION

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SEAL

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PROJECT TITLE:
THORNTON ROAD
MIXED WASTE TRANSFER & RECYCLING CENTER
SHOTWELL TRANSFER STATION, INC.

DRAWING TITLE:
FINAL SITE GRADING AND DRAINAGE PLAN

DESIGNED BY:	DRAWN BY:
S.A.S.	J.A.L.
CHECKED BY:	PROJECT NO.: KING 07-1
SCALE: AS SHOWN	DATE: FEB. 2008
FILE NAME: KING-D0012	
SHEET NO. 4	DRAWING NO. S3

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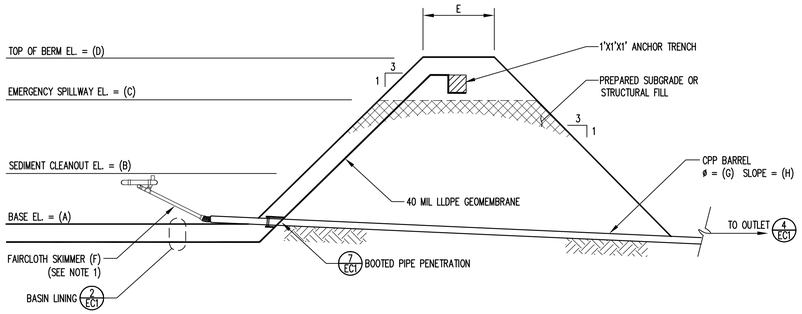
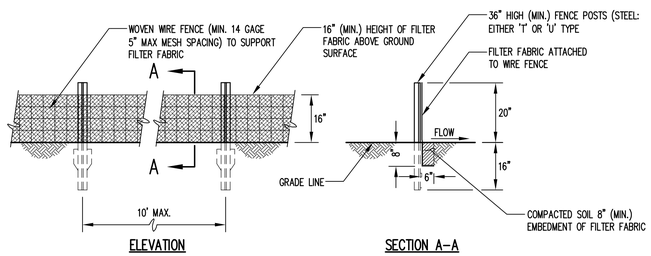


PERMANENT SEDIMENT BASIN SCHEDULE									
BASIN	A (FT)	B (FT)	C (FT)	D (FT)	E (FT)	F (IN)	G (IN)	H (FT/FT)	L (FT)
PERMANENT SEDIMENT BASIN	206.0	208.0	209.3	210.0	10	2.0	4	0.025	40

NOTE:
1. SEE FIGURE 6.64A FROM THE 6/06 EDITION OF THE NC EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL. ALSO REFER TO J.W. FAIRCLOTH & SON INC. (WWW.FAIRCLOTHSKIMMER.COM) FOR INSTALLATION INFORMATION.

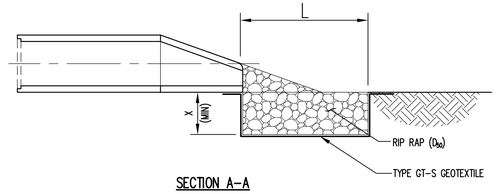
PERMANENT SEDIMENT BASIN
DETAIL NOT TO SCALE 1/EC1

SEDIMENT BASIN LINING
DETAIL NOT TO SCALE 2/EC1

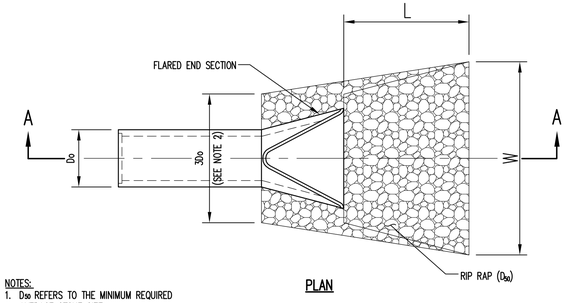


ELEVATION SECTION A–A

SILT FENCE
DETAIL NOT TO SCALE 3/EC1



SECTION A–A



NOTES:
1. D_{50} REFERS TO THE MINIMUM REQUIRED AVERAGE STONE SIZE
2. FOR MORE THAN ONE PIPE, EXTEND RIP RAP 1.0' MIN. BEYOND OUTSIDE EDGES OF PIPES.

PLAN

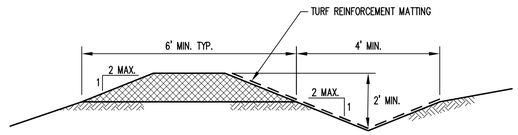
RIP RAP OUTLET PROTECTION					
PIPE/OUTLET	D_o	L (FT)	W (FT)	X (IN)	D_{50} (IN)
OUTLET FROM WET DETENTION BASIN	1.5'	4	5.5	12	6
OUTLET FROM PERMANENT SEDIMENT BASIN	4"	4	4.5	12	6
C-1	1.5'	6	7.5	12	6
C-2	1.5'	6	7.5	12	6
C-3	1.5'	4	5.5	12	6
* RIP RAP WIDTH IS EQUAL TO CHANNEL WIDTH AT FLOW DEPTH OF 2 FEET.					

RIP RAP OUTLET PROTECTION
DETAIL NOT TO SCALE 4/EC1

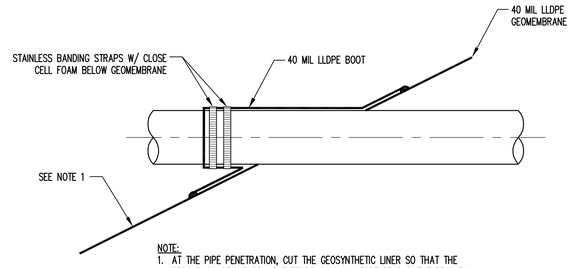
SEEDING SCHEDULE		
MATERIAL	SEED TYPE	APPLICATION RATE
LIME	–	4,000 LBS/ACRE
FERTILIZER	–	1,000 LBS/ACRE
SEED		
PERMANENT	KENTUCKY 31 TALL FESCUE PENSACOLA BAHIAGRASS SERICEA LESPEDEZA KOBE LESPEDEZA SEASONAL NURSE CROP	80 LBS/ACRE 50 LBS/ACRE 30 LBS/ACRE 10 LBS/ACRE SEE NOTE 2
TEMPORARY	SEASONAL NURSE CROP	SEE NOTE 2
MULCH	–	4,000–5,000 LBS/ACRE
BINDER	–	150 GALLONS/ACRE

NOTES:
1. APPLICATION RATES AND/OR CHEMICAL ANALYSIS SHALL BE CONFIRMED OR ESTABLISHED BY A SOIL TEST.
2. USE SEASONAL NURSE CROP IN ACCORDANCE WITH SEEDING DATES AS STATED BELOW:
   APRIL 15 – AUGUST 15 — 10 LBS/ACRE GERMAN MILLET OR 15 LBS/ACRE SUDANGRASS
   AUGUST 16 – APRIL 14 — 25 LBS/ACRE RYE (GRAIN)
3. FROM SEPTEMBER 1 – MARCH 1, USE UNSCARIFIED SERICEA SEED.

SEEDING SCHEDULE
DETAIL NOT TO SCALE 5/EC1



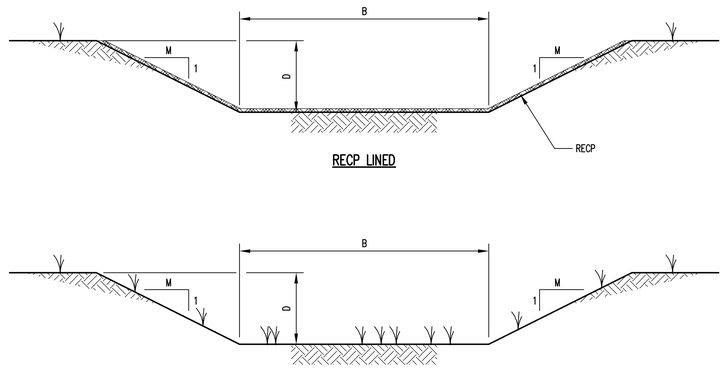
TEMPORARY DIVERSION CHANNEL
DETAIL NOT TO SCALE 6/EC1



NOTE:
1. AT THE PIPE PENETRATION, CUT THE GEOSYNTHETIC LINER SO THAT THE SECONDARY GEOMEMBRANE EXTENDS A MIN. 1-FOOT BEYOND THE PRIMARY GEOMEBRANE. CONTINUOUSLY WELD THE THE PRIMARY GEOMEMBRANE TO THE SECONDARY GEOMEMBRANE. THE APRON ON THE PIPE BOOT SHALL BE WELDED TO THE SECONDARY GEOMEMBRANE.

BOOTED PIPE PENETRATION
DETAIL NOT TO SCALE 7/EC1

CHANNEL/SWALE SCHEDULE				
CHANNEL/ SWALE	WIDTH (B)	DEPTH (D)	SLOPE (M)	LINING
WATER QUALITY SWALE DC-2A	2'	2'	3	GRASS/RECP
WATER QUALITY SWALE DC-2B	0	1.5'	3	GRASS
DRAINAGE CHANNEL DC-1A	0	1.5'	3	GRASS/RECP



RECP LINED

GRASS LINED

NOTES:
1. WHERE DEPTH OF CUT TO CHANNEL BOTTOM EXCEEDS 'D', INSTALL TRM TO HEIGHT 'D' ABOVE CHANNEL BOTTOM.
2. REFER TO SCHEDULE THIS SHEET.

DRAINAGE CHANNELS
DETAIL NOT TO SCALE 8/EC1

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THORNTON ROAD
MIXED WASTE TRANSFER & RECYCLING CENTER
SHOTWELL TRANSFER STATION, INC.

DRAWING TITLE:
EROSION AND SEDIMENTATION CONTROL DETAILS
(SHEET 1 OF 3)

DESIGNED BY:	DRAWN BY:
S.A.S.	J.A.L.
CHECKED BY:	PROJECT NO.: KING 07-1
SCALE: AS SHOWN	DATE: FEB. 2008
FILE NAME: KING-D0009	
SHEET NO.: 5	DRAWING NO.: EC1

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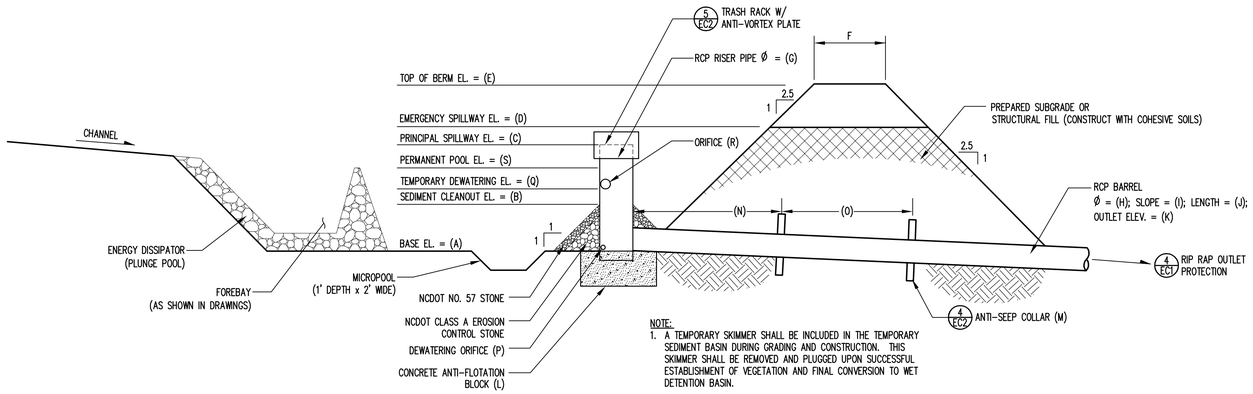


NOTE:
1. A TEMPORARY SKIMMER SHALL BE INCLUDED IN THE TEMPORARY SEDIMENT BASIN DURING GRADING AND CONSTRUCTION. THIS SKIMMER SHALL BE REMOVED AND PLUGGED UPON SUCCESSFUL ESTABLISHMENT OF VEGETATION AND FINAL CONVERSION TO WET DETENTION BASIN.

WET DETENTION BASIN SCHEDULE

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
207.0'	208.2'	211.5'	212.0'	213.0'	10'	24"	18"	6%	80'	207.0'	4' X 4' X 2'		25'		1.5"	210.8'	4"	210.0'

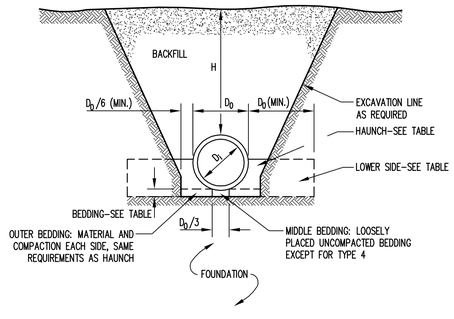
TYPICAL WET DETENTION BASIN SECTION

DETAIL NOT TO SCALE — 1 / EC2

NOTE:
1. IN FILL AREAS, PREPARED SUBGRADE IS EQUIVALENT TO STRUCTURAL FILL. FOR CUT AREAS REMOVE AND REPLACE WITH STRUCTURAL FILL (SEE PROJECT SPECIFICATIONS.)

TYPICAL ROADWAY CROSS SECTION

DETAIL NOT TO SCALE — 2 / EC2



STANDARD EMBANKMENT INSTALLATION SOILS AND MINIMUM COMPACTION REQUIREMENTS

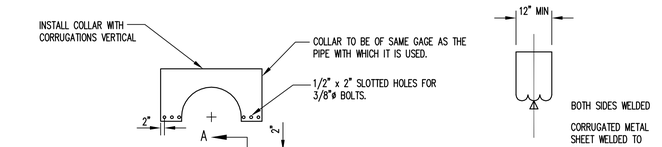
INSTALLATION TYPE	BEDDING THICKNESS	HAUNCH AND OUTER BEDDING	LOWER SIDE
TYPE 1	D_O/24"(600mm) MINIMUM, NOT LESS THAN 3"(75mm). IF ROCK FOUNDATION, USE D_O/12"(300mm) MINIMUM, NOT LESS THAN 6"(150mm).	95% SW, SP, GW, GP	90% SW, SP, GW, GP; 95% ML, SM, GM OR GC, SC WITH <20% PASSING NO.200 SIEVE; OR 100% CL, MH, SC, GC, CH.
TYPE 2	D_O/24"(600mm) MINIMUM, NOT LESS THAN 3"(75mm). IF ROCK FOUNDATION, USE D_O/12"(300mm) MINIMUM, NOT LESS THAN 6"(150mm).	90% SW, SP, GW, GP; OR 95% ML, SM, GM OR GC, SC WITH <20% PASSING NO.200 SIEVE	85% SW, SP, GW, GP; 90% ML, SM, GM OR GC, SC WITH <20% PASSING NO.200 SIEVE; OR 95% CL, MH, SC, GC, CH.
TYPE 3	D_O/24"(600mm) MINIMUM, NOT LESS THAN 3"(75mm). IF ROCK FOUNDATION, USE D_O/12"(300mm) MINIMUM, NOT LESS THAN 6"(150mm).	85% SW, SP, GW, GP; 90% ML, SM, GM OR GC, SC WITH <20% PASSING NO.200 SIEVE; OR 95% CL, MH, SC, GC, CH	85% SW, SP, GW, GP; 90% ML, SM, GM OR GC, SC WITH <20% PASSING NO.200 SIEVE; OR 95% CL, MH, SC, GC, CH.
TYPE 4	NO BEDDING REQUIRED, EXCEPT IF ROCK FOUNDATION, USE D_O/12"(300mm) MINIMUM, NOT LESS THAN 6"(150mm).	NO COMPACTION REQUIRED, EXCEPT IF CL, MH, SC, GC, CH USE 85%	NO COMPACTION REQUIRED, EXCEPT IF CL, MH, SC, GC, CH USE 85%

NOTES:
1. COMPACTION AND SOIL SYMBOLS (95% SW) REFER TO SW SOIL MATERIAL (USCS CLASSIFICATION) WITH MINIMUM STANDARD PROCTOR COMPACTION (ASTM D 698) OF 95%.
2. THE TRENCH TOP ELEVATION SHALL BE NO LOWER THAN 0.1H BELOW FINISHED GRADE OR, FOR ROADWAYS, ITS TOP SHALL BE NO LOWER THAN AN ELEVATION OF 1'(0.3m) BELOW THE BOTTOM OF THE PAVEMENT BASE MATERIAL.
3. SOIL IN BEDDING AND HAUNCH ZONES SHALL BE COMPACTED TO AT LEAST THE SAME COMPACTION AS SPECIFIED FOR THE MAJORITY OF SOIL IN THE BACKFILL ZONE.
4. THE TRENCH WIDTH SHALL BE WIDER THAN SHOWN IF REQUIRED FOR ADEQUATE SPACE TO ATTAIN THE SPECIFIED COMPACTION IN THE HAUNCH AND BEDDING ZONES.
5. FOR TRENCH WALLS THAT ARE WITHIN 10 DEGREES OF VERTICAL, THE COMPACTION OR FIRMNESS OF THE SOIL IN THE TRENCH WALLS AND LOWER SIDE ZONE NEED NOT BE CONSIDERED.
6. FOR TRENCH WALLS WITH GREATER THAN 10 DEGREE SLOPES THAT CONSIST OF EMBANKMENT, THE LOWER SIDE SHALL BE COMPACTED TO AT LEAST THE SAME COMPACTION AS SPECIFIED FOR THE SOIL IN THE BACKFILL ZONE.

STANDARD PIPE TRENCH INSTALLATION FOR CONCRETE PIPES

DETAIL NOT TO SCALE — 3 / EC2

(BASED ON AMERICAN CONCRETE PIPE ASSOCIATION RECOMMENDATIONS)



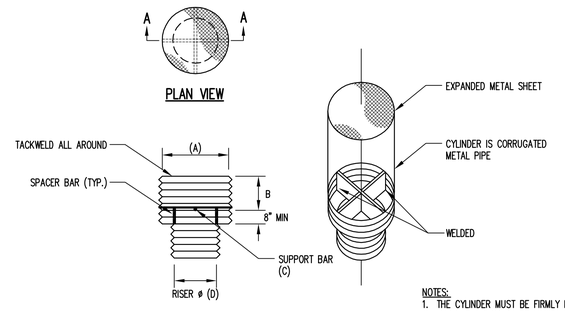
ELEVATION OF UNASSEMBLED COLLAR

SECTION A–A

NOTES:
1. ALL MATERIAL TO BE IN ACCORDANCE WITH PROJECT SPECIFICATIONS.
2. ALL COLLARS ARE TO BE ASPHALT COATED.
3. UNASSEMBLED COLLARS SHALL BE MARKED BY PAINTING OR TAGGING TO IDENTIFY MATCHING PAIRS.
4. THE LAP BETWEEN THE TWO HALF SECTIONS AND BETWEEN THE PIPE AND CONNECTING BAND SHALL BE CAULKED WITH ASPHALT MASTIC AT TIME OF INSTALLATION.
5. EACH COLLAR SHALL BE FURNISHED WITH TWO 1/2"ø RODS WITH STANDARD TANK LUGS FOR CONNECTING COLLARS TO PIPE

ANTI-SEEP COLLAR

DETAIL NOT TO SCALE — 4 / EC2



SECTION A–A ISOMETRIC

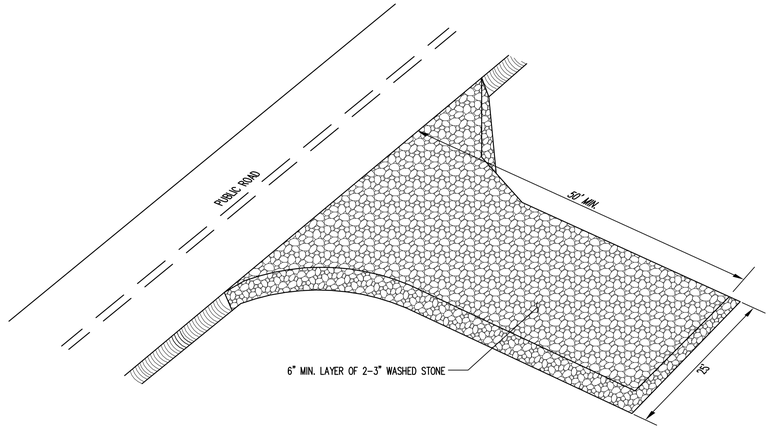
NOTES:
1. THE CYLINDER MUST BE FIRMLY FASTENED TO THE TOP OF THE RISER.
2. SUPPORT BARS ARE WELDED TO THE TOP OF THE RISER OR ATTATCHED BY STRAPS BOLTED TO THE TOP OF THE RISER.

TRASH RACK SCHEDULE

BASIN	A (IN)	B (IN)	C (IN)	D (IN)
1	36	15	1/2	24

TRASH RACK WITH ANTI-VORTEX PLATE

DETAIL NOT TO SCALE — 5 / EC2



TEMPORARY GRAVEL CONSTRUCTION ENTRANCE

DETAIL NOT TO SCALE — 6 / EC2

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SHOTWELL TRANSFER STATION, INC.

DRAWING TITLE:
EROSION AND SEDIMENTATION CONTROL DETAILS
(SHEET 2 OF 3)

DESIGNED BY:	DRAWN BY:
S.A.S.	C.T.J.
CHECKED BY:	PROJECT NO.:
	KING 07-1
SCALE:	DATE:
AS SHOWN	FEB. 2008
FILE NAME	
KING-D0010	
SHEET NO.	DRAWING NO.
6	EC2

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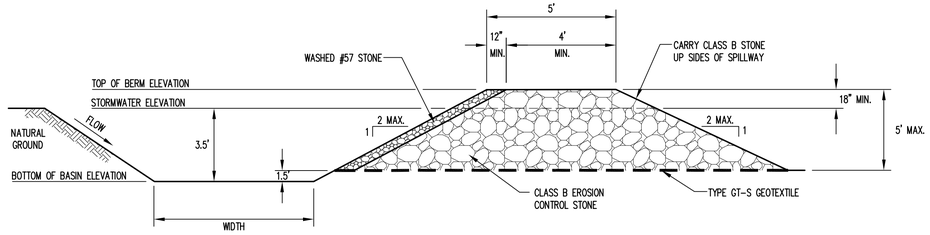
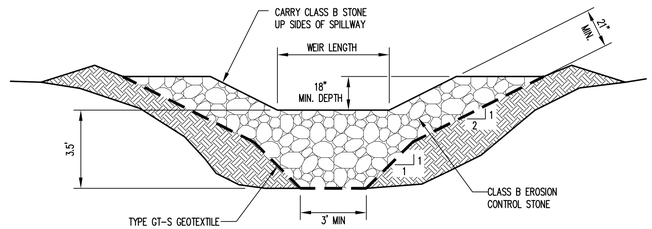
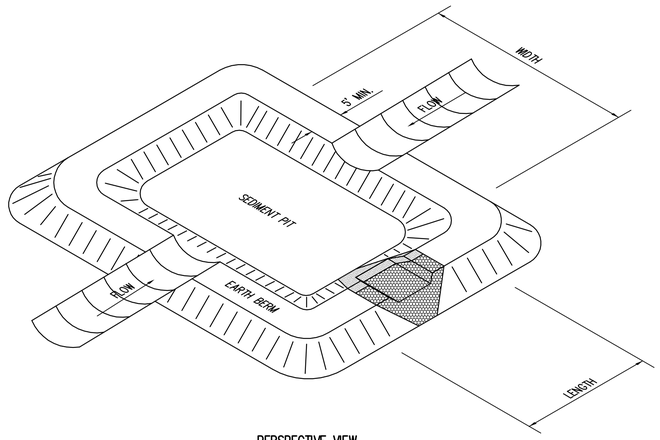


SECTION THRU TRAP AND OUTLET

TEMPORARY SEDIMENT TRAP SCHEDULE						
SEDIMENT TRAP	BOTTOM OF BASIN ELEVATION	STORMWATER ELEVATION	TOP OF BERM ELEVATION	WIDTH	LENGTH	WIER LENGTH
ST-1	201.0'	204.5'	206.0'	25	50	10'
ST-2	200.0'	203.5'	205.0'	20	40	10'



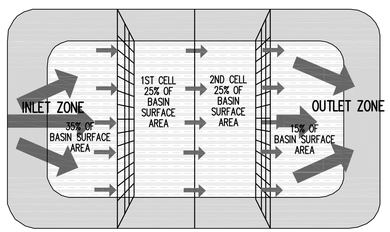
SECTION THRU BERM AND OUTLET



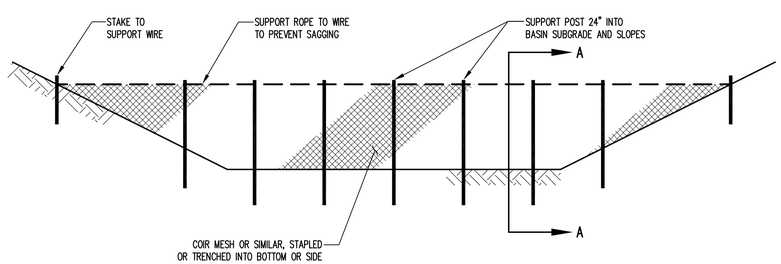
PERSPECTIVE VIEW

NOTES:
1. CLEAN TRAP WHEN SEDIMENT REACHES ONE-HALF OF THE DESIGN DEPTH.
2. FOLLOW GUIDELINES OF THE LATEST EDITION OF THE NC EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.

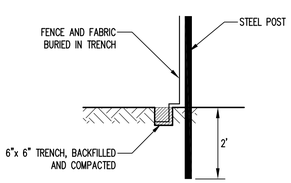
TEMPORARY SEDIMENT TRAP
DETAIL 1 / EC3
NOT TO SCALE



PLAN VIEW



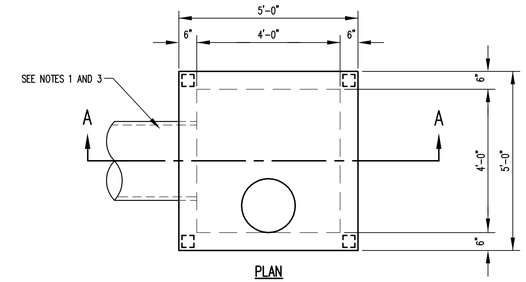
ELEVATION



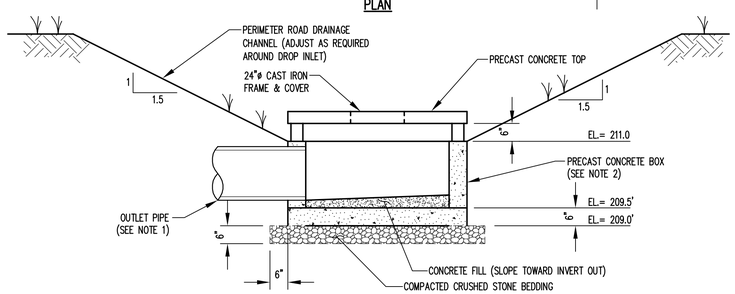
SECTION A-A

STANDARD BAFFLES
DETAIL 2 / EC3
NOT TO SCALE

NOTES:
1. BAFFLE MATERIAL SHOULD BE SECURED AT THE BOTTOM AND SIDES USING STAPLES OR BY TRENCHING AS FOR SILT FENCE.
2. MOST OF THE SEDIMENT WILL ACCUMULATE IN THE FIRST BAY, WHICH SHOULD BE READILY ACCESSIBLE FOR MAINTENANCE.
3. PROVIDE 3 BAFFLES (USE TWO IF LESS THAN 20 FEET IN LENGTH).
4. BAFFLE SHALL BE 700 g/m² COIR EROSION BLANKET.
5. TOPS OF BAFFLES SHOULD BE 2 INCHES LOWER THAN THE TOP OF THE BERMS.
6. INSPECT BAFFLES FOR REPAIR ONCE A WEEK AND AFTER EACH RAINFALL.



PLAN



SECTION A-A

DROP INLET
DETAIL 3 / EC3
NOT TO SCALE

NOTES:
1. PROVIDE WATERTIGHT JOINTS ON ALL PIPING.
2. PRECAST CONCRETE BOXES SHALL CONFORM TO THE FOLLOWING REQUIREMENTS:
   A. CONCRETE: COMPRESSIVE STRENGTH 4000 PSI
   B. REINFORCING: ASTM A-615, GRADE 60
   C. MEETS H-20 LOADING.
3. PIPES MAY BE ORIENTED DIFFERENTLY WITH RESPECT TO THE THE CHANNEL THAN DISPLAYED HERE. SEE DRAWING S1 FOR PROPER ORIENTATION.
4. THE CONTRACTOR SHALL PROVIDE ADEQUATE PROTECTION FROM SEDIMENTATION FOR ALL DROP INLETS USING GRAVEL AND WIRE MESH FILTERS OR OTHER METHOD AS APPROVED BY THE ENGINEER.

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(SHEET 3 OF 3)

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CHECKED BY:	PROJECT NO.: KING 07-1
SCALE: AS SHOWN	DATE: FEB. 2008
FILE NAME: KING-D0014	
SHEET NO.: 7	DRAWING NO.: EC3

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