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CMA ENGINEERS

March 16, 2015

Mr. Paul M. Gildersleeve, P.E.
New Hampshire Department of Environmental Services (DES)
Waste Management Division (WMD)
Permitting & Design Review Section (P&DRS)
29 Hazen Drive, P.O. Box 95
Concord, NH 03302-0095

RE: Concord Regional Solid Waste/Resource Recovery Cooperative
Franklin Secure Residue Landfill (DPHS-SW-85-003)
Stage II Closure Construction
Type II Modification to Solid Waste Management Facility Permit and Application for Waiver
CMA #874-A

Dear Mr. Gildersleeve:

On behalf of the Concord Regional Solid Waste/Resource Recovery Cooperative (Cooperative), CMA Engineers, Inc. is submitting the enclosed Type II Modification to Solid Waste Facility Permit and supporting documentation for the Franklin Secure Residue Landfill Stage II Closure Construction. Please find enclosed three copies of the applications, a check for the application fee of $5,746.27 and proposed construction drawings for your review. In addition, an Application for Waiver for minimum slope of cap and the lower buffer layer of the capping system is also included in support of the permit modification application.

As you recall, Stage I Closure was constructed in 2013/2014 and capped approximately 12.4 acres of the 20.1-acre landfill over Phases I, II, and portions of Phase III. The proposed Stage II Closure encompasses approximately 7.7 acres, and will cap the remaining areas of Phase III, IV, and V. The Cooperative ceased acceptance of ash waste as of December 31, 2014, therefore construction of Stage II will formally close the landfill site. The proposed capping system is consistent with the overall Closure Plan approved as part of the Type I-B Permit Modifications approved on January 31, 2013, with modifications as described herein to reflect current status of the project. The request for waiver is similar to what was approved for the Stage I Closure Construction.

The Type II Permit Modification Application fee of $5,746.27 is calculated in accordance with Env-Sw 310.08(b) as the product of the Minimum Base Fee (MBF = $15,000) and the ratio of cap area (7.7 acres) to the total permitted footprint of (20.1 acres). Accordingly, this Stage II Closure fee represents the difference between the MBF ($15,000) and the Stage I Closure application fee ($9,253.73).

If you have any questions, please do not hesitate to call.

Very truly yours,
CMA ENGINEERS, INC.

Paul D. Schmidt
Senior Project Manager

Andrew P. Vardakis
Project Engineer

APV/PDS/ams

Enclosures

cc: Jim Presher, CRSW/RRC

CMA ENGINEERS

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Concord Regional Solid Waste/Resource Recovery Cooperative
Franklin Secure Residue Landfill – Stage II Closure Construction
Permit Number: DPHS-SW-85-003

Type II Modification to Solid Waste Management Facility Permit

Stage II Closure Construction

March 2015

Submitted to:

NH Department of Environmental Services
Waste Management Division
P.O. Box 95, 29 Hazen Drive
Concord, New Hampshire 03302-0095

Prepared for:

Concord Regional Solid Waste/Resource Recovery Cooperative
P.O. Box 157
Franklin, NH 03235

Prepared by:

CMA Engineers, Inc.
Civil and Environmental Engineers
35 Bow Street
Portsmouth, New Hampshire 03801

STATE OF NEW HAMPSHIRE
PAUL D. SCHMIDT
No. 9525
LICENSED
PROFESSIONAL ENGINEER

Franklin Secure Residue Landfill
DPHS-SW-85-003

Type II Modification to Solid Waste Management Facility Permit

Stage II Closure Construction

Franklin, New Hampshire

March 2015

Table of Contents

NHDES Type II Modification Application Form

Section

1.0 Description of Proposed Construction
2.0 Permits Required
3.0 Capping System
- 3.1 Hydraulics of Drainage Geocomposite
- 3.2 Capping System Stability Analysis
  - *3.2.1 Static Stability of the Cover System*
  - *3.2.2 Stability of Cover System Under Equipment Loading*
  - *3.2.3 Wheel Loading During Post-Closure Maintenance*

4.0 Stormwater Management System
5.0 Landfill Gas Management
6.0 Post-Closure Requirements
7.0 Project Schedule

Appendices

A. Capping System Calculations
- *A.1 Hydraulic Capacity Calculations*
- *A.2 Slope Stability Calculations*
- *A.3 Wheel Loading Calculations*

B. Revised Stormwater Calculations
C. Technical Specifications
D. Closure Construction Cost Estimate
E. Application for Waiver
F. Construction Drawings

NHDES TYPE II MODIFICATION APPLICATION FORM

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Waste Management Division

For Office Use Only:
WMD Log #:_____
Date Rec'd.:_____
No. of Copies:_____ ❒ **Fee: $**_____
Check #_____
❒ **No Fee Required**

APPLICATION FORM FOR

Type II Modification To Solid Waste Management Facility Permit

pursuant to
RSA 149-M and New Hampshire Administrative Solid Waste Rules Env-Sw 315

SECTION I. FACILITY IDENTIFICATION

(1)	Facility name: Franklin Secure Residue Landfill
(2)	Functional Classification: ☐ Collection/Storage/Transfer ☐ Processing/Treatment ☒ Landfill
(3)	Mailing address: P.O. Box 157 Franklin, NH 03235
(4)	Permit number: DPHS-SW-85-003
(5)	Location, by street address and municipality: Punch Brook Road, Franklin, NH 03235

SECTION II. PERMITTEE IDENTIFICATION

(1)	Permittee/applicant name: Concord Regional Solid Waste/Resource Recovery Cooperative			
(2)	Mailing address: P.O. Box 157 Franklin, NH 03235			
(3)	Telephone number: (603) 934-5037			
(4)	If different than above, identify the individual associated with and designated by the permittee/applicant to be the contact individual for matters concerning this application:			
	(a)	Name: James Presher	(b)	Title: Director
	(c)	Mailing address:		
	(d)	Telephone number:	(e)	E-mail: crswrrc@aol.com

SECTION III. DESCRIPTION OF PROPOSED MODIFICATION

Provide a complete description of the proposed modification by answering each of the following questions. Use additional paper as necessary.

(1) Identify the type of final plans being submitted for approval. (Check one that applies. If more than one applies, submit a separate application for each):

☐	Final design/construction plans for non-landfill facility	☐	Final closure plan for non-landfill facility
☐	Final design/construction plans for landfill:	☒	Final closure/capping plans for lined landfill
	☐ Initial Phase ☐ Subsequent Phase	☐	Final closure/capping plans for unlined landfill
☐	Final operating plan	☐	Final financial assurance plan

(2) Provide a **BRIEF** description of the proposed modification/requested approval:

Final design approval for Stage II Closure Construction of the Franklin Secure Residue Landfill. See complete description attached.

(3) Identify, below, the preliminary plans approved in the permit which provide the basis for the final plans being submitted with this application:

Check one	TYPE OF PRELIMINARY PLAN	DES Approval Date	WMD Log #
☒	Facility design plans/specifications	8/8/2013	12553, 12554, 12709
☐	Facility operating plan		
☒	Facility closure plan	1/31/2013	11567, 11646
☐	Facility financial assurance plan		
☐	Other plan *(specify):*		

(4)	Submit the proposed final plans for which approval is being sought. The plans must be prepared based on the preliminary plans identified in (3) above and according to the below listed instructions. When appropriate, final plans may be presented in the form of replacement pages ready for substitution into the related approved preliminary plans, with each page being clearly marked to show the date of revision. Mark the submitted/attached plans as "Attachment III(4)".	
	☒	Facility design/construction plans must be prepared in accordance with Env-Sw 1103.05
	☐	Facility operating plans must be prepared in accordance with Env-Sw 1105.11
	☐	Facility closure plans must be prepared in accordance with Env-Sw 1106.04
	☐	Financial assurance plans must be prepared as specified in Env-Sw 1400 and must include all related financial assurance documents required to effect the plan

SECTION IV. CERTIFICATION OF COMPLIANCE/COMPLIANCE REPORT

If you are able to certify that each of the following statements is true, do so by your signature. If you are unable to certify that each of the following statements is true, you must prepare and submit a separate Compliance Report as specified by Env-Sw 303.15.

COMPLIANCE STATEMENT

The applicant shall certify that each of the statements listed in (1)-(8) below are true for each of the following individuals and entities:

- ☒ **The applicant, and**
- ☒ **The facility owner, and**
- ☒ **The facility operator, and**
- ☐ **All individuals and entities holding 10% or more of the applicant's debt or equity, and**
- ☒ **All of the applicant's officers, directors, and partners, and**
- ☐ **All individuals and entities having managerial, supervisory or substantial decision making authority and responsibility for the management of facility operations or the activity(s) for which approval is being sought**

(1)	No individual or entity listed above has been convicted of or plead guilty or no contest to a felony in any state or federal court during the 5 years before the date of the application.	
(2)	No individual or entity listed above has been convicted of or plead guilty or no contest to a misdemeanor for a violation of environmental statutes or rules in any state or federal court during the 5 years before the date of the application.	
(3)	No individual or entity listed above has owned or operated any hazardous or solid waste facility which has been the subject of an administrative or judicial enforcement action for a violation of environmental statutes or rules during the 5 years before the date of the application.	
(4)	No individual or entity listed above has been the subject of any administrative or judicial enforcement action for a violation of environmental statutes and rules during the 5 years before the date of the application.	
(5)	All hazardous and solid waste facilities owned or operated in New Hampshire by any individual or entity listed above are in compliance with either.	
	(a)	All applicable environmental statutes, rules, and DES permit requirements; or
	(b)	A DES approved schedule for achieving compliance therewith.
(6)	All individuals and entities listed above are in compliance with all civil and criminal penalty provisions of any outstanding consent agreement, settlement, or court order to which DES is a party.	
(7)	All individuals and entities listed above have paid, or are in compliance with the payment schedule for any administrative fine assessed by DES.	
(8)	All individuals and entities listed above are in compliance with all terms and conditions under every administrative order, court order or settlement agreement relating to programs implemented by DES.	

Signature of the permittee/applicant certifying the above statements are true:

Permittee/Applicant Name **(Print Clearly or Type)** James Presher, Director of Concord Regional Solid Waste/Resource Recovery Cooperative

Permittee/Applicant Signature James R Presher

Date 3-11-15

OR

Circle the untrue statement(s) and attach a Compliance Report, pursuant to Env-Sw 303.15

SECTION V. PERMITTEE/ APPLICANT SIGNATURE REQUIREMENTS

The permittee/applicant must sign the following statement prior to submitting this application. All copies of the application filed with DES must bear the permittee's/applicant's ORIGINAL signature. If the permittee/applicant is not an individual, an individual duly authorized by the permittee/applicant shall sign the application.

To the best of my knowledge and belief, the information and material submitted herewith is correct and complete. I understand that any approval granted by DES based on false and/or incomplete information shall be subject to revocation or suspension, and that administrative, civil or criminal penalties may also apply. I certify that this application is submitted on a complete and accurate form, as provided by DES, without alteration of the text.

Permittee/Applicant Name **(Print Clearly or Type)** James Presher, Director of Concord Regional Solid Waste/Resource Recovery Cooperative

Permittee/Applicant Signature Jim R Presher

Date 3-11-15

SECTION VI. PROPERTY OWNER SIGNATURE

If the permittee/applicant and property owner are not the same, the property owner must also sign this form as follows. All copies of the application filed with DES must bear an ORIGINAL signature. If the property owner is not an individual, an individual duly authorized by the property owner shall sign the application.

(1)	I hereby affirm that the permittee/applicant has the legal right to occupy and use the property on which the subject facility is or will be located for the purposes specified in this application.
(2)	I hereby affirm that I shall grant access to the property for closure and post-closure monitoring of the subject facility and site as required by RSA 149-M and the New Hampshire Solid Waste Rules, as amended.

Property Owner Name **(Print Clearly or Type)** _____

Property Owner Signature _____

Date _____

1.0 DESCRIPTION OF CONSTRUCTION

This Type II Permit Modification Application is for final design approval of the Stage II Closure Construction of the Franklin Secure Residue Landfill. The Stage II Closure project encompasses approximately 7.7 acres (accounting for a small area of liner overlap) and will cap the remaining areas of Phases III and IV, and all of Phase V. This is the final stage of closure, as the approximate 12.4-acre Stage I Closure was constructed in 2013/2014, which capped all of Phases I and II and portions of Phases III and IV. The landfill stopped receiving ash on December 31, 2015.

Costs for Stage II Closure construction were estimated and submitted to NHDES for financial assurance in November, 2014. The construction cost for the Stage II Closure is estimated to be approximately $1,500,000. The total cost, including engineering and contingencies, is estimated to be approximately $2,000,000. The cost estimate assumes capping system materials from off-site in accordance with previous capping sections. Materials from on-site, including loam and some drainage sand, are proposed to be utilized which is anticipated will result in lower actual costs. The detailed closure construction cost estimate is included in Appendix D.

The proposed capping system is in conformance with the Closure Plan approved as part of the Type I-B Permit Modification approved on January 31, 2013. A summary of the capping system design and permitting requirements follows with supporting calculations in Appendix A. The Technical Specifications and Construction Drawings for the Stage II Closure Construction are enclosed as Appendix C and F, respectively.

2.0 PERMITS REQUIRED

In addition to the Type II Permit Modification for approval of the capping system design for Stage II Closure Construction, an Alteration of Terrain (AoT) permit was required for the previously constructed Stage I Closure project. Permit AoT-0611 approval was received on August 7, 2013. As part of the Stage II Closure design, it was determined that minor changes to the proposed stormwater drainage system would improve the overall function of the landfill capping system. A notification of the minor changes to the AoT permit is required for this minor change, which is discussed further in Section 4.0. Revised calculations are enclosed as Appendix B.

A US EPA Stormwater Pollution Prevention Plan (SWPPP) has been developed for the Stage I & II Closure Construction in accordance with the NPDES Construction General Permit (CGP). This SWPPP will be updated upon selection of a Contractor for the Stage II Construction in 2015.

The proposed work does not impact the existing groundwater management permit, existing groundwater monitoring wells, or existing landfill operational monitoring and reporting. The post-closure monitoring and reporting requirements for the closed area, are described further in Section 6.0.

3.0 CAPPING SYSTEM

The proposed capping system includes the use of a single geomembrane system as the primary barrier to infiltration of precipitation into the landfill. The capping system will consist of a total of 3 feet of materials over the site, generally consisting of the following (bottom to top):

- 12 inches of gas migration sand (buffer and gas collection)
- 40-mil textured HDPE geomembrane liner (impermeable barrier layer)
- Double-sided drainage geocomposite (HDPE geonet and non-woven geotextile fabric for lateral drainage)
- 12 inches of select drainage sand (buffer and vertical percolation)
- 12 inches of loam (vertical percolation and vegetative cover)

Other materials including geotextiles, select gravel, and stone are to be utilized elsewhere in the construction, such as the intermediate drainage benches, toe drain swales, and other locations.

It is noted that the proposed capping system deviates from the NHDES Rules set forth in Env-Sw 805.10. A separate Application for Waiver is concurrently being submitted with this Type II Permit Modification, included as Appendix E. The Waiver Application is seeking to eliminate the buffer layer over the waste, as it is not necessary over the existing ash surface. The Waiver Application also seeks a reduction in the minimum cap slope from 5% to 2%. The same waiver request was granted for Stage I Closure Construction in 2013.

It is also noted the proposed capping system deviates slightly from the Stage I Closure design. The top two layers of the Stage I design included 6” of topsoil over 6” of moisture retention soil. The proposed Stage II cap replaces those two 6-inch layers with a 12-inch layer of loam. The proposed loam material is a sandy loam/till material which is to be screened from an on-site stockpile from previous landfill expansion projects. As described below, the capping system will function as designed for hydraulics and stability and vegetative cover.

The design of this geomembrane capping system includes consideration of geotechnical stability of capping materials, drainage of precipitation from both the loam surface and geocomposite, gas

transmission from beneath the geomembrane, and other issues. Supporting calculations relative to the design are described below.

3.1 Hydraulics of Drainage Geocomposite

An analysis of the proposed double-sided drainage geocomposite hydraulics was performed using the impingement rate method. Drainage geocomposite materials are capable of transmitting a significant amount of water, thereby minimizing or eliminating any head in the sand layer above the geomembrane cap and the potential for sloughing during a storm event. In accordance with NHDES policy, the analysis was performed for the peak infiltration rate for this capping system section as determined by the HELP Model for a 10-inch 48-hour storm event. Analysis of a peak infiltration rate generated by the HELP model for a 5-year period is also provided. The HELP Model results are included with the calculations in Appendix A.1.

Flow through the geocomposite is dependent on gradient, slope length, and the transmissivity of the geocomposite layer. The permeability of the geocomposite can be affected by elastic deformation, creep, chemical clogging, and biological clogging. The hydraulic evaluations described below included appropriate reduction factors for the above conditions for capping systems in determining the appropriate flow lengths and required transmissivity values.

The Stage II Closure Construction, as proposed, yields a drainage design test case for a flow length of 150 feet at a 4:1 side slope for the middle to upper portions of the landfill. A longer flow length at a flatter slope presented the worst case scenario. A design test for the more typical flow length of approximately 100 feet at a 3:1 side slope also analyzed for the lower portions of the landfill. Calculations are provided in Appendix A.1 indicating that the hydraulic capacities of the specified high flow double-sided drainage geocomposite are suitable for the proposed conditions of the capping system. The proposed design of the transition of the capping system to the stormwater collection system provides for the effective release of all infiltrated water so that no pore pressure will develop in the sand above the geomembrane liner. Proposed distances between drainage benches and swales included in the closure design conform to the maximum drainage lengths in the test cases.

The transmissivity values used for the geocomposite in the analysis are typical minimum values for a high flow double-sided geocomposite at the gradients indicated under the loading conditions of the capping system. These values will need to be met or exceeded by the product selected by the Contractor as outlined in the Technical Specifications (Appendix C). As demonstrated in the calculations, the specified transmissivity values

provide a global factor of safety of 1.5 including moderate reduction factors for intrusion, creep and clogging, during a predicted peak infiltration event resulting from the 10-inch design storm. A factor of safety of 4.7 is provided for the peak infiltration rate otherwise predicted by the HELP Model over a five year period.

The select drainage sand placed over the geocomposite will function primarily as a buffer and a vertical percolation layer rather than a horizontal drainage layer. With the proposed design, the 12-inch loam layer above the drainage sand will restrict the vertical percolation into the drainage sand to levels anticipated to be well below the transmissivity range for the specified drainage sand layer. In fact, the performance of the capping system hydraulics is improved if the drainage sand layer permeability is also somewhat restrictive, where moisture is retained for evapotranspiration and reduces the impingement load on the drainage geocomposite. The critical specification for the drainage sand is its gradation. An open gradation with a 12% limit on fines has been specified. The HELP Model calculations and drainage geocomposite design assumed a very conservative permeability for the drainage sand, to assure that any water percolating through the moisture retention layer is modeled to move to the geocomposite without restriction.

When designing with drainage geocomposites, it is also necessary to consider the effect of blinding and clogging on the geotextile's ability to transmit flow to the drainage net beneath it. The apparent opening size (AOS) of the geotextile is important when considering the type of soil to be placed above it. The AOS is defined as the sieve number that has openings closest in size to the openings in the geotextile. The AOS is determined using the ASTM D4751 test method to find the O_{95}, or 5% passing, particle size. If the O_{95} is too large, then the finer soil particles may be carried though the geotextile, leaving larger soil voids behind and could eventually cause the soil structure to collapse and sinkholes to form. An analysis of the required AOS was performed using the upper and lower limits of the permissible gradations for select sand on this project and it was determined that the geotextile's AOS should not be larger than 0.69 mm. This corresponds to having an AOS sieve size of #37 or greater (calculations provided in Appendix A.1). An AOS of #70 has been specified for the project and is a typical value of the available drainage geocomposite materials.

3.2 Capping System Stability Analysis

A finite analysis approach was used to determine the stability factor of safety and liner tension for the side slopes. Steeper slopes are more susceptible to becoming unstable because of the reduced resisting forces, especially when there is water (pore pressure) in the drainage sand layer. The assumed removal of all water from the drainage sand layer

by the geocomposite significantly reduces the risk of sliding. The sliding driving force and resistive forces are dependent on the interface shear strength as quantified by the friction angles and cohesive strengths between the select drainage sand/geocomposite, buffer gas sand/textured geomembrane liner, and geocomposite/textured geomembrane liner. By inspection, the critical interface in this design consists of that between the drainage geocomposite materials and the textured geomembrane liner.

3.2.1 Static Stability of the Cover System

The static stability of the cover system was analyzed with the finite analysis method for the design case of 3:1 side slopes. The buttressing forces at the toe of slope were neglected in these analyses, but if included, would increase the factor of safety. The analyses determined that a minimum interface strength envelope of 26.5°, or a total shear strength of 114 psf for two feet of cover soil, would provide a factor of safety of 1.5 for slopes up to 3:1. For the various interfaces sand/liner, geocomposite/sand, and geocomposite/liner, the interface shear strength value of 114 psf would be met by both the combination of the internal friction angle and any cohesion. For instance a friction angle of 22° and 60 psf cohesion, provides a total interface shear strength of 152 psf.

The critical interface is between the geocomposite and geomembrane liner. Based on our experience, most commercially available materials will exceed the minimum interface shear strength requirements. Demonstration of friction angles by direct shear box testing will be required for the Contractor's proposed materials. Example calculations and a force diagram for the static stability of the cover system are included in Appendix A.2.

3.2.2 Stability of Cover System Under Equipment Loading

The analysis of equipment loading on the liner during construction activities included a piece of equipment, a D6N LGP dozer, operating on the cover system. The analysis considered both static and dynamic loading conditions. The dynamic loading conditions were modeled as an abrupt braking force produced by the equipment while placing material down the slope. The braking force was assumed to be 150% of the vehicle weight.

Stability was analyzed for construction conditions over the 3:1 side slopes. The first condition evaluated the stability during placement of the drainage sand layer with the buttressing forces excluded. The second condition was for placement of the loam layer or equipment movement over the finished capping system, also excluding the buttressing forces. The conditions and results for simple placement

of materials without braking are the same as those in the static stability analysis. When equipment applies brakes or turns (dynamic), the conditions change.

The factors of safety for all dynamic conditions (breaking down slope) exceeded a factor of safety of 1.1. As a conservative measure, the Contractor will be instructed to work all areas from the bottom up or laterally, and to exercise caution and avoid any braking on the slope. Example calculations and a force diagram are included in Appendix A.2.

3.2.3 Wheel Loading During Post-Closure Maintenance

Considering the anticipated loads on the cap produced by equipment performing post-closure maintenance (mowing) with an assumed maximum loading based upon a 12-ton tractor resulted in an estimated point load on the liner of about 9.4 lbs. The allowable load, based upon 70 lbs. as the minimum puncture resistance reported for 40-mil HDPE, produces a factor of safety of 7.4, exceeding the requirements of 2.0 for the capping system. Example calculations are included in Appendix A.3.

4.0 STORMWATER MANAGEMENT SYSTEM

The Stage II Closure design incorporates intermediate drainage benches constructed on the capping system side slopes to convey the stormwater run-off and water from within the drainage geocomposite and drainage sand off of the capping system. The benches will be constructed approximately 100 feet apart and will include select gravel and stone materials for transmitting water from the capping system and for erosion protection. The drainage benches ultimately discharge to a perimeter toe drain swale, constructed of the same select gravel and stone materials, and convey flow to the existing drainage system of rock swales and culverts to Detention Pond No. 3.

Based on as-built conditions from Stage I Closure Construction and final ash filling grades over Stages III, IV, and V, the locations of the side slope drainage benches have been slightly revised from the original AoT Permit Application and Type I-B Closure Plan to improve their horizontal spacing and longitudinal slope. Revised calculations have been performed and reveal that the proposed revisions do not significantly change the original stormwater discharges to Detention Pond No. 3. Calculations are enclosed in Appendix B. Upon approval of this closure plan, a notification of the minor changes will be provided under the existing AoT permit.

Stormwater and capping system drainage from areas below the lowest intermediate drainage bench flows through the capping system and geocomposite and enters the constructed toe drain

swales for routing to Detention Pond No. 3. The design of the toe drain swale accommodates release of the capping system water from the drainage geocomposite and drainage sand through the select gravel and stone materials, eliminating the potential for build-up of head within the sand layer.

Existing Detention Pond No. 3 currently manages stormwater run-off from much of the existing Stage I Closure area as well as stormwater off the intermediate plastic cover over the proposed Stage II Closure area. The Stage II Closure construction will result in vegetated surfaces over the entire landfill footprint and will significantly reduce the peak flow and total flows to the detention ponds. No improvements to the existing detention ponds are required as a result of this project.

5.0 LANDFILL GAS MANAGEMENT

While the landfill materials include ash residue from combusted municipal solid waste, the generation of some landfill gas, including hydrogen, has been observed at the site. The design includes the installation of passive gas vents and a gas migration sand layer to provide preferential pathways for gas migration from beneath the cap.

6.0 POST-CLOSURE REQUIREMENTS

Post-closure monitoring will be performed on the capped area. The purpose of post-closure monitoring is to observe that the physical integrity of the closed area is maintained. Inspections of the capping system are to be performed initially twice each year (April and November). The report following each formal inspection will be submitted to NHDES annually by March 31st. Items not performing as intended are to be repaired in a timely manner.

Post-closure monitoring will involve:

- Inspection of the stormwater management system, including culverts, swales, catch basins and the detention ponds. Culverts will be checked to confirm that they are clear and sediments that have accumulated in swales will be removed. Catch basins will be cleared of sediment, debris, and any blockage;

- Inspection of the landfill surface to confirm that vegetation is well established and has been mowed annually if necessary to prevent trees and shrubs from growing on the cap and to observe any evidence damage due to erosion.

- Inspection and maintenance of the leachate storage, pumping and pre-treatment system to ensure leachate is being stored and removed for proper disposal. Initially, the

pretreatment and pumping system will be maintained. Once leachate flows decrease, periodic transfer by tanker truck may be employed. The leachate tank level and alarm system shall also be maintained. When the pretreatment system is no longer needed, all leachate flows will be redirected to the 20,000 gallon HDPE primary tank, and the pretreatment tanks and system will be permanently closed. When the pumping system is no longer needed, the 20,000 gallon primary tank and the 200,000 emergency storage tank will remain in service, and the pumping system and force mains and appurtenances will be decommissioned.

- The industrial discharge permit for disposal of leachate at the WRBP wastewater treatment plant is reviewed and renewed annually and is planned to be maintained during the closure and post-closure period. Following closure it is anticipated that the leachate pre-treatment, monitoring and reporting requirements under the industrial discharge permit with WRBP staff will be reviewed and modified as appropriate to reflect the anticipated reduction in leachate generation.

- Differential settlement of the ash residue is not a concern and therefore inspections or instrument survey of the capping system for settlement is not necessary or required.

- The current monitoring program for head on liner, secondary flow, leachate flow monitoring, leachate testing, and quarterly reporting to the NHDES shall be continued as outlined in the current Operating Plan for the facility until such time as the capping system construction is substantially completed. A request for a substantial reduction in the monitoring program is anticipated to be submitted toward the end of the closure construction based on an evaluation of leachate generation data through the closure period. The head monitoring standpipe riser in Phase V is damaged within the landfill below grade. The riser from the access to the main leachate line is proposed to be maintained and monitored for depth of leachate/head on liner in Phase V.

- The sampling program in the existing groundwater release detection permit will also be maintained during the closure period. An application for renewal of the permit is required in June. It is anticipated that the Cooperative will request a decrease in the sampling requirements at that time for the initial post-closure period.

7.0 PROJECT SCHEDULE

Assuming permits are approved in a timely manner, construction is planned to commence in the Spring of 2015 and be completed by the Fall of 2015.

APPENDIX A
CAPPING SYSTEM CALCULATIONS

APPENDIX A.1
Hydraulic Capacity Calculations

Objective:

Determine the performance of the proposed drainage geocomposite over the geomembrane liner during the maximum infiltration rate through the loam layer and select drainage sand to the drainage geocomposite resulting from a 10-inch rain event over 48 hours using the HELP Model simulation.

Design Case:

Capping System is constructed with a healthy vegetative stand. 10-inch storm event occurs in October of 3rd year in simulated model (1979), days 291 and 292.

Assumptions:

- Help Model simulation Peak flows calculated using CN of 71.4 for the capping system.
- Drainage geocomposite has an ultimate transmissivity of $5x10^{-4}$ m^2/sec.
- Max drainage length of 150 feet between benches on 4:1 side slopes (worst case design scenario).
- Reduction factors for flow in geocomposite for long-term intrusion, creep, and clogging included.
- Drainage geocomposite geotextile fabric is specified to resist piping of sand materials from above (AOS filter analysis).

Conclusions:

- Estimated maximum infiltration rate of 3.011 in/day or $3.48x10^{-5}$ in/sec for the 10-inch/48 hour storm event.
- The proposed drainage geocomposite has a flow capacity of 2.3 in^3/sec.
- Factor of Safety of 1.5 provided for peak infiltration, with the pertinent reduction factors for intrusion, creep and clogging.
- Specified AOS for drainage geocomposite meets filter criteria.

CMA ENGINEERS, Inc. Civil/Environmental Engineers 35 Bow Street Portsmouth, NH 03801	Project: Franklin Secure Residue Landfill - Stage II Closure Project No: 874 Date: 3/12/15 Calc. By: APV Checked By: PDS

FLOW THROUGH DRAINAGE NET/FABRIC COMPOSITE

Input Variables:	**Design Case**		**Design Case**		
Slope X:1	4		3		
Gradient (i)	0.25		0.33		ft/ft
Length of slope (L)	150		100		ft
Width	12		12		inches
Type of Composite	Double-sided		Double-sided		
Geocomposite Transmissivity	5.00E-04		5.00E-04		m^2/sec
	5.38E-03		5.38E-03		ft^2/sec
Factors of Safety for Composite					
Elastic Deformation (FSin)	1.2		1.2		
Creep (FScr)	1.2		1.2		
Chemical Clogging (FScc)	1.1		1.1		
Biological Clogging (FSbc)	1.3		1.3		
	HELP (10")	HELP 5 yr	HELP (10")	HELP 5 yr	
Peak Drainage	3.011	0.9596	3.011	0.9596	in/day
Peak Impingement Rate (e)	3.48E-05	1.11E-05	3.48E-05	1.11E-05	in/sec
Design Flow Through Sand and Drainage Composite					
Qreq = eLw	7.53E-01	2.40E-01	5.02E-01	1.60E-01	in^3/sec
Ultimate Flow Rate Through Drainage Composite					
Qult = Trans*i*w	2.32E+00	2.32E+00	3.10E+00	3.10E+00	in^3/sec
Allowable Flow Rate Through Drainage Composite					
Qall = Qult * [1/ (FSin * FScr * FScc * FSbc)]	1.13E+00	1.13E+00	1.50E+00	1.50E+00	in^3/sec
Factor of Safety for Flow Through Composite					
FS = Qall / Qreq	**1.50**	**4.70**	**3.00**	**9.41**	

CMA ENGINEERS, Inc. Civil/Environmental Engineers 35 Bow Street Portsmouth, NH 03801	Project: Project No: Date: Calc. By: Checked By:	Franklin Secure Residue Landfill - Stage II Closure 874 3/12/15 APV PDS

FLOW THROUGH DRAINAGE NET/FABRIC COMPOSITE (continued)

NOTES:

Peak infiltration rate estimated by HELP for 10-inch 48-hour storm event in the month of October
considered to be worse-case design with limited evapotranspiration from vegetative layer and ambient temperature

Method is conservative due to assumption that all of the infiltrated flow along the assumed length must pass
through the drainage composite at the same time, and any component of flow in the drainage sand is neglected

Geocomposite Factors of Safety were derived from Koerner "Designing with Geosynthetics"
Moderate values for Elastic Deformation and Creep were assumed on the 3:1 slopes
Chemical Clogging on the cap is not considered to be problematic

Factors of Safety were calculated to demonstrate if the drainage geocomposite could transmit the necessary infiltrating water
Flow in the drainage sand was neglected

REFERENCES:

Koerner, Robert M., "Designing with Geosynthetics", Third Edition,
Prentice Hall, Englewood Cliffs, NJ, 1994.

Dominico, P.A. and F.W. Schwartz, "Physical and Chemical Hydrogeology",
John Wiley and Sons, 1990.

CMA ENGINEERS, Inc. Civil/Environmental Engineers 35 Bow Street Portsmouth, NH 03801	Project: Franklin Secure Residue Landfill - Stage II Closure Project No: 874 Date: 3/12/15 Calc. By: APV Checked By: PDS

SOIL FILTER CRITERIA FOR GEOTEXTILE

Input Variables:	Coarse	Fine
Soil Sizes		
d10 (mm)	0.425	0.1
d50 (mm)	1.85	0.5
d60 (mm)	2.54	0.65
Coeffecient of Uniformity (Cu) Cu = d60/d10	5.98	6.50
Requried Particle Size (O95) O95 < 9 d50/Cu O95 (mm) <	2.786	0.692
Corresponds to Sieve #	9	37

Conclusion:

AOS > #37 Sieve, in order to prevent loss of more than 5% of material

NOTES:

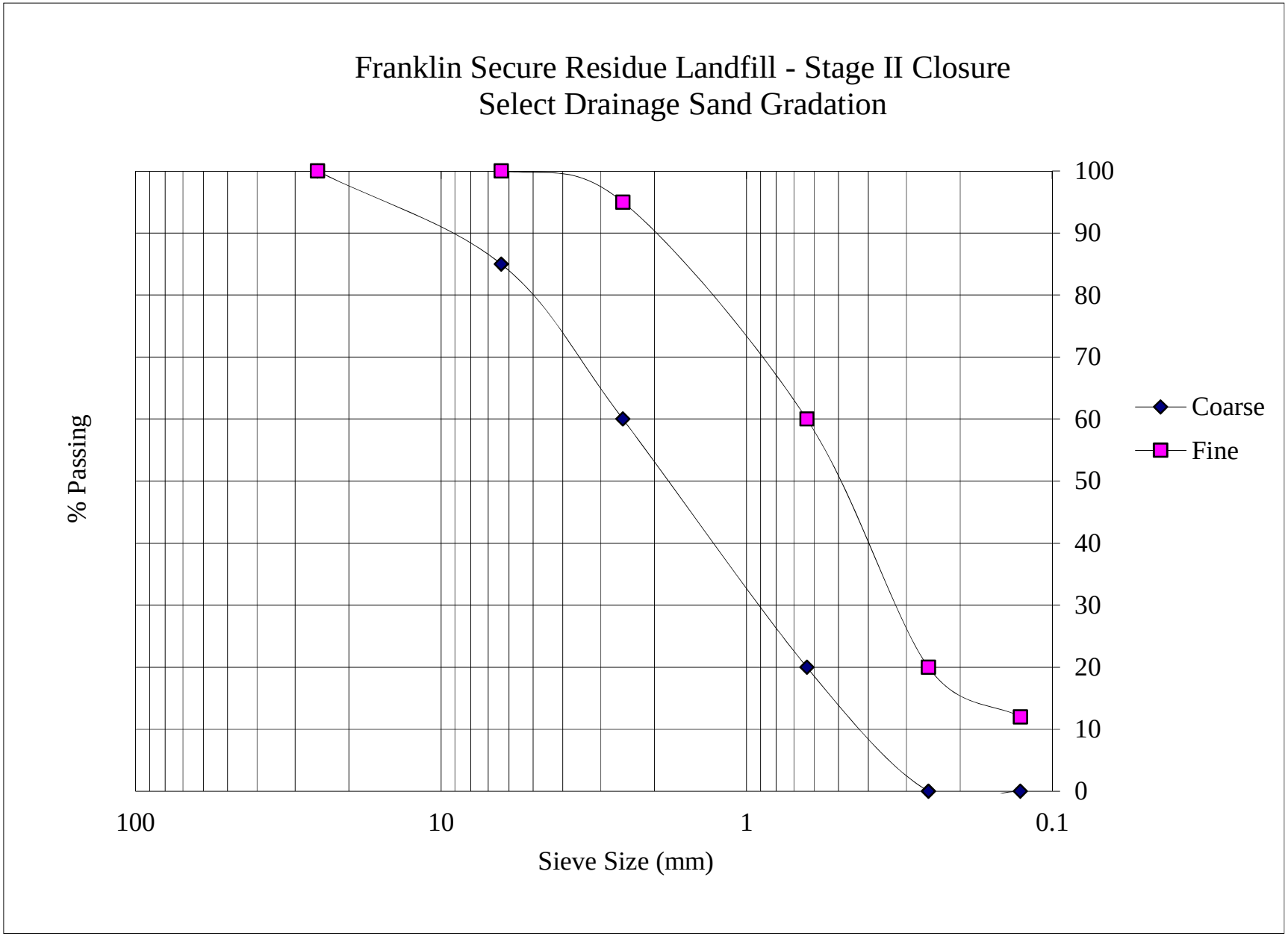
Soil sizes taken from lower and upper limits of allowable gradations for drainage sand specification

Utilized relation developed by Giroud (1982) for computing O95

The O95 or Apparent Opening Size (AOS) of the geotextile is the size where 5% pass through the fabric

REFERENCES:

Koerner, Robert M., "Designing with Geosynthetics", Third Edition,
Prentice Hall, Englewood Cliffs, NJ, 1994.


Franklin Secure Residue Landfill - Stage II Closure
Select Drainage Sand Gradation
% Passing
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
Sieve Size (mm)
Coarse
Fine

PRODUCT DATA SHEET

GSE FabriNet HF Geocomposite

GSE FabriNet HF geocomposite consists of a 250 mil thick GSE HyperNet HF geonet heat-laminated on one or both sides with a GSE nonwoven needle-punched geotextile. The geotextile is available in mass per unit area range of 6 oz/yd^2 to 16 oz/yd^2. The geocomposite is designed and formulated to perform drainage function under a range of anticipated site loads, gradients and boundary conditions.

AT THE CORE:
A 250 mil thick GSE HyperNet HF geonet heat-laminated on one or both sides with a nonwoven needle-punched geotextile.

Product Specifications

Tested Property	Test Method	Frequency	Minimum Average Roll Value		
Geocomposite			6 oz/yd^2	8 oz/yd^2	10 oz/yd^2
Transmissivity[2], gal/min/ft (m^2/sec) Double-Sided Composite Single-Sided Composite	ASTM D 4716	1/540,000 ft^2	 2.4 (5 x 10^{-4}) 7.2 (1.5 x 10^{-3})	 2.4 (5 x 10^{-4}) 7.2 (1.5 x 10^{-3})	 1.4 (3 x 10^{-4}) 4.8 (1x 10^{-3})
Ply Adhesion, lb/in	ASTM D 7005	1/50,000 ft^2	1.0	1.0	1.0
Geonet Core[3] – GSE HyperNet HF					
Transmissivity[2], gal/min/ft (m^2/sec)	ASTM D 4716		14.5 (3 x 10^{-3})	14.5 (3 x 10^{-3})	14.5 (3 x 10^{-3})
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	0.94	0.94	0.94
Tensile Strength (MD), lb/in	ASTM D 5035/7179	1/50,000 ft^2	55	55	55
Carbon Black Content, %	ASTM D 1603[6]/4218	1/50,000 ft^2	2.0	2.0	2.0
Geotextile[3,4]					
Mass per Unit Area, oz/yd^2	ASTM D 5261	1/90,000 ft^2	6	8	10
Grab Tensile, lb	ASTM D 4632	1/90,000 ft^2	160	220	260
Puncture Strength, lb	ASTM D 4833	1/90,000 ft^2	90	120	165
AOS, US sieve[1] (mm)	ASTM D 4751	1/540,000 ft^2	70 (0.212)	80 (0.180)	100 (0.150)
Permittivity, sec^{-1}	ASTM D 4491	1/540,000 ft^2	1.5	1.3	1.0
Flow Rate, gpm/ft^2	ASTM D 4491	1/540,000 ft^2	110	95	75
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	per formulation	70	70	70
NOMINAL ROLL DIMENSIONS					
Geonet Core Thickness, mil	ASTM D 5199	1/50,000 ft^2	250	250	250
Roll Width[5], ft			15	15	15
Roll Length[5], ft	Double-Sided Composite Single-Sided Composite		230 260	210 260	210 250
Roll Area, ft^2	Double-Sided Composite Single-Sided Composite		3,450 3,900	3,150 3,900	3,150 3,750

[Product specifications continued on back]

AT THE CORE:

A 250 mil thick HyperNet HF geonet heat-laminated on one or both sides with a nonwoven needlepunched geotextile.

Product Specifications [continued]

NOTES:

- (1)AOS in mm is a maximum average roll value.
- (2)Gradient of 0.1, normal load of 10,000 psf, water at 70˚F between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- (3)Component properties prior to lamination.
- (4)Refer to geotextile product data sheet for additional specifications.
- (5)Roll widths and lengths have a tolerance of ±1%.
- (6)Modified.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

GSE ENVIRONMENTAL™

DURABILITY RUNS DEEP

For more information on this product and others, please visit us at GSEworld.com, call 800.435.2008 or contact your local sales office.

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**              Recompiled for Windows (32/64-bit) (09 Aug 2012)            **
**          Institute of Soil Science, University of Hamburg, Germany       **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      F:\ENGINEERING\HELP 3.95 D\CMA Projects\874-Franklin\Franklin Precip 10.d4
TEMPERATURE DATA FILE:        F:\ENGINEERING\HELP 3.95 D\CMA Projects\874-Franklin\Franklin Temp.d7
SOLAR RADIATION DATA FILE:    F:\ENGINEERING\HELP 3.95 D\CMA Projects\874-Franklin\Franklin Solar.d13
EVAPOTRANSPIRATION DATA:      F:\ENGINEERING\HELP 3.95 D\CMA Projects\874-Franklin\Franklin Evapo.d11
SOIL AND DESIGN DATA FILE:    F:\ENGINEERING\HELP 3.95 D\CMA Projects\874-Franklin\Franklin Soil Stage II.d10
OUTPUT DATA FILE:             F:\ENGINEERING\HELP 3.95 D\CMA Projects\874-Franklin\Franklin Results Reg.out


                    TIME:    11:33       DATE:     3/10/2015


******************************************************************************

                  TITLE:   FRANKLIN LF - STAGE II CLOSURE

******************************************************************************


          NOTE:   INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
                COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER   1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER    7
          THICKNESS                    =       12.00    INCHES
          POROSITY                     =        0.4730 VOL/VOL
          FIELD CAPACITY               =        0.2220 VOL/VOL
          WILTING POINT                =        0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT   =        0.3761 VOL/VOL
      EFFECTIVE SAT. HYD. COND.    =   0.520000001416E-03 CM/SEC
    NOTE:   SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   4.63
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER   2
                                  --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
                        MATERIAL TEXTURE NUMBER    2
          THICKNESS                    =       12.00    INCHES
          POROSITY                     =        0.4370 VOL/VOL
          FIELD CAPACITY               =        0.0620 VOL/VOL
          WILTING POINT                =        0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =        0.1221 VOL/VOL
      EFFECTIVE SAT. HYD. COND.    =   0.579999992624E-02 CM/SEC
```

```
                              LAYER   3
                              --------

                 TYPE 2 - LATERAL DRAINAGE LAYER
                   MATERIAL TEXTURE NUMBER   20
      THICKNESS                        =        0.25     INCHES
      POROSITY                         =        0.8500  VOL/VOL
      FIELD CAPACITY                   =        0.0100  VOL/VOL
      WILTING POINT                    =        0.0050  VOL/VOL
      INITIAL SOIL WATER CONTENT   =        0.0102  VOL/VOL
   EFFECTIVE SAT. HYD. COND.    =    10.0000000000       CM/SEC
      SLOPE                            =       33.00     PERCENT
       DRAINAGE LENGTH                 =       120.0      FEET


                              LAYER   4
                              --------

                 TYPE 4 - FLEXIBLE MEMBRANE LINER
                   MATERIAL TEXTURE NUMBER   35
      THICKNESS                        =        0.04     INCHES
      POROSITY                         =        0.0000  VOL/VOL
      FIELD CAPACITY                   =        0.0000  VOL/VOL
      WILTING POINT                    =        0.0000  VOL/VOL
      INITIAL SOIL WATER CONTENT   =        0.0000  VOL/VOL
   EFFECTIVE SAT. HYD. COND.    =   0.199999996490E-12  CM/SEC
     FML PINHOLE DENSITY            =        1.00     HOLES/ACRE
     FML INSTALLATION DEFECTS       =        1.00     HOLES/ACRE
        FML PLACEMENT QUALITY          =   2 - EXCELLENT


                              LAYER   5
                              --------

                 TYPE 3 - BARRIER SOIL LINER
                   MATERIAL TEXTURE NUMBER    2
      THICKNESS                        =       12.00     INCHES
      POROSITY                         =        0.4370  VOL/VOL
      FIELD CAPACITY                   =        0.0620  VOL/VOL
      WILTING POINT                    =        0.0240  VOL/VOL
      INITIAL SOIL WATER CONTENT   =        0.4370  VOL/VOL
   EFFECTIVE SAT. HYD. COND.    =   0.579999992624E-02  CM/SEC


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

   NOTE:   SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
            SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A
           GOOD STAND OF GRASS, A SURFACE SLOPE OF 33.%
                 AND A SLOPE LENGTH OF   120. FEET.

       SCS RUNOFF CURVE NUMBER                =       71.40
   FRACTION OF AREA ALLOWING RUNOFF      =      100.0      PERCENT
    AREA PROJECTED ON HORIZONTAL PLANE   =        1.000    ACRES
   EVAPORATIVE ZONE DEPTH                =       12.0       INCHES
    INITIAL WATER IN EVAPORATIVE ZONE    =        4.513    INCHES
    UPPER LIMIT OF EVAPORATIVE STORAGE   =        5.676    INCHES
    LOWER LIMIT OF EVAPORATIVE STORAGE   =        1.248    INCHES
    INITIAL SNOW WATER                   =        0.000    INCHES
     INITIAL WATER IN LAYER MATERIALS    =       11.225    INCHES
     TOTAL INITIAL WATER                 =       11.225    INCHES
 TOTAL SUBSURFACE INFLOW                 =        0.00     INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CONCORD NEW HAMPSHIRE

STATION LATITUDE = 43.20 DEGREES
MAXIMUM LEAF AREA INDEX = 3.50
START OF GROWING SEASON (JULIAN DATE) = 129
END OF GROWING SEASON (JULIAN DATE) = 275
EVAPORATIVE ZONE DEPTH = 12.0 INCHES
AVERAGE ANNUAL WIND SPEED = 6.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 66.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 75.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 74.00 %

NOTE: PRECIPITATION DATA FOR CONCORD NEW HAMPSHIRE
WAS ENTERED BY THE USER.

NOTE: TEMPERATURE DATA FOR CONCORD NEW HAMPSHIRE
WAS ENTERED BY THE USER.

NOTE: SOLAR RADIATION DATA FOR CONCORD NEW HAMPSHIRE
WAS ENTERED BY THE USER.

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 4
DRAIN #1: LATERAL DRAINAGE FROM LAYER 3 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 5

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DAILY OUTPUT FOR YEAR 1979

DAY	A I R	O I L	RAIN IN.	RUNOFF IN.	ET IN.	S E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
280			0.01	0.000	0.039	0.2437	0.0011	.1528	.2199E-05
281			0.00	0.000	0.062	0.2343	0.0008	.1189	.1712E-05
282			0.45	0.000	0.066	0.2628	0.0006	.9137E-01	.1318E-05
283			0.22	0.000	0.065	0.2731	0.0005	.7615E-01	.1099E-05
284			0.00	0.000	0.059	0.2655	0.0004	.6072E-01	.8779E-06
285			0.45	0.000	0.062	0.2967	0.0004	.6145E-01	.8881E-06
286			0.00	0.000	0.041	0.2822	0.0002	.2176E-01	.3140E-06
287			0.00	0.000	0.053	0.2618	0.0002	.2676E-01	.3873E-06
288			0.03	0.000	0.064	0.2500	0.0009	.1195	.1722E-05
289			0.00	0.000	0.047	0.2394	0.0009	.1213	.1747E-05
290			0.00	0.000	0.046	0.2312	0.0008	.1117	.1609E-05
291			5.00	0.775	0.071	0.3836	0.0077	1.077	.1547E-04
292			5.00	2.242	0.050	0.3702	0.0215	3.011	.4324E-04
293	*		0.00	0.000	0.023	0.2845	0.0115	1.610	.2312E-04
294	*		0.00	0.000	0.030	0.2651	0.0030	.4254	.6115E-05
295	*		0.00	0.000	0.000	0.2558	0.0016	.2318	.3331E-05
296	*		0.00	0.000	0.000	0.2491	0.0011	.1556	.2239E-05
297	*		0.25	0.000	0.020	0.2453	0.0008	.1174	.1691E-05
298			0.00	0.000	0.016	0.2572	0.0007	.9984E-01	.1439E-05
299			0.00	0.000	0.035	0.2522	0.0006	.8908E-01	.1285E-05
300			0.00	0.000	0.037	0.2462	0.0004	.5960E-01	.8617E-06
301			0.00	0.000	0.039	0.2409	0.0004	.6020E-01	.8703E-06
302			0.15	0.000	0.049	0.2492	0.0005	.6495E-01	.9385E-06
303			0.00	0.000	0.034	0.2439	0.0002	.2708E-01	.3952E-06
304			0.00	0.000	0.031	0.2386	0.0002	.2642E-01	.3858E-06
305			0.00	0.000	0.040	0.2323	0.0002	.2663E-01	.3889E-06
306			0.10	0.000	0.044	0.2354	0.0003	.4036E-01	.5857E-06

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1979

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	8.03	2.29	2.85	3.07	4.86	0.70
	3.45	4.18	3.15	13.79	2.92	1.93
RUNOFF	0.000	0.000	1.930	10.977	0.012	0.000
	0.000	0.000	0.000	3.017	0.000	0.000
EVAPOTRANSPIRATION	0.427	0.581	0.618	1.417	3.113	2.131
	2.989	2.838	2.313	1.439	0.809	0.365
LATERAL DRAINAGE COLLECTED	0.1541	0.0676	0.0489	1.7134	1.4806	0.6747
FROM LAYER 3	0.2906	0.3118	0.4358	8.9238	1.9873	0.6330
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.002	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.001	0.001	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.004	0.001	0.000

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ANNUAL TOTALS FOR YEAR 1979

	INCHES	CU. FEET	PERCENT
PRECIPITATION	51.22	185928.609	100.00
RUNOFF	15.935	57843.672	31.11
EVAPOTRANSPIRATION	19.039	69113.117	37.17
DRAINAGE COLLECTED FROM LAYER 3	16.7215	60699.012	32.65
PERC./LEAKAGE THROUGH LAYER 5	0.000242	0.879	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0003		
CHANGE IN WATER STORAGE	-0.476	-1728.096	-0.93
SOIL WATER AT START OF YEAR	9.269	33647.664	
SOIL WATER AT END OF YEAR	9.404	34135.590	
SNOW WATER AT START OF YEAR	2.176	7897.804	4.25
SNOW WATER AT END OF YEAR	1.565	5681.783	3.06
ANNUAL WATER BUDGET BALANCE	0.0000	0.016	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1977 THROUGH 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.48	2.71	2.75	3.20	2.83	2.59
	2.73	3.56	3.20	6.23	2.87	2.76
STD. DEVIATIONS	3.49	2.92	1.36	0.76	1.41	1.09
	1.84	0.53	2.02	4.56	0.65	1.42
RUNOFF						
TOTALS	0.242	0.732	4.058	3.438	0.013	0.000
	0.000	0.004	0.002	0.608	0.000	0.111
STD. DEVIATIONS	0.490	1.361	2.172	4.265	0.024	0.000
	0.000	0.008	0.005	1.347	0.000	0.242
EVAPOTRANSPIRATION						
TOTALS	0.490	0.484	0.429	1.693	2.827	2.715
	2.275	3.011	1.469	1.419	0.905	0.371
STD. DEVIATIONS	0.068	0.099	0.131	0.933	0.805	0.640
	1.403	0.367	0.578	0.148	0.158	0.046
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.1503	0.0669	0.0482	1.5747	1.1427	0.4319
	0.3107	0.5218	0.8041	3.7320	1.4403	1.4673
STD. DEVIATIONS	0.0211	0.0044	0.0026	0.9992	0.6957	0.1972
	0.1332	0.4303	0.8271	3.6431	1.2300	0.9745
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4						
AVERAGES	0.0000	0.0000	0.0000	0.0004	0.0003	0.0001
	0.0001	0.0001	0.0002	0.0009	0.0003	0.0003
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0002	0.0002	0.0000
	0.0000	0.0001	0.0002	0.0008	0.0003	0.0002

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1977 THROUGH 1981

	INCHES		CU. FEET	PERCENT
PRECIPITATION	38.92	(10.553)	141279.6	100.00
RUNOFF	9.209	(4.1297)	33427.81	23.661
EVAPOTRANSPIRATION	18.088	(2.0887)	65658.01	46.474

LATERAL DRAINAGE COLLECTED FROM LAYER 3	11.69104 (5.50827)	42438.480	30.03865
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00017 (0.00008)	0.617	0.00044
AVERAGE HEAD ON TOP OF LAYER 4	0.000 (0.000)		
CHANGE IN WATER STORAGE	-0.068 (0.2541)	-245.32	-0.174

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PEAK DAILY VALUES FOR YEARS 1977 THROUGH 1981

	(INCHES)	(CU. FT.)
PRECIPITATION	5.00	18150.000
RUNOFF	2.564	9308.5703
DRAINAGE COLLECTED FROM LAYER 3	3.01090	10929.58203
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000043	0.15695
AVERAGE HEAD ON TOP OF LAYER 4	0.021	
MAXIMUM HEAD ON TOP OF LAYER 4	0.082	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	12.59	45713.4961

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4547
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1040

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1981

LAYER	(INCHES)	(VOL/VOL)
1	3.0394	0.2533
2	1.6174	0.1348
3	0.0026	0.0106
4	0.0000	0.0000
5	5.2440	0.4370
SNOW WATER	0.984	

****
****

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**              Recompiled for Windows (32/64-bit) (09 Aug 2012)            **
**          Institute of Soil Science, University of Hamburg, Germany       **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      F:\ENGINEERING\HELP 3.95 D\CMA Projects\874-Franklin\Franklin Precip Reg.d4
TEMPERATURE DATA FILE:        F:\ENGINEERING\HELP 3.95 D\CMA Projects\874-Franklin\Franklin Temp.d7
SOLAR RADIATION DATA FILE:    F:\ENGINEERING\HELP 3.95 D\CMA Projects\874-Franklin\Franklin Solar.d13
EVAPOTRANSPIRATION DATA:      F:\ENGINEERING\HELP 3.95 D\CMA Projects\874-Franklin\Franklin Evapo.d11
SOIL AND DESIGN DATA FILE:    F:\ENGINEERING\HELP 3.95 D\CMA Projects\874-Franklin\Franklin Soil Stage II.d10
OUTPUT DATA FILE:             F:\ENGINEERING\HELP 3.95 D\CMA Projects\874-Franklin\Franklin Results Reg.out


                    TIME:    11:51       DATE:     3/10/2015


******************************************************************************

                 TITLE:   FRANKLIN LF - STAGE II CLOSURE

******************************************************************************


          NOTE:   INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
                COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER    7
            THICKNESS                    =       12.00    INCHES
            POROSITY                     =        0.4730 VOL/VOL
            FIELD CAPACITY               =        0.2220 VOL/VOL
            WILTING POINT                =        0.1040 VOL/VOL
            INITIAL SOIL WATER CONTENT   =        0.3761 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =   0.520000001416E-03 CM/SEC
      NOTE:   SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   4.63
            FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER    2
            THICKNESS                    =       12.00    INCHES
            POROSITY                     =        0.4370 VOL/VOL
            FIELD CAPACITY               =        0.0620 VOL/VOL
            WILTING POINT                =        0.0240 VOL/VOL
            INITIAL SOIL WATER CONTENT   =        0.1221 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =   0.579999992624E-02 CM/SEC
```

```
                              LAYER   3
                              --------

                 TYPE 2 - LATERAL DRAINAGE LAYER
                   MATERIAL TEXTURE NUMBER   20
      THICKNESS                        =        0.25     INCHES
      POROSITY                         =        0.8500  VOL/VOL
      FIELD CAPACITY                   =        0.0100  VOL/VOL
      WILTING POINT                    =        0.0050  VOL/VOL
      INITIAL SOIL WATER CONTENT   =        0.0102  VOL/VOL
   EFFECTIVE SAT. HYD. COND.    =    10.0000000000       CM/SEC
      SLOPE                            =       33.00     PERCENT
       DRAINAGE LENGTH                 =       120.0      FEET


                              LAYER   4
                              --------

                 TYPE 4 - FLEXIBLE MEMBRANE LINER
                   MATERIAL TEXTURE NUMBER   35
      THICKNESS                        =        0.04     INCHES
      POROSITY                         =        0.0000  VOL/VOL
      FIELD CAPACITY                   =        0.0000  VOL/VOL
      WILTING POINT                    =        0.0000  VOL/VOL
      INITIAL SOIL WATER CONTENT   =        0.0000  VOL/VOL
   EFFECTIVE SAT. HYD. COND.    =   0.199999996490E-12  CM/SEC
     FML PINHOLE DENSITY            =        1.00     HOLES/ACRE
     FML INSTALLATION DEFECTS       =        1.00     HOLES/ACRE
        FML PLACEMENT QUALITY          =   2 - EXCELLENT


                              LAYER   5
                              --------

                 TYPE 3 - BARRIER SOIL LINER
                   MATERIAL TEXTURE NUMBER    2
      THICKNESS                        =       12.00     INCHES
      POROSITY                         =        0.4370  VOL/VOL
      FIELD CAPACITY                   =        0.0620  VOL/VOL
      WILTING POINT                    =        0.0240  VOL/VOL
      INITIAL SOIL WATER CONTENT   =        0.4370  VOL/VOL
   EFFECTIVE SAT. HYD. COND.    =   0.579999992624E-02  CM/SEC


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

   NOTE:   SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
            SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A
           GOOD STAND OF GRASS, A SURFACE SLOPE OF 33.%
                 AND A SLOPE LENGTH OF   120. FEET.

       SCS RUNOFF CURVE NUMBER                =       71.40
   FRACTION OF AREA ALLOWING RUNOFF      =      100.0      PERCENT
    AREA PROJECTED ON HORIZONTAL PLANE   =        1.000    ACRES
   EVAPORATIVE ZONE DEPTH                =       12.0       INCHES
    INITIAL WATER IN EVAPORATIVE ZONE    =        4.513    INCHES
    UPPER LIMIT OF EVAPORATIVE STORAGE   =        5.676    INCHES
    LOWER LIMIT OF EVAPORATIVE STORAGE   =        1.248    INCHES
    INITIAL SNOW WATER                   =        0.000    INCHES
     INITIAL WATER IN LAYER MATERIALS    =       11.225    INCHES
     TOTAL INITIAL WATER                 =       11.225    INCHES
 TOTAL SUBSURFACE INFLOW                 =        0.00     INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CONCORD NEW HAMPSHIRE

STATION LATITUDE = 43.20 DEGREES
MAXIMUM LEAF AREA INDEX = 3.50
START OF GROWING SEASON (JULIAN DATE) = 129
END OF GROWING SEASON (JULIAN DATE) = 275
EVAPORATIVE ZONE DEPTH = 12.0 INCHES
AVERAGE ANNUAL WIND SPEED = 6.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 66.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 75.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 74.00 %

NOTE: PRECIPITATION DATA FOR CONCORD NEW HAMPSHIRE
WAS ENTERED BY THE USER.

NOTE: TEMPERATURE DATA FOR CONCORD NEW HAMPSHIRE
WAS ENTERED BY THE USER.

NOTE: SOLAR RADIATION DATA FOR CONCORD NEW HAMPSHIRE
WAS ENTERED BY THE USER.

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 4
DRAIN #1: LATERAL DRAINAGE FROM LAYER 3 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 5

****

DAILY OUTPUT FOR YEAR 1981

DAY	A I R	O I L	RAIN IN.	RUNOFF IN.	ET IN.	S E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
290			0.00	0.000	0.044	0.1936	0.0002	.3419E-01	.4972E-06
291			1.23	0.000	0.044	0.2911	0.0002	.2964E-01	.4320E-06
292	*		0.01	0.000	0.036	0.2841	0.0002	.2688E-01	.3907E-06
293			0.00	0.000	0.039	0.2642	0.0000	.2423E-03	.3601E-08
294			0.00	0.000	0.032	0.2523	0.0003	.4365E-01	.6320E-06
295	*		0.00	0.000	0.024	0.2436	0.0006	.8701E-01	.1255E-05
296	*		2.40	0.000	0.000	0.2400	0.0007	.9271E-01	.1337E-05
297	*		0.24	0.000	0.000	0.2380	0.0006	.8895E-01	.1283E-05
298			0.00	0.000	0.023	0.2370	0.0005	.7547E-01	.1089E-05
299			0.55	0.015	0.000	0.3634	0.0003	.4751E-01	.6865E-06
300			0.73	0.006	0.000	0.3442	0.0067	.9357	.1344E-04
301			0.19	0.000	0.000	0.3333	0.0068	.9596	.1378E-04
302			0.00	0.000	0.013	0.3005	0.0051	.7208	.1036E-04
303			0.00	0.000	0.027	0.2802	0.0029	.4040	.5811E-05
304			0.00	0.000	0.029	0.2638	0.0017	.2398	.3446E-05
305			0.00	0.000	0.036	0.2520	0.0014	.1903	.2737E-05
306			0.00	0.000	0.033	0.2427	0.0010	.1415	.2036E-05
307			0.00	0.000	0.040	0.2342	0.0008	.1148	.1654E-05
308			0.00	0.000	0.042	0.2272	0.0007	.9724E-01	.1402E-05
309			0.00	0.000	0.038	0.2214	0.0006	.8018E-01	.1157E-05
310			0.44	0.000	0.033	0.2533	0.0005	.6770E-01	.9779E-06
311			0.00	0.000	0.023	0.2496	0.0004	.5462E-01	.7903E-06
312			0.00	0.000	0.024	0.2457	0.0003	.4373E-01	.6341E-06
313			0.00	0.000	0.027	0.2420	0.0003	.4368E-01	.6334E-06
314			0.00	0.000	0.025	0.2398	0.0004	.4939E-01	.7153E-06
315			0.02	0.000	0.032	0.2373	0.0002	.2446E-01	.3577E-06

****

MONTHLY TOTALS (IN INCHES) FOR YEAR 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.48	7.77	0.86	3.12	3.21	2.81
	5.54	3.25	4.61	6.51	3.51	4.17
RUNOFF	0.041	3.148	3.955	2.171	0.055	0.000
	0.000	0.000	0.000	0.020	0.000	0.000
EVAPOTRANSPIRATION	0.503	0.342	0.334	0.672	3.882	3.166
	4.257	3.298	1.671	1.247	1.032	0.366
LATERAL DRAINAGE COLLECTED	0.1335	0.0627	0.0464	0.0331	2.1647	0.3050
FROM LAYER 3	0.5431	0.5637	1.2741	4.5284	3.3396	2.6899
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.001	0.001	0.001
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.001	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.002	0.001	0.001

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ANNUAL TOTALS FOR YEAR 1981

	INCHES	CU. FEET	PERCENT
PRECIPITATION	45.84	166399.219	100.00
RUNOFF	9.391	34088.105	20.49
EVAPOTRANSPIRATION	20.770	75395.812	45.31
DRAINAGE COLLECTED FROM LAYER 3	15.6841	56933.309	34.21
PERC./LEAKAGE THROUGH LAYER 5	0.000227	0.825	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0003		
CHANGE IN WATER STORAGE	-0.005	-18.838	-0.01
SOIL WATER AT START OF YEAR	10.240	37169.672	
SOIL WATER AT END OF YEAR	9.903	35949.512	
SNOW WATER AT START OF YEAR	0.653	2368.929	1.42
SNOW WATER AT END OF YEAR	0.984	3570.254	2.15
ANNUAL WATER BUDGET BALANCE	0.0000	-0.003	0.00

****

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1977 THROUGH 1981

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.48	2.71	2.75	3.20	2.83	2.59
	2.73	3.56	3.20	4.23	2.87	2.76
STD. DEVIATIONS	3.49	2.92	1.36	0.76	1.41	1.09
	1.84	0.53	2.02	1.72	0.65	1.42
RUNOFF						
TOTALS	0.242	0.732	4.058	3.438	0.013	0.000
	0.000	0.004	0.002	0.004	0.000	0.111
STD. DEVIATIONS	0.490	1.361	2.172	4.265	0.024	0.000
	0.000	0.008	0.005	0.009	0.000	0.242
EVAPOTRANSPIRATION						
TOTALS	0.490	0.484	0.429	1.693	2.827	2.715
	2.275	3.011	1.469	1.410	0.905	0.371
STD. DEVIATIONS	0.068	0.099	0.131	0.933	0.805	0.640
	1.403	0.367	0.578	0.148	0.158	0.046
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.1503	0.0669	0.0482	1.5747	1.1427	0.4319
	0.3107	0.5218	0.8041	2.4365	1.3478	1.4673
STD. DEVIATIONS	0.0211	0.0044	0.0026	0.9992	0.6957	0.1972
	0.1332	0.4303	0.8271	2.2020	1.1955	0.9745
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4						
AVERAGES	0.0000	0.0000	0.0000	0.0004	0.0003	0.0001
	0.0001	0.0001	0.0002	0.0006	0.0003	0.0003
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0002	0.0002	0.0000
	0.0000	0.0001	0.0002	0.0005	0.0003	0.0002

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1977 THROUGH 1981

	INCHES		CU. FEET	PERCENT
PRECIPITATION	36.92	(8.359)	134019.6	100.00
RUNOFF	8.605	(2.9545)	31237.64	23.308

EVAPOTRANSPIRATION	18.079	(2.0838)	65626.50	48.968
LATERAL DRAINAGE COLLECTED FROM LAYER 3	10.30309	(4.74532)	37400.227	27.90653
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00015	(0.00007)	0.545	0.00041
AVERAGE HEAD ON TOP OF LAYER 4	0.000	(0.000)		
CHANGE IN WATER STORAGE	-0.068	(0.2541)	-245.32	-0.183

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PEAK DAILY VALUES FOR YEARS 1977 THROUGH 1981

	(INCHES)	(CU. FT.)
PRECIPITATION	2.43	8820.900
RUNOFF	2.564	9308.5703
DRAINAGE COLLECTED FROM LAYER 3	0.95955	3483.17065
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000014	0.05003
AVERAGE HEAD ON TOP OF LAYER 4	0.007	
MAXIMUM HEAD ON TOP OF LAYER 4	0.012	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	12.59	45713.4961

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4547
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1040

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1981

LAYER	(INCHES)	(VOL/VOL)
1	3.0394	0.2533
2	1.6174	0.1348
3	0.0026	0.0106
4	0.0000	0.0000
5	5.2440	0.4370
SNOW WATER	0.984	

****

CMA ENGINEERS, Inc.	Project:	Franklin Secure Residue Landfill - Stage II Closure
Civil/Environmental Engineers	Project no.:	874
	Date	3/12/15
35 Bow Street	Calc By:	APV
Portsmouth, NH 03801	Checked By:	PDS

SOIL FILTER ANALYSIS

Analysis based on modifications to Terzaghi's filter criteria

Proposed Gradations

Select Drainage Sand

US Standard Sieve Size (#)	Grain Size (in)	% Passing By Weight Range		Average
1"	1.000	100	100	100
4	0.250	85	100	92.5
10	0.100	60	95	77.5
40	0.025	20	60	40
100	0.010	0	20	10
200	0.005	0	12	6

	Grain Size (in.)		Average
D15	0.0075	0.018	0.013
D85	0.080	0.250	0.165

NHDOT Class C Stone

US Standard Sieve Size (#)	Grain Size (in)	% Passing By Weight Range		Average
12"	12	100	100	100
4"	4	50	90	70
1.5"	1.5	0	30	15
3/4"	0.75	0	10	5

	Grain Size (in.)		Average
D15	0.90	2.00	1.45
D85	3.50	8.50	6.00

Select Gravel - NHDOT 304.4 (Crushed Stone Fine)

US Standard Sieve Size (#)	Grain Size (in)	% Passing By Weight Range		Average
2"	2	100	100	100
1.5"	1.5	85	100	92.5
3/4"	0.75	45	75	60
4	0.250	10	45	27.5
200	0.005	0	5	2.5

	Grain Size (in.)		Average
D15	0.040	0.340	0.19
D85	1.000	1.750	1.38

CMA ENGINEERS, Inc.	Project:	Franklin Secure Residue Landfill - Stage II Closure
Civil/Environmental Engineers	Project no.:	874
	Date	3/12/15
35 Bow Street	Calc By:	APV
Portsmouth, NH 03801	Checked By:	PDS

SOIL FILTER ANALYSIS (continued)
Analysis based on modifications to Terzaghi's filter criteria

Tzeraghi's Criteria can be expressed as follows:

$D_{15\ Filter}$ >= 5 D_{15} Soil, <= 20 D_{15} Soil
$D_{15\ Filter}$ <= 5 D_{85} Soil

Zone of Acceptable Filters (See Attached Figure)

For Select Sand/Select Gravel Interface

Range SG-$D_{15\ =}$	0.065	0.26
SG-$D_{15\ <}$	0.825	

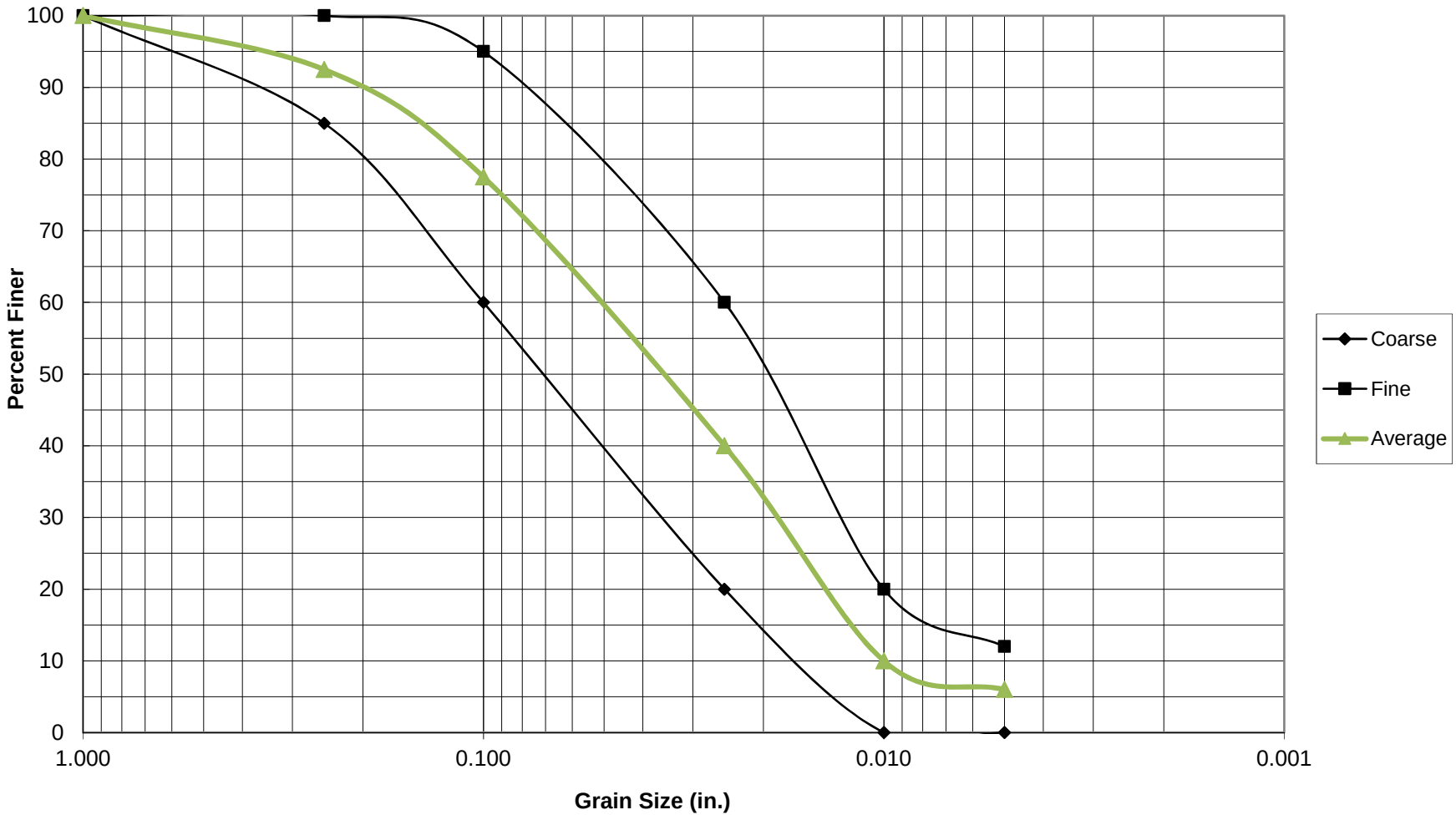
For Select Gravel/Stone Interface

Range SG-D_{15}	0.0725	0.29
SG-$D8_{5\ >}$	0.29	

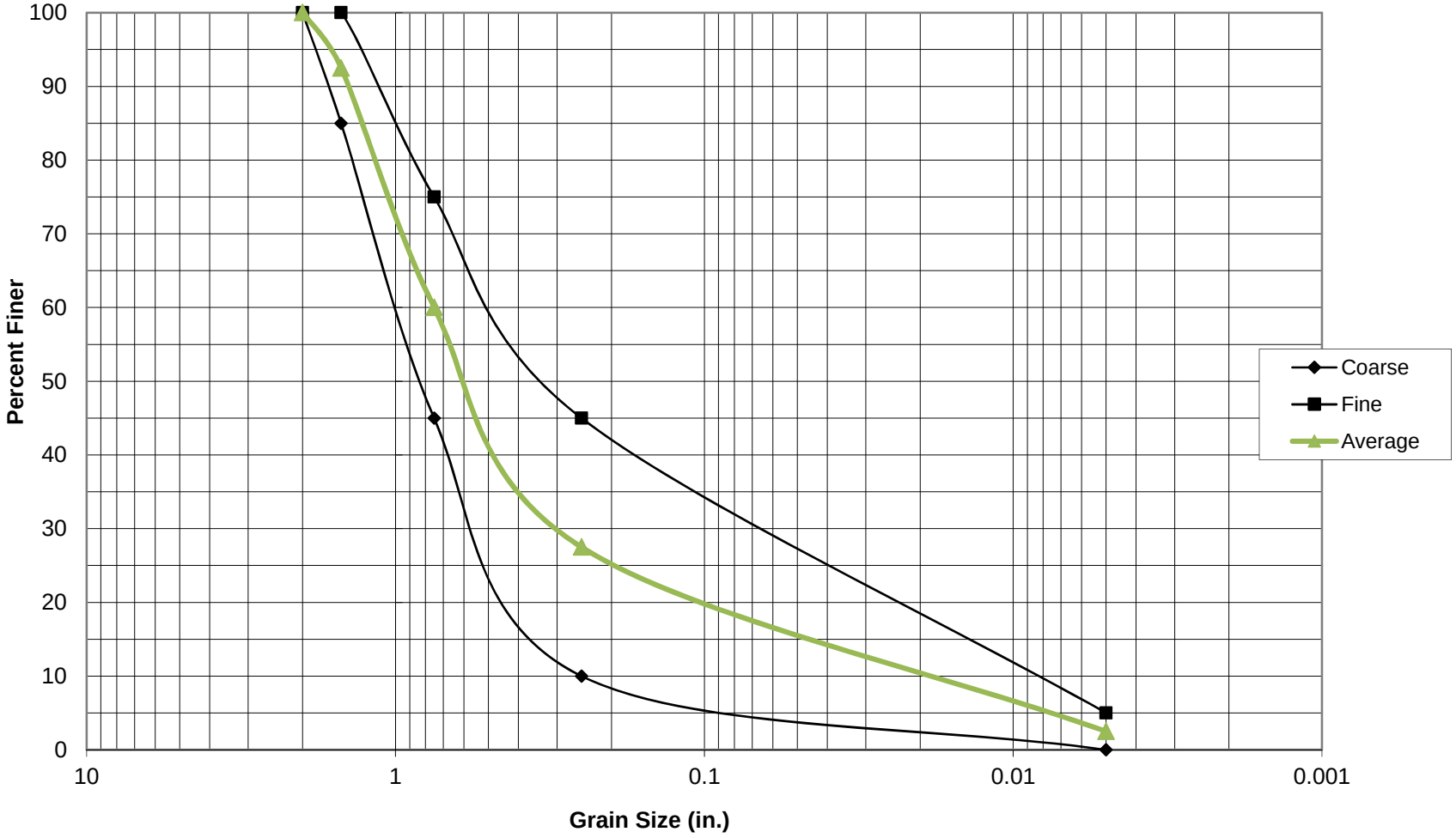
Notes:
Analysis indicates that Select Gravel meets filter criteria

References:
"Development of Criteria for the Geotextile and Granular Filters", J.P. Giroud

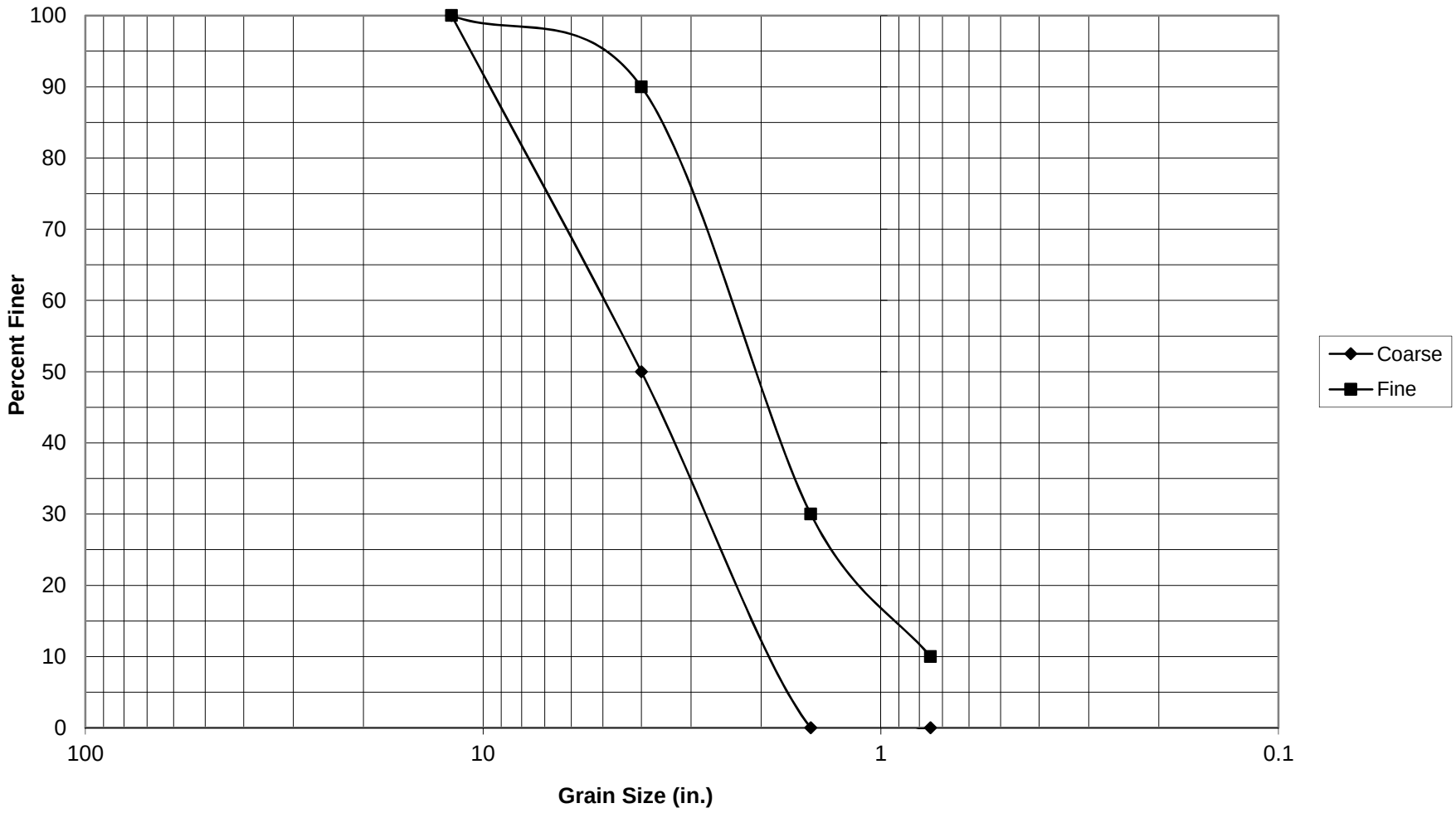
Franklin Secure Residue Landfill - Stage II Closure
Particle Size Distribution
Select Drainage Sand

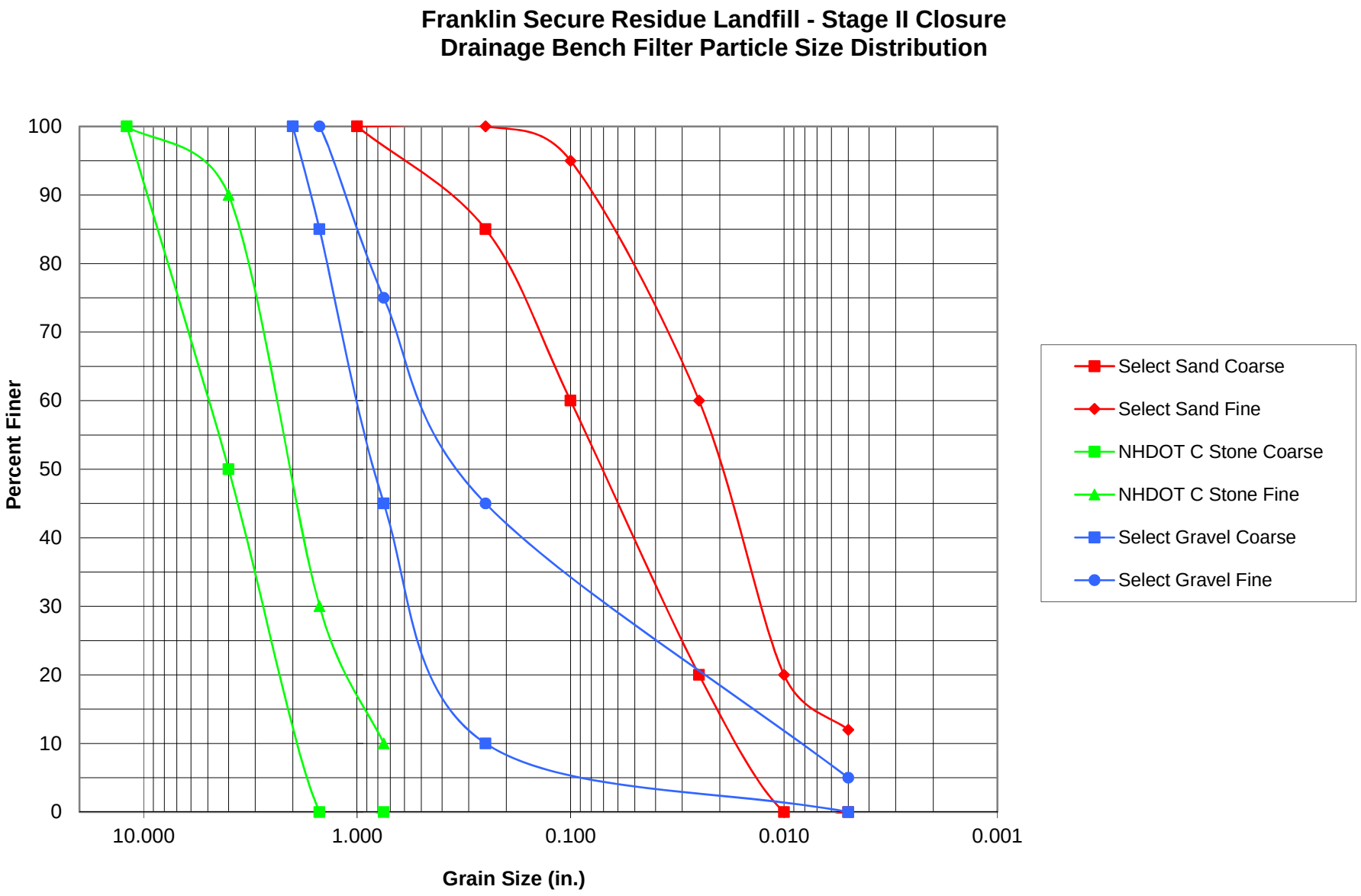


Franklin Secure Residue Landfill - Stage II Closure
Particle Size Distribution
Select Gravel (NHDOT 304.4)



Franklin Secure Residue Landfill - Stage II Closure
Particle Size Distribution
NHDOT Class C Stone




Franklin Secure Residue Landfill - Stage II Closure
Drainage Bench Filter Particle Size Distribution
Percent Finer
100
90
80
70
60
50
40
30
20
10
0
10.000
1.000
0.100
0.010
0.001
Grain Size (in.)
Select Sand Coarse
Select Sand Fine
NHDOT C Stone Coarse
NHDOT C Stone Fine
Select Gravel Coarse
Select Gravel Fine

APPENDIX A.2
Slope Stability Calculations

Objective:

Determine veneer static and dynamic stability of the capping system.

Design Cases:

- Side slope stability on 3:1 side slope, during placement of 12-inches of drainage sand.
- Long term side slope stability on 3:1 side slope with 24-inches of cover material.

Assumptions:

- Thickness of select sand = 12 inches.
- Soil density = 120 lb./ft^3.
- Minimum specified interface shear strength of 26.5 degrees or 114 psf. Anticipated friction angles and cohesion for the various interfaces will exceed the minimum strength requirement.
- Buttressing forces neglected during select sand placement. Conservative.
- Liner is 40-mil textured HDPE.
- Geocomposite is double-sided geonet with non-woven geotextile.

Conclusions:

- 3:1 side slopes are stable under static loading conditions with a minimum factor of safety of 1.50, assuming minimum shear strength envelope of 26.5 degrees is provided. It is assumed that the geocomposite and textured liner interface will be the critical interface.
- 3:1 side slopes would be marginally stable under equipment loading during placement of 12 inches of drainage sand and other cover soils in a downward fashion. However, contractor will be required to push and place materials from the bottom up to maintain slope stability and eliminate downward dynamic forces.

CMA ENGINEERS, Inc. Civil/Environmental Engineers 35 Bow Street Portsmouth, NH 03801	Project: Project No: Date: Calc. By: Checked By:	Franklin Secure Residue Landfill - Stage II Closure 874 3/12/15 APV PDS

SLOPE STABILITY: STATIC STABILITY OF COVER SYSTEM
Capping Section With Double Sided Geocomposite
Uniform slope thickness, buttress forces neglected

Method: Finite Analysis
(See Attached Force Diagrams)

Example Calculation

Input Variables:	
Thickness of cover soils (t)	2 ft
Slope X:1	3
Slope angle (b)	18.43 degrees
Length of slope (L)	1 ft
Unit weight of cover soils (Ws)	120 pcf
Min Interface Friction Angles (a)	26.5 degrees

Calculations (per foot width)

	Min Interface	
Weight of Cover Soil (Wc): Wc = t*L*Ws	240	psf
Normal Force (Fn): Fn = Wc*cos(b)	228	psf
Frictional Resisting Forces (Fr): Fr = Fn*tan(a)	114	psf
Driving Force (Fd): Fd = Wc*sin(b)	76	psf
Factor of Safety (FS): FS = Fr/Fd	**1.50**	

SLOPE STABILITY: STATIC STABILITY OF COVER SYSTEM (continued)

NOTES:

EPA Document: "Geosynthetic Design Guidance for Hazardous Waste Landfill Cells & Surface Impoundments" Recommends a minimum Safety Factor of 1.2 for sliding

NHDES recommends a Safety Factor of 1.5 for long term stability

The drainage composite elimiates any head build up on the liner

Buttressing forces neglected but could be used in evaluation to increase factor of safety

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REFERENCES:

EPA/600/2-87/097: "Geosynthetic Design Guidance for Hazardous Waste Landfill Cells & Surface Impoundments"

EPA/600/52-89/057: "Stability of Lined Slopes and Surface Impoundments"

Proceedings of the 4th GRI Seminar: "Landfill Closures: Geosynthetics, Interface Friction, and New Developments," Drexel University, Philadelphia, PA, 1990

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CHECKED BY _____ DATE _____
SCALE _____

FORCE DIAGRAM

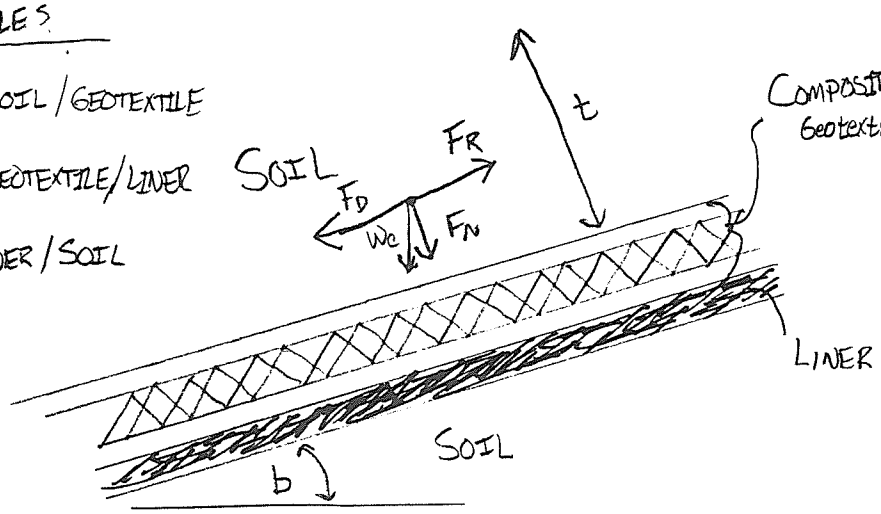
STABILITY OF COVER SOILS - UNIFORM SLOPE INTO A LINED SWALE

INTERFACE FRICTION ANGLES

a_1 = SOIL / GEOTEXTILE

a_2 = GEOTEXTILE / LINER

a_3 = LINER / SOIL



W_s = Unit weight of cover soil

$W_c = W_s \cdot L \cdot t \cdot 1$

$F_N = W_c \cos(b)$

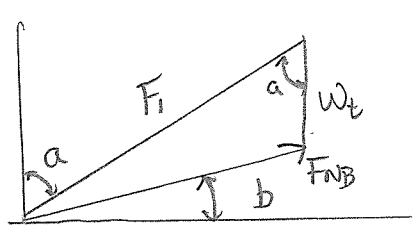
$F_D = W_c \sin(b)$

$F_R = F_N \tan(a_1)$
$= F_N \tan(a_2)$
$= F_N \tan(a_3)$

- Use limiting case

BUTTRESSING FORCE → F_{NB}

a = INTERFACE FRICTION ANGLE
LIMITING CASE



W_t = weight of toe wedge
$= 0.5\, t\, (t/\tan(b)) \cdot 1 \cdot W_s$

$\sin(a) = \frac{X}{W_t}$

$X = W_t \sin(a)$

$\sin(90-(a+b)) = \frac{X}{F_{NB}}$

$F_{NB} = \frac{W_t \sin a}{\cos(a+b)}$

$$\boxed{FS = \frac{F_R + F_{NB}}{F_D}}$$

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SLOPE STABILITY: STABILITY OF COVER SYSTEM UNDER EQUIPMENT LOADING
Uniform slope thickness, buttressing forces neglected

Method: Finite Analysis
(See Attached Force Diagrams)

Example Calculation

Input Variables:	Placement of Sand Layer	Longterm Stability and Placement of Topsoil
Thickness of cover soils (t) (ft)	1	2
Slope X:1	3	3
Slope angle (b)	18.43	18.43
Length of slope (L) (ft)	120	120
Unit weight of cover soils (Ws) (pcf)	120	120
Min interface friction angle (a)	26.5	26.5

Equipment Input Variables:

Equipment	D6N LGP	D6N LGP
Ground Pressure (Gp) (psi)	4.89	4.89
Contact Area (Ca) (in^2)	8,103	8,103
Operating Weight (Ow) (lbs)	39,593	39,593
Track Width (Tw) (in)	33.07	33.07
Track Length (Tl) (ft)	10.21	10.21

Calculations (per foot width)

	Placement of Sand Layer	Longterm Stability and Placement of Topsoil
Weight of Cover Soil (Wc) (lbs): Wc = t*L*Ws	14,400	28,800
Weight of Vehicle on Slope On Top of Soil Cover (Wv') (lbs): Wv = (Ow/2 tracks)/Tw	7,183	7,183
Stress at FML (Qz) (psf): Qz = (Ow/2 TRACKS)/((Tl+2t)*(Tw+2t)) assuming 1:1 distribution	341	206
Percentage of Attenuation (%q) %q = Qz/Gp	48.5%	29.3%
Attenuation Force (Wv) (lbs): Wv = Wv'*(%q)	3,481	2,105

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SLOPE STABILITY: STABILITY OF COVER SYSTEM UNDER EQUIPMENT LOADING (continued)

	Placement of Sand Layer	Longterm Stability and Placement of Topsoil
Normal Force (Fn) (lbs): Fn = (Wv+Wc)cos(b)	16,963	29,319
Frictional Resisting Force (Fr) (lbs): Fr = Fn*tan(a)	8,458	14,618
Driving Force (Fd) (lbs): Fd = (Wv)sin(b)	5,654	9,773
Braking Force (Fb) (lbs): (Assume Fb=50%Wv) Fb = 0.5*Wv	1,740	1,053
Factor of Safety Static Condition: FS =(Fr)/Fd	**1.50**	**1.50**
Factor of Safety Dynamic Condition: FS = (Fr+Fc)/(Fd+Fb)	**1.14**	**1.35**

NOTES:
Stability during placement of select sand calculated with 1 foot of material

Percentage of Attenuation through the depth of soil is calculated
by determining the contact stress from one track at the bottom
of the cover soil, assuming a 1:1 distribution

Contractor will be required to grade materials from bottom to top or laterally on all areas
However, sudden braking while going down slope would not likley cause failure as calculated above

REFERENCES:

EPA/600/2-87/097: "Geosynthetic Design Guidance for
Hazardous Waste Landfill Cells & Surface Impoundments"

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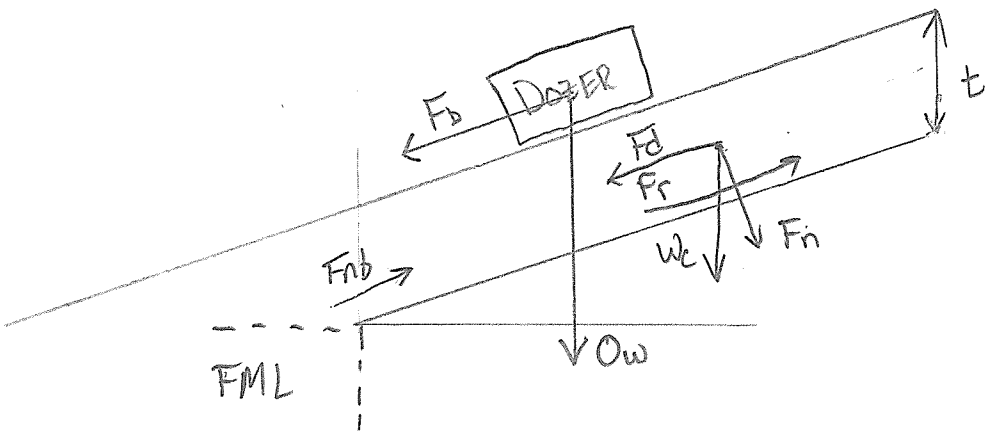
FORCE DIAGRAM

STABILITY OF COVER SOILS - EQUIPMENT SLIDING



$F_n = W_c \cdot \cos(b)$

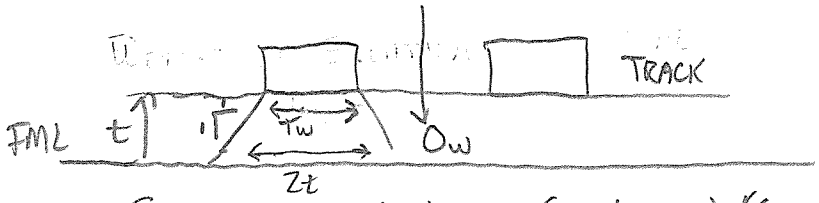
$F_d = W_c \cdot \sin(b)$

$F_r = F_n \cdot \tan(a)$

F_b = Braking Force

O_w = Operating Weight

FOR NEUTRAL BLOCK FORCE SEE THE FORCE DIAGRAMS FOR THE UNIFORM SLOPE INTO EXISTING GRADE OR LINED SWALE AS APPROPRIATE



1:1 Attenuation

T_L = TRACK LENGTH
T_W = TRACK WIDTH
G_p = Ground Pressure

$F_b = 25\% \, W_v$

STRESS AT FML (Q_z) = $(O_w / 2\,\text{TRACKS}) / ((T_l + 2t) \cdot (T_w + 2t))$

% Attenuation (%q) = Q_z / G_p

ATTENUATION FORCE W_v = $W_v' \times \%q$

$$\boxed{FS\,(\text{STATIC}) = \frac{(F_{nb} + F_r)}{F_d}}$$

$$\boxed{FS_{\text{DYNAMIC (Braking)}} = \frac{(F_{nb} + F_r)}{(F_d + F_b)}}$$

APPENDIX A.3
Wheel Loading Calculations

Objective:

Determine puncture resistance of the capping system when subjected to post closure maintenance loading from a tractor.

Design Cases:

- 12 ton agricultural tractor working atop the capping system for mowing operation.

Assumptions:

- Thickness of cover soil = 24 inches.
- Ground contact pressure (tire pressure) = 55 psi.
- Tire width = 12 inches
- Liner puncture resistance = 70 lbs.

Conclusions:

- Factor of safety of approximately 7.4 is provided assuming a 2:1 wheel load distribution through the cover sands.

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WHEEL LOADING ANALYSIS

Input Variables:			
Tractor Weight (Wv)	24,000	lbs	
No. of Wheels (N)	4		
Ground Contact Pressure (Gp)	55	psi	
- (tire air pressure)			
Cover Thickness (t)	24	in	
Minimum Puncture Resistance			
of Liner (Pr)	70	lbs	(GSE 40 mil Friction Flex 79 lbs min)

Analysis:

Wheel Load (Wl):
Wl = Wv/N 6,000 lbs/wheel

Effective Radius (R):
R = sqrt(Wl/3.142*Gp) 5.89 inches

Field Contact Stress (Qc):
Qc = Gp*(R^2/(R+t)^2) 2.14 psi

Assumption
Tire Width = 12 inches
2:1 Distributrion Slope

Load on Liner (L):
L = (W*R/12)*Qc 9.44 lbs

Factor of Safety (FS):
FS=Pr/L **7.41**

CONCLUSION:
Factor of Safety is Acceptable (FS>2)

REFERENCES:

EPA/600/2-87/097: "Geosynthetic Design Guidance for Hazardous Waste Landfill Cells & Surface Impoundments"

PRODUCT DATA SHEET

GSE HD FrictionFlex Geomembrane (Double-Sided)

GSE HD FrictionFlex is a spray-on texture version of GSE HD. It is a high density polyethylene (HDPE) geomembrane that is textured on both sides using GSE's patented texturing process and manufactured with the highest quality resin specifically formulated for flexible geomembranes. This process is the only one that produces a textured material without significant reduction of any physical properties. The product is used in applications that require excellent chemical resistance and endurance properties.

AT THE CORE:
A spray-on textured version of GSE HD geomembrane suitable for applications that require excellent chemical resistance and endurance properties.

Product Specifications

These product specifications meet or exceed GRI GM13.

Tested Property	Test Method	Frequency	Minimum Average Value				
Thickness, (minimum average) mm (mil) Lowest individual reading, mm (mil)	ASTM D 5994	every roll	0.75 (30) 0.68 (27)	1.0 (40) 0.9 (36)	1.5 (60) 1.35 (54)	2.0 (80) 1.8 (72)	2.5 (100) 2.25 (90)
Density, g/cm³	ASTM D 1505	every 5th roll	0.94	0.94	0.94	0.94	0.94
Tensile Properties (each direction) Strength at Break, N/mm-width (lb/in) Strength at Yield, N/mm-width (lb/in) Elongation at Break, % Elongation at Yield, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 51 mm (2.0 in) G.L. 33 mm (1.3 in)	every 5th roll	 17 (97) 11 (63) 600 13	 24 (137) 14 (80) 600 13	 37 (211) 23 (131) 600 13	 48 (274) 30 (171) 600 13	 60 (343) 38 (217) 600 13
Tear Resistance, N (lb)	ASTM D 1004	every 5th roll	93 (21)	125 (28)	187 (42)	249 (56)	311 (70)
Puncture Resistance, N (lb)	ASTM D 4833	every 5th roll	263 (59)	352 (79)	530 (119)	703 (158)	881 (198)
Carbon Black Content, %	ASTM D 1603 / D 4218	every 5th roll	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0
Carbon Black Dispersion	ASTM D 5596	every 5th roll	Note (1)	Note (1)	Note (1)	Note (1)	Note (1)
Asperity Height	ASTM D 7466	every second roll	Note (2)	Note (2)	Note (2)	Note (2)	Note (2)
Notched Constant Tensile Load, hrs	ASTM D 5397, Appendix	90,000 kg	500	500	500	500	500
Oxidative Induction Time, minutes	ASTM D 3895, 200° C; O_2, 1 atm	90,000 kg	> 100	>100	>100	>100	>100
TYPICAL ROLL DIMENSIONS							
Roll Length(3), m (ft)			250 (820)	200 (656)	100 (328)	80 (262)	60 (197)
Roll Width(3), m (ft)			7.0 (23)	7.0 (23)	7.0 (23)	7.0 (23)	7.0 (23)
Roll Area, m² (ft²)			1,750 (18,860)	1,400 (15,088)	700 (7,544)	560 (6,026)	420 (4,531)
40' Standard Container, roll			9	9	16	16	16

NOTES:
- (1)Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- (2)0.40 mm average. 8 of 10 readings ≥0.35 mm. Lowest individual ≥0.30 mm.
- (3)Roll lengths and widths have a tolerance of ±1%.
- GSE HD Standard Textured is provided in rolls weighing approximately 1,150 kg (2,535 lb) each.
- All GSE geomembranes have dimensional stability of ±2% when tested with ASTM D 1204 and LTB of <-77° C when tested with ASTM D 746.
- Alternate the measurement side for double-sided textured sheet.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

GSE ENVIRONMENTAL™

DURABILITY RUNS DEEP

For more information on this product and others, please visit us at GSEworld.com, call 66.2.937.0091 or contact your local sales office.

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APPENDIX B
REVISED STORMWATER CALCULATIONS

Objective:
Confirm design of proposed intermediate drainage benches and toe drain swale are appropriate to accommodate a 25-year/24-hour storm event. Determine whether any modifications to existing stormwater detention or treatment systems are required.

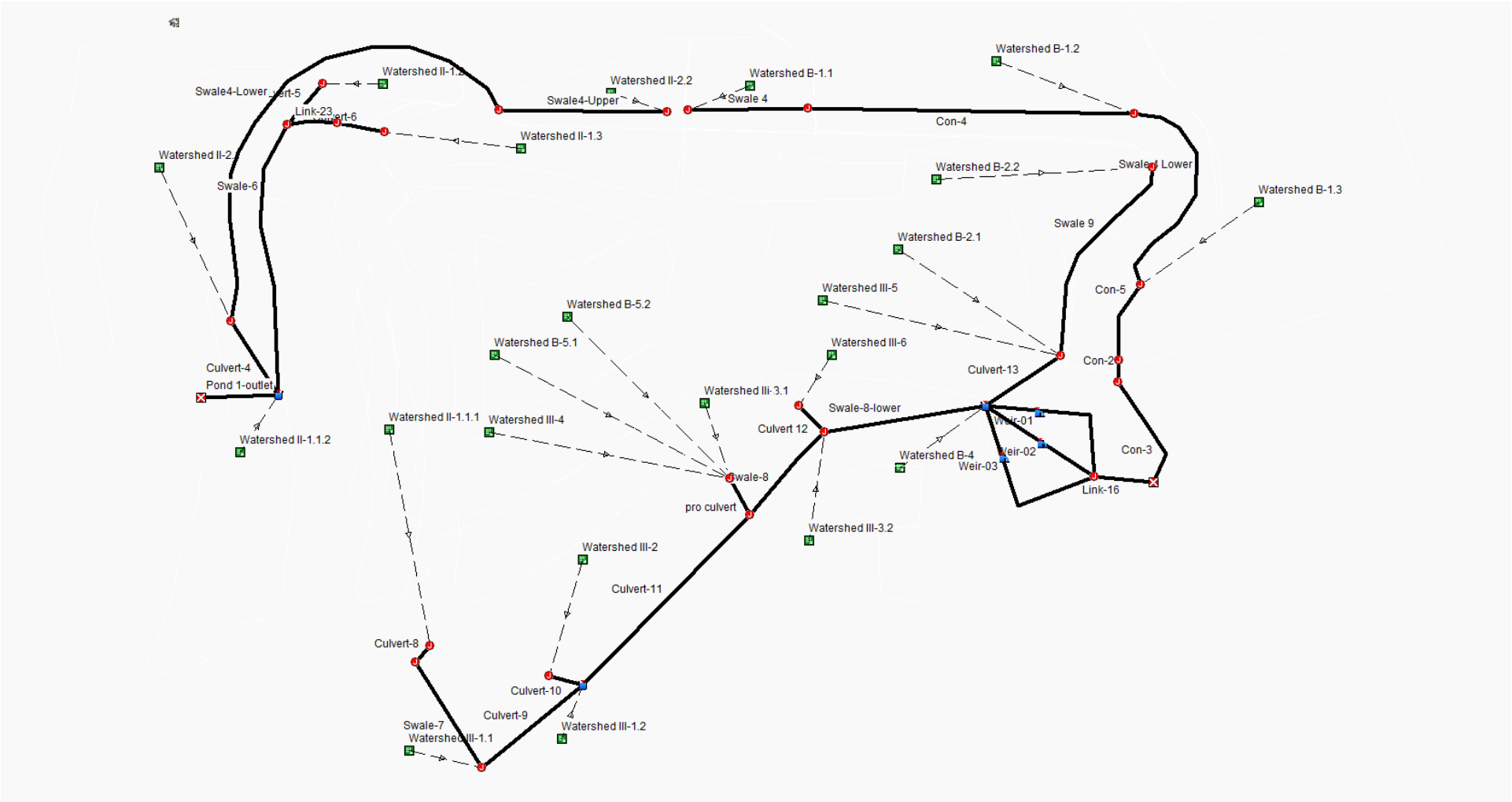
Calculations updated for Stage II Closure final design from those presented in Stage I Closure design.

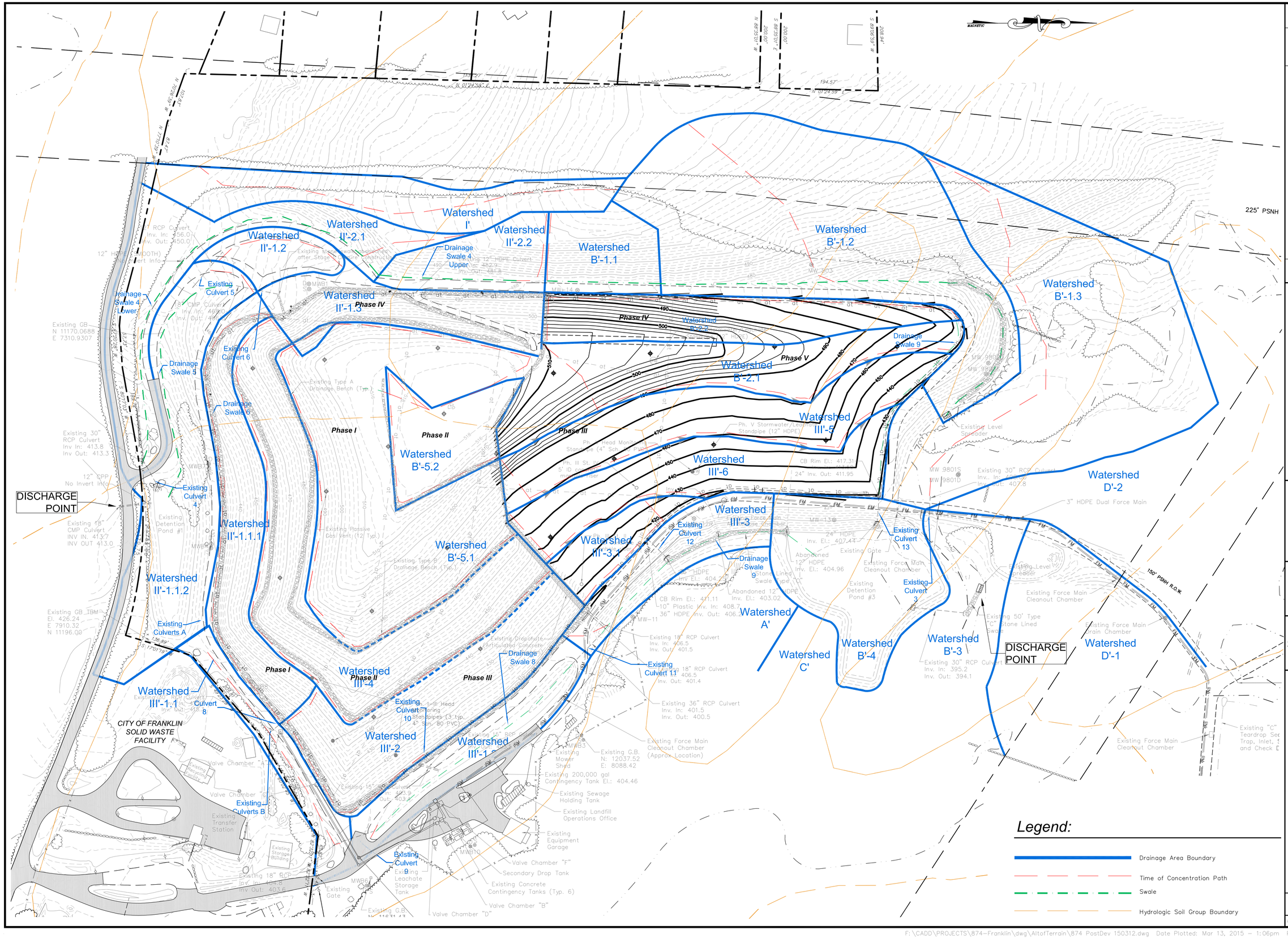
Design Case:
Stage II Closure is constructed and includes a healthy vegetative stand, intermediate drainage benches and toe drain swale functioning as designed. Peak flow results from 25-year/24-hour storm is modeled to confirm performance of system.

- Good vegetative cover established side slopes.
- Existing Detention Pond No. 3 manages run-off from the Stage I & II Closure areas in addition to other areas of the site.

Assumptions:
- Peak flows calculated using CN of 74 for the closed areas.

Conclusions:
- Intermediate drainage benches and toe drain swale size is appropriate to handle peak flows.
- Existing Detention Pond No. 3 is appropriate to manage the flows from the proposed closure area, without any modifications.


Watershed B-1.2
Watershed II-1.2
Watershed II-2.2
Watershed B-1.1
Swale4-Lower
Swale4-Upper
Swale 4
Link-23
Con-4
Watershed II-1.3
Watershed II-2
Watershed B-2.2
Swale 9
Watershed B-1.3
Swale-6
Watershed B-2.1
Watershed III-5
Con-5
Watershed B-5.2
Watershed B-5.1
Watershed III-6
Culvert-13
Con-2
Culvert-4
Pond 1-outlet
Watershed III-3.1
Swale-8-lower
Watershed II-1.1.1
Watershed III-4
Culvert 12
Weir-01
Watershed B-4
Weir-02
Weir-03
Con-3
Watershed II-1.1.2
Swale-8
Link-16
pro culvert
Watershed III-3.2
Watershed III-2
Culvert-11
Culvert-8
Culvert-10
Culvert-9
Swale-7
Watershed III-1.1
Watershed III-1.2



no.	revision	date	by
1	Revised for Stage II Closure Construction (Type II Application)	March 2015	APV

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designed by: PDS/APV
drawn by: APV
approved by: PDS
date: May 2013
project no: 874
file name: 874 PostDev 150312.dwg
scale: 30 60 60 (in feet) 1" = 60'

CRSW/RRC
Franklin Secure Residue Landfill
Franklin, New Hampshire
Stage II Closure Construction
AoT Post-Development Drainage Plan

drawing no. 3

sheet: 3 of 5

F:\CADD\PROJECTS\874-Franklin\dwg\AltofTerrain\874 PostDev 150312.dwg Date Plotted: Mar 13, 2015 - 1:06pm Plotted By: AVARDAKIS

Project Description

File Name 874-Franklin-Post-Development 150312.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Kinematic Wave
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... YES

Analysis Options

Start Analysis On ..... May 14, 2013 00:00:00
End Analysis On ..... May 15, 2013 00:00:00
Start Reporting On ..... May 14, 2013 00:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	22
Nodes	29
Junctions	24
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	3
Links	29
Channels	13
Pipes	13
Pumps	0
Orifices	3
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1	RainGage-01	Time Series	25-yr	Cumulative	inches	None	None	25	4.95	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Watershed B-1.1	0.87	75.90	4.95	2.49	2.16	1.29	0 00:38:39
2	Watershed B-1.2	5.29	68.53	4.95	1.89	9.97	7.52	0 00:21:02
3	Watershed B-1.3	5.48	66.19	4.95	1.71	9.36	7.42	0 00:17:30
4	Watershed B-2.1	2.12	74.00	4.95	2.32	4.93	3.97	0 00:18:36
5	Watershed B-2.2	1.48	74.00	4.95	2.32	3.44	2.35	0 00:28:30
6	Watershed B-4	2.02	56.33	4.95	1.04	2.09	1.78	0 00:08:48
7	Watershed B-5.1	3.47	74.00	4.95	2.32	8.06	8.11	0 00:07:41
8	Watershed B-5.2	1.62	74.00	4.95	2.32	3.76	2.63	0 00:27:12
9	Watershed II-1.1.1	1.42	74.42	4.95	2.36	3.35	2.97	0 00:13:57
10	Watershed II-1.1.2	2.56	52.26	4.95	0.80	2.04	0.53	0 01:38:27
11	Watershed II-1.2	0.44	79.45	4.95	2.80	1.23	1.14	0 00:12:01
12	Watershed II-1.3	1.29	75.40	4.95	2.44	3.15	3.32	0 00:05:00
13	Watershed II-2.1	2.10	74.78	4.95	2.39	5.02	4.71	0 00:11:04
14	Watershed II-2.2	0.87	76.59	4.95	2.55	2.21	2.28	0 00:06:13
15	Watershed III-1.1	0.76	50.20	4.95	0.68	0.52	0.20	0 00:43:17
16	Watershed III-1.2	1.12	84.00	4.95	3.23	3.61	3.70	0 00:05:00
17	Watershed III-2	2.01	74.00	4.95	2.32	4.67	4.91	0 00:05:00
18	Watershed III-3.1	0.56	74.00	4.95	2.32	1.30	1.36	0 00:05:00
19	Watershed III-3.2	1.00	46.40	4.95	0.49	0.49	0.26	0 00:06:06
20	Watershed III-4	3.19	74.00	4.95	2.32	7.41	7.79	0 00:05:00
21	Watershed III-5	2.08	74.00	4.95	2.32	4.83	4.66	0 00:09:50
22	Watershed III-6	1.85	74.00	4.95	2.32	4.31	4.25	0 00:08:46

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-01	Junction	486.00	0.00	0.00	0.00	0.00	2.21	486.42	0.00	0.58	0 00:00	0.00	0.00
2	Jun-02	Junction	480.00	0.00	0.00	0.00	0.00	2.17	482.42	0.00	0.58	0 00:00	0.00	0.00
3	Jun-03	Junction	413.00	0.00	0.00	0.00	0.00	6.78	416.28	0.00	0.72	0 00:00	0.00	0.00
4	Jun-05	Junction	468.00	0.00	0.00	0.00	0.00	3.24	468.48	0.00	1.02	0 00:00	0.00	0.00
5	Jun-06	Junction	450.00	0.00	0.00	0.00	0.00	4.22	450.48	0.00	2.52	0 00:00	0.00	0.00
6	Jun-07	Junction	456.00	0.00	0.00	0.00	0.00	1.14	456.23	0.00	0.77	0 00:00	0.00	0.00
7	Jun-08	Junction	466.50	0.00	0.00	0.00	0.00	3.22	466.97	0.00	2.53	0 00:00	0.00	0.00
8	Jun-13	Junction	404.00	0.00	0.00	0.00	0.00	4.02	406.59	0.00	2.61	0 00:00	0.00	0.00
9	Jun-14	Junction	399.50	415.00	0.00	0.00	0.00	31.69	404.64	0.00	10.36	0 00:00	0.00	0.00
10	Jun-16	Junction	394.94	399.30	395.30	399.30	0.00	5.98	395.58	0.00	3.72	0 00:00	0.00	0.00
11	Jun-17	Junction	406.00	0.00	0.00	0.00	0.00	4.78	406.39	0.00	0.86	0 00:00	0.00	0.00
12	Jun-19	Junction	400.50	405.00	0.00	0.00	0.00	27.69	401.84	0.00	3.16	0 00:00	0.00	0.00
13	Jun-22	Junction	482.00	0.00	0.00	0.00	0.00	1.28	482.31	0.00	0.69	0 00:00	0.00	0.00
14	Jun-23	Junction	408.00	0.00	0.00	0.00	0.00	14.21	409.16	0.00	1.34	0 00:00	0.00	0.00
15	Jun-24	Junction	407.80	0.00	0.00	0.00	0.00	14.22	408.96	0.00	1.34	0 00:00	0.00	0.00
16	Jun-25	Junction	486.00	0.00	0.00	0.00	0.00	1.28	486.31	0.00	0.69	0 00:00	0.00	0.00
17	Jun-26	Junction	440.00	0.00	0.00	0.00	0.00	8.33	440.67	0.00	0.33	0 00:00	0.00	0.00
18	Jun-27	Junction	410.00	0.00	0.00	0.00	0.00	15.44	414.67	0.00	0.33	0 00:00	0.00	0.00
19	Jun-28	Junction	444.00	0.00	0.00	0.00	0.00	2.35	444.17	0.00	1.83	0 00:00	0.00	0.00
20	Jun-29	Junction	411.95	0.00	0.00	0.00	0.00	9.92	417.48	0.00	1.83	0 00:00	0.00	0.00
21	Jun-30	Junction	468.90	0.00	0.00	0.00	0.00	17.99	469.24	0.00	1.16	0 00:00	0.00	0.00
22	Jun-31	Junction	414.60	0.00	0.00	0.00	0.00	2.95	415.44	0.00	1.16	0 00:00	0.00	0.00
23	Jun-32	Junction	0.00	6.00	0.00	6.00	0.00	2.94	415.33	0.00	1.17	0 00:00	0.00	0.00
24	Jun-33	Junction	0.00	6.00	0.00	6.00	0.00	2.96	405.28	0.00	1.02	0 00:00	0.00	0.00
25	Out-02	Outfall	394.00					18.74	402.18					
26	Pond-1	Outfall	413.00					1.44	413.32					
27	Pond 1	Storage Node	412.00	416.00	412.00		0.00	10.60	414.02				0.00	0.00
28	Pond 3	Storage Node	395.00	400.00	395.00		0.00	42.82	398.76				0.00	0.00
29	Swale-8	Storage Node	402.00	405.00	0.00		0.00	10.59	402.66				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Con-2	Pipe	Jun-23	Jun-24	38.00	408.00	407.80	0.5300	30.000	0.0120	14.22	32.24	0.44	6.36	1.16	0.46	0.00	Calculated
2	Culvert 12	Pipe	Jun-13	Jun-14	52.00	406.20	404.25	3.7500	36.000	0.0150	4.02	111.94	0.04	7.49	0.39	0.13	0.00	Calculated
3	Culvert-10	Pipe	Jun-17	Swale-8	42.00	403.50	403.00	1.1900	15.000	0.0200	4.77	22.44	0.21	7.26	0.39	0.31	0.00	Calculated
4	Culvert-11	Pipe	Swale-8	Jun-19	84.00	402.00	400.50	1.7900	36.000	0.0120	10.17	96.56	0.11	8.87	0.64	0.22	0.00	Calculated
5	Culvert-13	Pipe	Jun-29	Pond 3	48.00	411.95	407.44	9.4000	24.000	0.0100	9.92	90.15	0.11	18.89	0.45	0.22	0.00	Calculated
6	Culvert-4	Pipe	Jun-03	Pond 1	57.00	413.80	413.30	0.8800	30.000	0.0130	6.78	38.42	0.18	5.89	0.71	0.28	0.00	Calculated
7	CuLvert-5	Pipe	Jun-07	Jun-06	91.00	456.00	450.00	6.5900	12.000	0.0120	1.13	9.91	0.11	8.39	0.23	0.23	0.00	Calculated
8	Culvert-6	Pipe	Jun-05	Jun-08	88.00	468.00	466.50	1.7000	18.000	0.0120	3.22	14.86	0.22	6.73	0.48	0.32	0.00	Calculated
9	Culvert-8	Pipe	Jun-31	Jun-32	33.00	414.60	414.50	0.3000	24.000	0.0200	2.94	8.09	0.36	2.38	0.83	0.42	0.00	Calculated
10	Culvert-9	Pipe	Jun-33	Swale-8	77.00	404.80	403.60	1.5600	18.000	0.0130	2.95	13.11	0.23	5.99	0.47	0.32	0.00	Calculated
11	Link-16	Pipe	Jun-16	Out-02	97.00	394.94	394.10	0.8700	30.000	0.0120	5.98	41.35	0.14	5.99	0.64	0.26	0.00	Calculated
12	Pond 1-outlet	Pipe	Pond 1	Pond-1	36.70	413.70	413.00	1.9100	18.000	0.0130	1.44	14.51	0.10	5.24	0.32	0.21	0.00	Calculated
13	pro culvert	Pipe	Jun-30	Jun-19	50.00	405.40	401.50	7.8000	18.000	0.0100	17.99	158.55	0.11	50.00	0.34	0.23	0.00	Calculated
14	Con-3	Channel	Jun-24	Out-02	175.00	407.80	402.00	3.3100	12.000	0.0320	14.21	269.80	0.05	2.61	0.18	0.18	0.00	
15	Con-4	Channel	Jun-22	Jun-26	567.00	482.00	440.00	7.4100	12.000	0.0320	1.28	33.78	0.04	3.60	0.22	0.22	0.00	
16	Con-5	Channel	Jun-27	Jun-23	692.59	410.00	408.00	0.2900	24.000	0.0700	14.21	89.10	0.16	0.88	0.71	0.36	0.00	
17	Link-23	Channel	Jun-08	Jun-06	88.00	466.50	450.00	18.7500	36.000	0.0320	3.21	791.16	0.00	6.47	0.27	0.09	0.00	
18	Swale 4	Channel	Jun-25	Jun-22	220.00	486.00	482.00	1.8200	12.000	0.0320	1.28	16.73	0.08	2.16	0.31	0.31	0.00	
19	Swale 4 Lower	Channel	Jun-26	Jun-27	380.00	440.00	414.00	6.8400	12.000	0.0500	8.29	20.78	0.40	4.13	0.67	0.67	0.00	
20	Swale 9	Channel	Jun-28	Jun-29	395.00	444.00	417.31	6.7600	24.000	0.0100	2.34	387.71	0.01	10.01	0.17	0.09	0.00	
21	Swale4-Lower	Channel	Jun-02	Jun-03	875.00	480.00	416.00	7.3100	12.000	0.0320	2.12	33.56	0.06	4.20	0.28	0.28	0.00	
22	Swale4-Upper	Channel	Jun-01	Jun-02	273.00	486.00	482.00	1.4700	12.000	0.0320	2.17	15.02	0.14	2.31	0.42	0.42	0.00	
23	Swale-6	Channel	Jun-06	Pond 1	426.00	450.00	416.00	7.9800	12.000	0.0320	4.19	17.02	0.25	5.94	0.48	0.48	0.00	
24	Swale-7	Channel	Jun-32	Jun-33	256.00	414.50	404.80	3.7900	12.000	0.0320	2.92	24.16	0.12	3.52	0.38	0.39	0.00	
25	Swale-8	Channel	Jun-19	Jun-14	192.00	400.50	399.75	0.3900	36.000	0.0400	27.51	302.35	0.09	1.83	0.82	0.28	0.00	
26	Swale-8-lower	Channel	Jun-14	Pond 3	243.00	399.75	395.05	1.9300	48.000	0.0400	31.63	1206.44	0.03	3.24	0.56	0.14	0.00	
27	Weir-01	Orifice	Pond 3	Jun-16		395.00	394.94		5.000		0.98							
28	Weir-02	Orifice	Pond 3	Jun-16		395.00	394.94		15.000		5.00							
29	Weir-03	Orifice	Pond 3	Jun-16		395.00	394.94		36.000		0.00							

Subbasin Hydrology

Subbasin : Watershed B-1.1

Input Data

Area (ac) 0.87
Weighted Curve Number 75.90
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	0.76	C	74.00
Gravel roads	0.11	C	89.00
Composite Area & Weighted CN	0.87		75.90

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.3	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	.4	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.04	0.00	0.00
Computed Flow Time (min) :	38.06	0.00	0.00

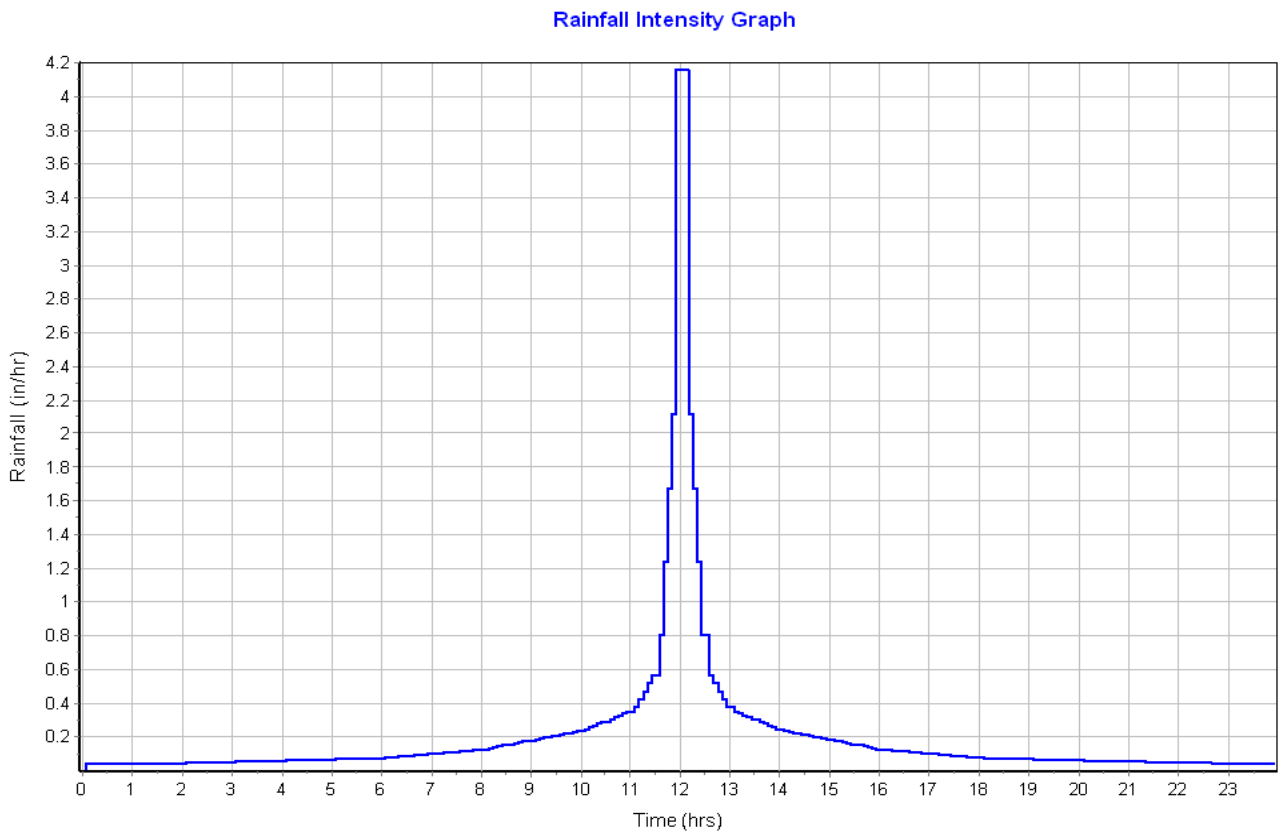
Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	34	0.00	0.00
Slope (%) :	.35	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	0.95	0.00	0.00
Computed Flow Time (min) :	0.60	0.00	0.00

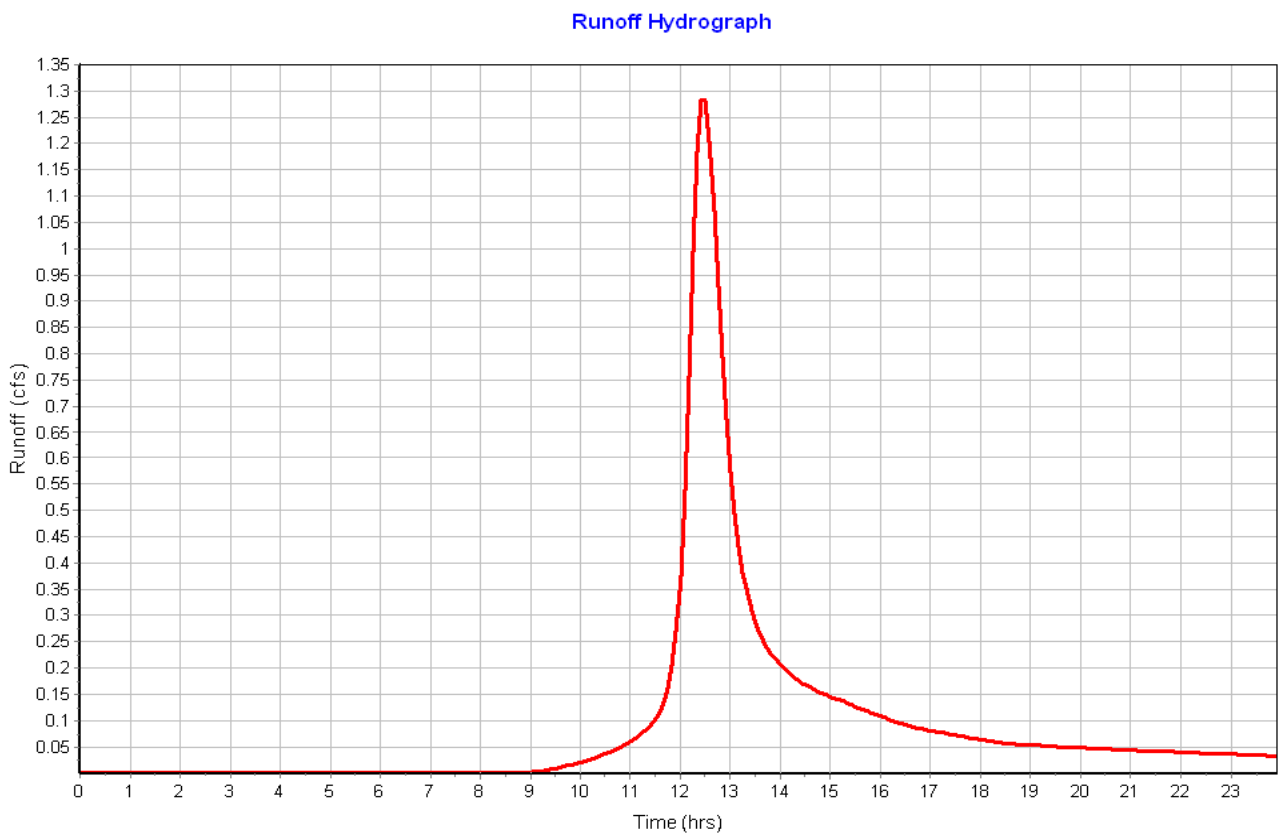
Total TOC (min) 38.65

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.49
Peak Runoff (cfs) 1.29
Weighted Curve Number 75.90
Time of Concentration (days hh:mm:ss) 0 00:38:39

Subbasin : Watershed B-1.1





Subbasin : Watershed B-1.2

Input Data

Area (ac) 5.29
Weighted Curve Number 68.53
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Brush, Good	3.73	C	65.00
> 75% grass cover, Good	1.25	C	74.00
Gravel roads	0.31	C	89.00
Composite Area & Weighted CN	5.29		68.53

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	4	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.09	0.00	0.00
Computed Flow Time (min) :	19.07	0.00	0.00

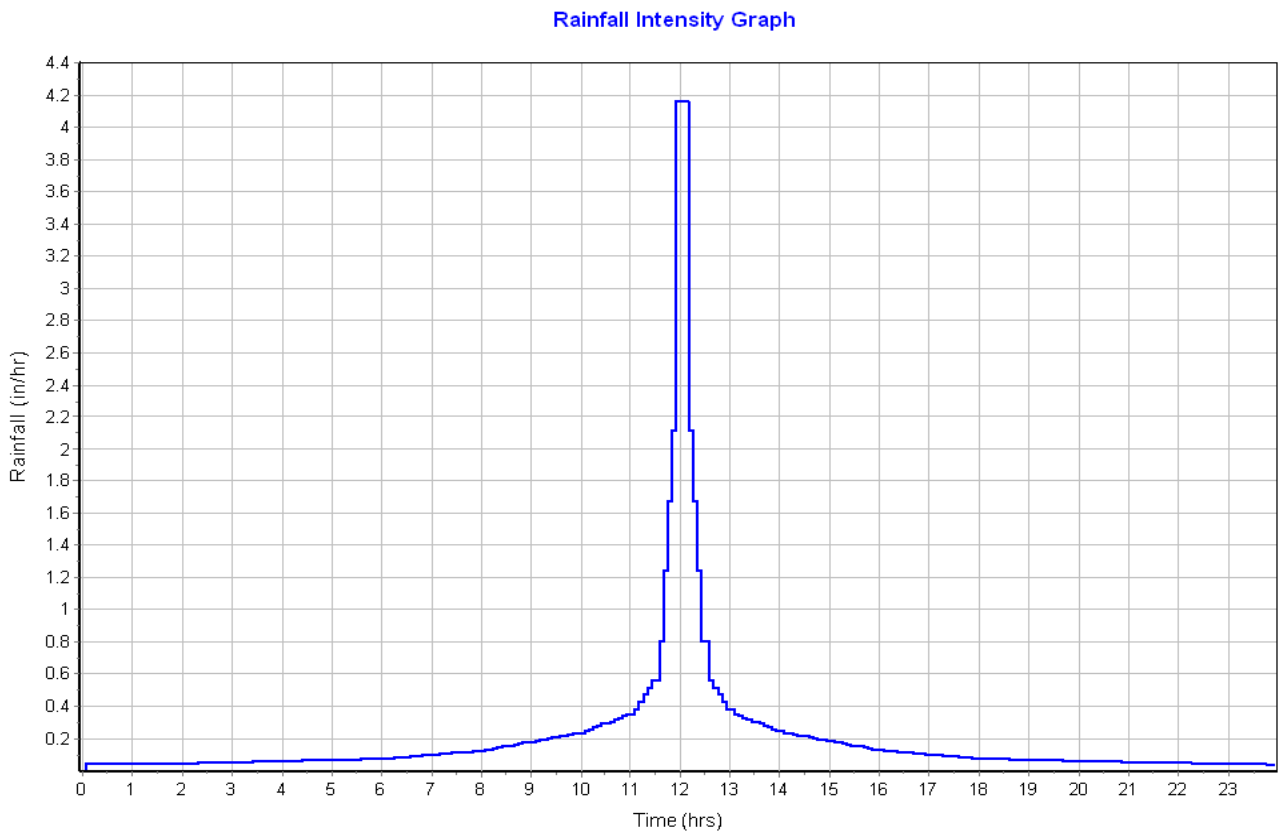
Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	250	0.00	0.00
Slope (%) :	18	0.00	0.00
Surface Type :	Woodland	Unpaved	Unpaved
Velocity (ft/sec) :	2.12	0.00	0.00
Computed Flow Time (min) :	1.97	0.00	0.00

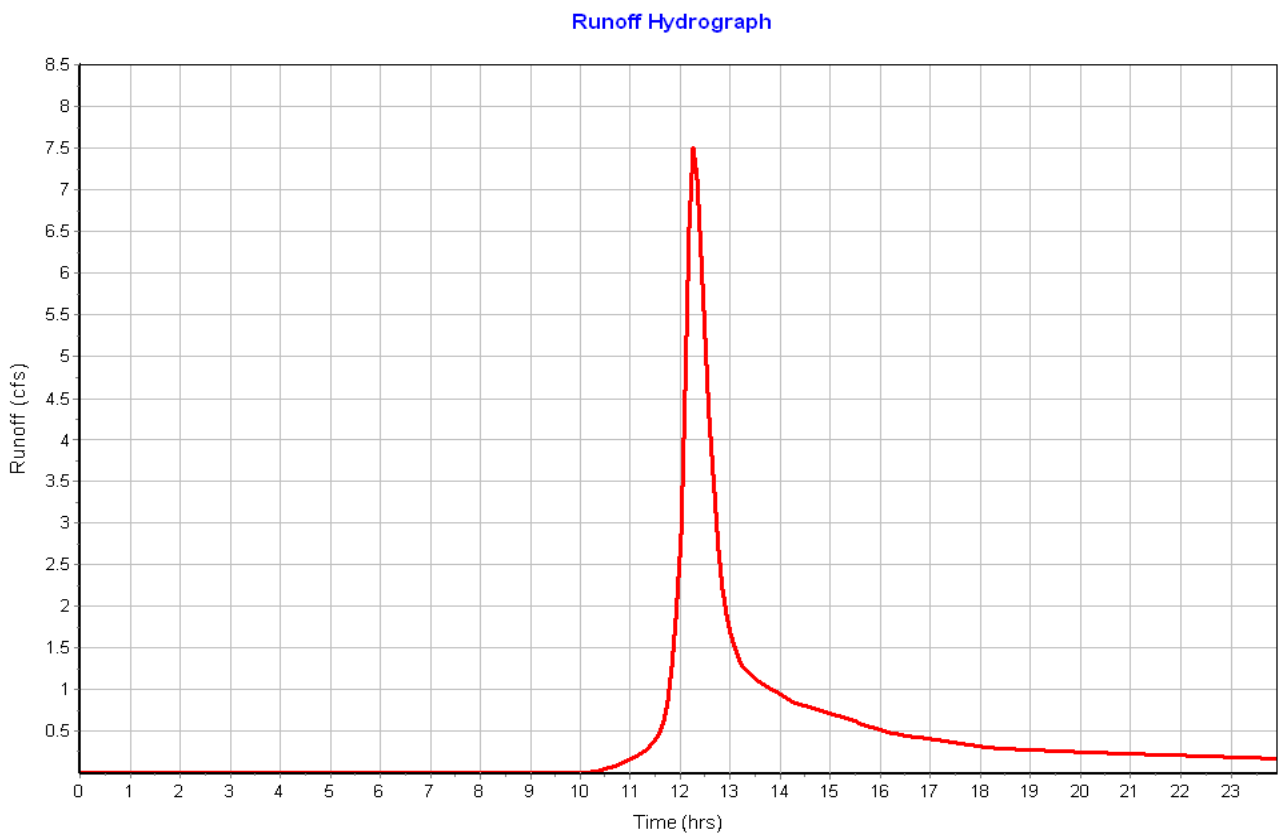
Total TOC (min) 21.04

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 1.89
Peak Runoff (cfs) 7.52
Weighted Curve Number 68.53
Time of Concentration (days hh:mm:ss) 0 00:21:02

Subbasin : Watershed B-1.2





Subbasin : Watershed B-1.3

Input Data

Area (ac) 5.48
Weighted Curve Number 66.19
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	0.30	C	74.00
Gravel roads	0.16	C	89.00
Brush, Good	5.02	C	65.00
Composite Area & Weighted CN	5.48		66.19

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.3	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	8	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.15	0.00	0.00
Computed Flow Time (min) :	11.48	0.00	0.00

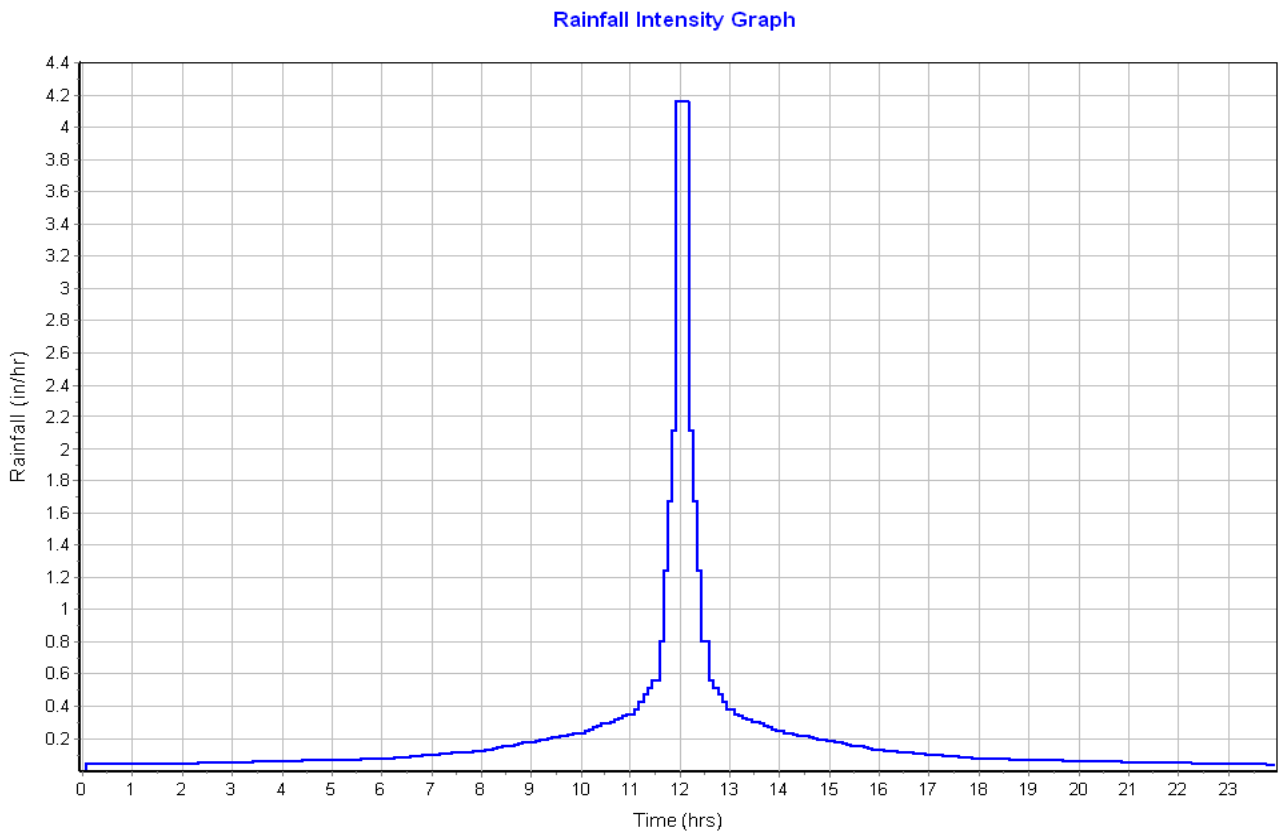
Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	640	0.00	0.00
Slope (%) :	12.5	0.00	0.00
Surface Type :	Woodland	Unpaved	Unpaved
Velocity (ft/sec) :	1.77	0.00	0.00
Computed Flow Time (min) :	6.03	0.00	0.00

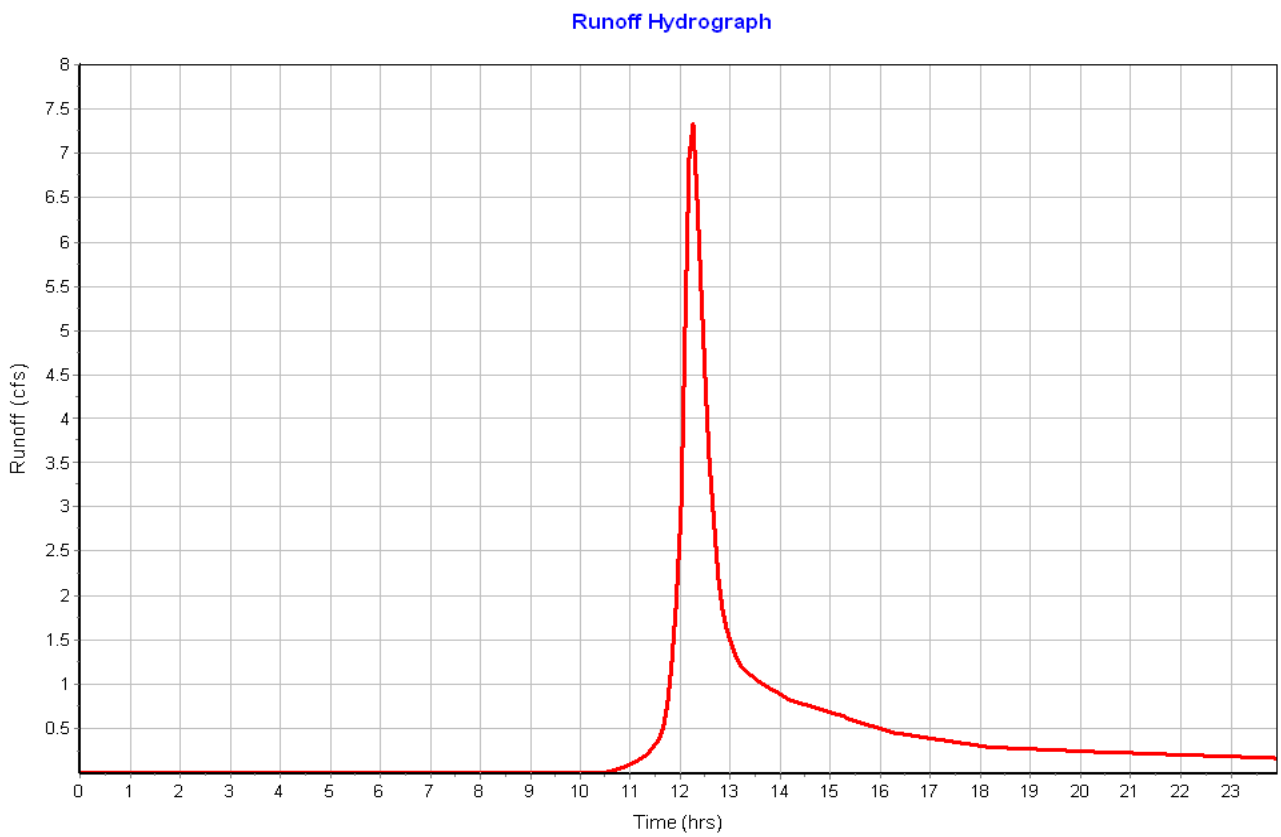
Total TOC (min) 17.51

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 1.71
Peak Runoff (cfs) 7.42
Weighted Curve Number 66.19
Time of Concentration (days hh:mm:ss) 0 00:17:31

Subbasin : Watershed B-1.3





Subbasin : Watershed B-2.1

Input Data

Area (ac) 2.12
Weighted Curve Number 74.00
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good, Cap	2.12	C	74.00
Composite Area & Weighted CN	2.12		74.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	5	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.10	0.00	0.00
Computed Flow Time (min) :	17.44	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	75	0.00	0.00
Slope (%) :	25	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	3.50	0.00	0.00
Computed Flow Time (min) :	0.36	0.00	0.00

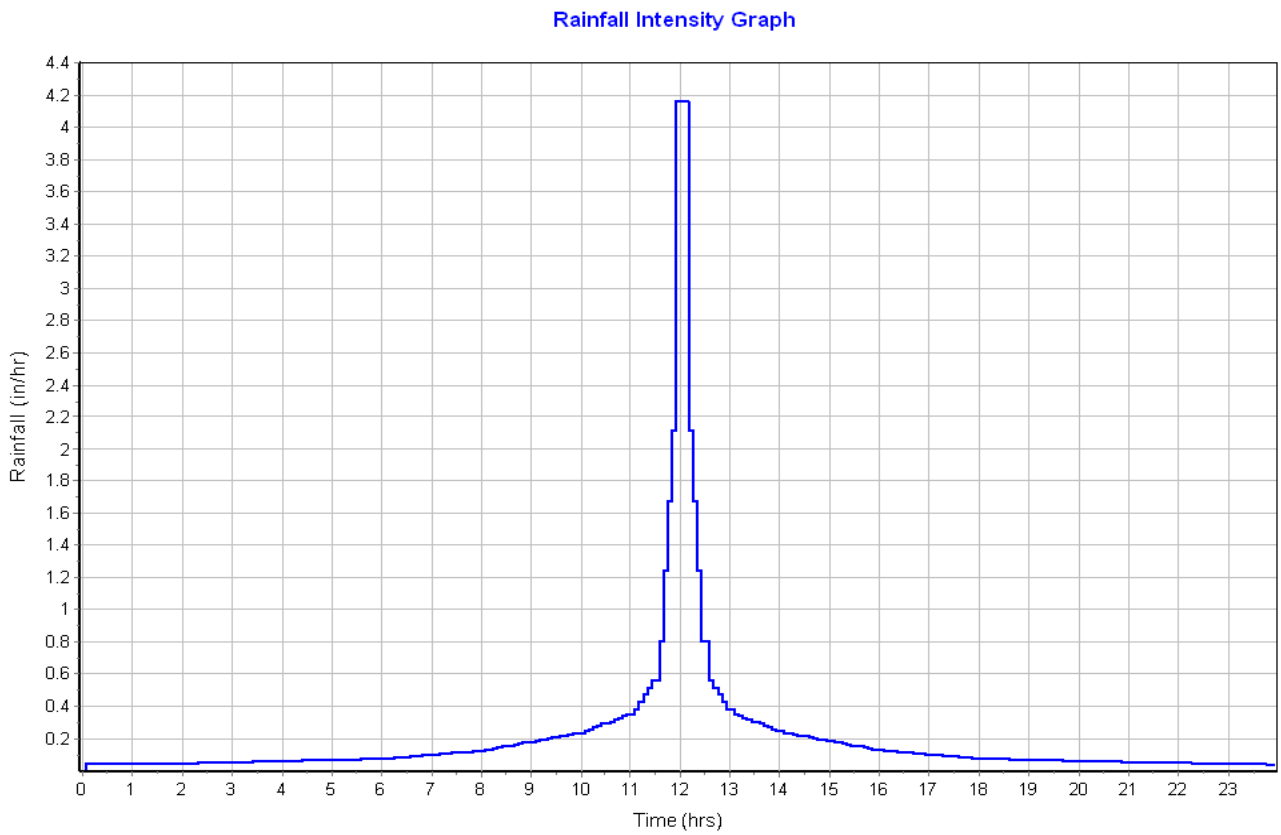
Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.033	.033	0.00
Flow Length (ft) :	450	310	0.00
Channel Slope (%) :	3	13	0.00
Cross Section Area (ft^2) :	4	4	0.00
Wetted Perimeter (ft) :	2	2	0.00
Velocity (ft/sec) :	12.41	25.84	0.00
Computed Flow Time (min) :	0.60	0.20	0.00

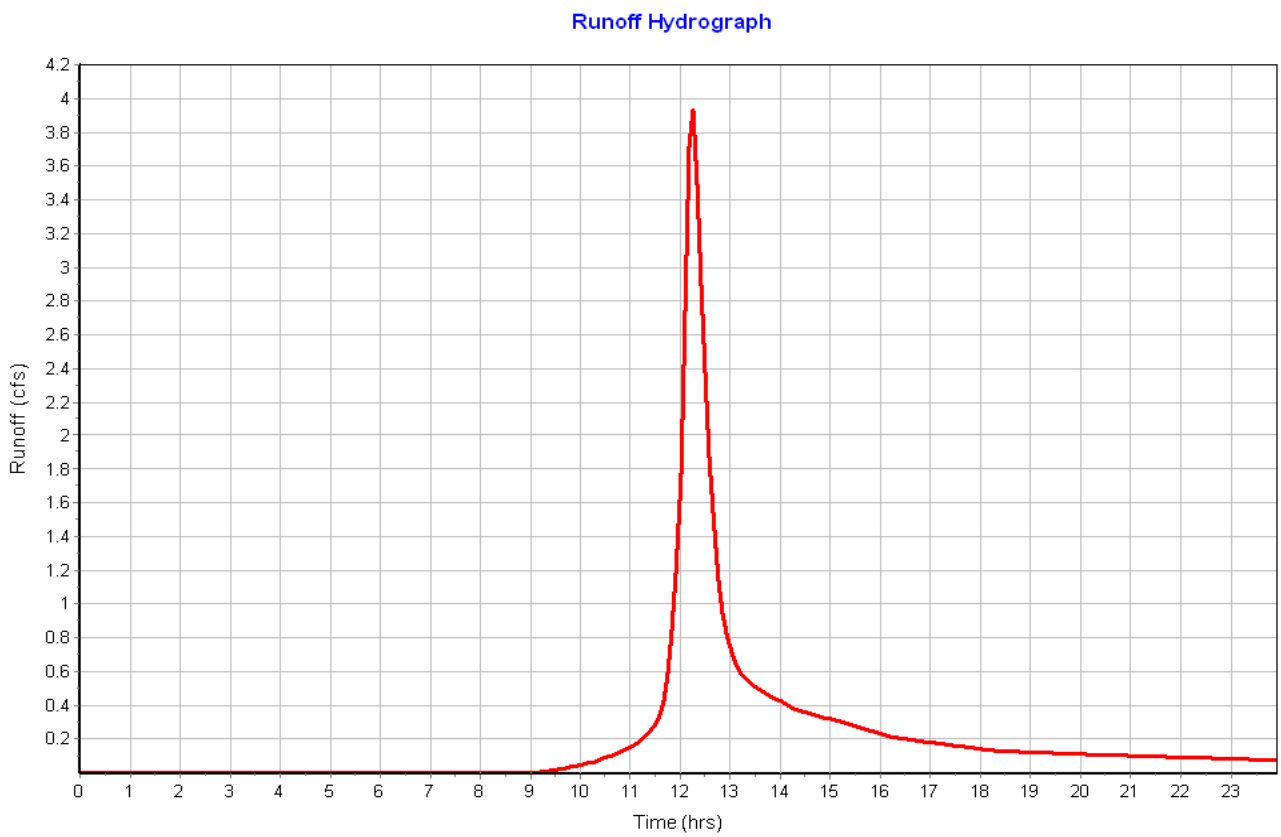
Total TOC (min) 18.60

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.32
Peak Runoff (cfs) 3.97
Weighted Curve Number 74.00
Time of Concentration (days hh:mm:ss) 0 00:18:36

Subbasin : Watershed B-2.1





Subbasin : Watershed B-2.2

Input Data

Area (ac) 1.48
Weighted Curve Number 74.00
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good, Cap	1.48	C	74.00
Composite Area & Weighted CN	1.48		74.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	95	0.00	0.00
Slope (%) :	33	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.20	0.00	0.00
Computed Flow Time (min) :	7.87	0.00	0.00

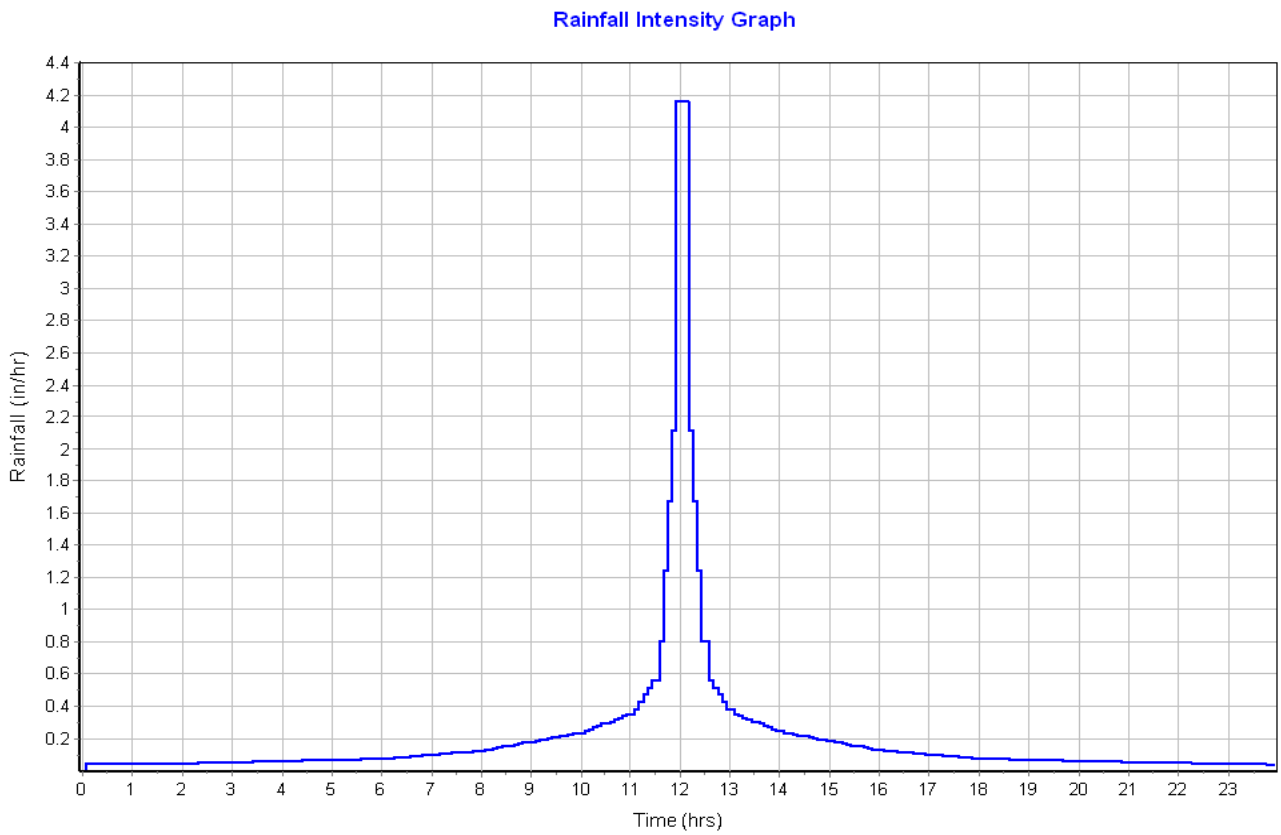
Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	820	0.00	0.00
Channel Slope (%) :	1.6	0.00	0.00
Cross Section Area (ft²) :	10	0.00	0.00
Wetted Perimeter (ft) :	6	0.00	0.00
Velocity (ft/sec) :	0.66	0.00	0.00
Computed Flow Time (min) :	20.63	0.00	0.00

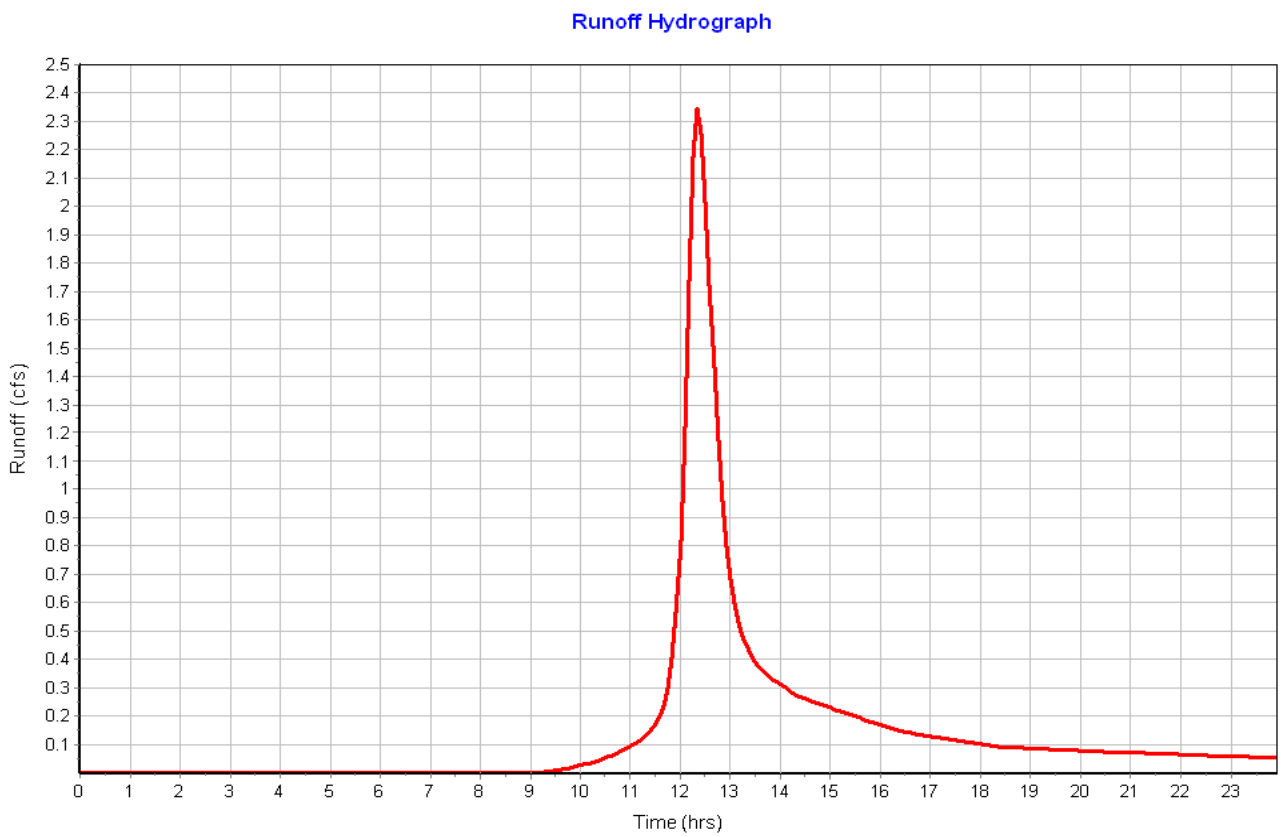
Total TOC (min) 28.50

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.32
Peak Runoff (cfs) 2.35
Weighted Curve Number 74.00
Time of Concentration (days hh:mm:ss) 0 00:28:30

Subbasin : Watershed B-2.2





Subbasin : Watershed B-4

Input Data

Area (ac) 2.02
Weighted Curve Number 56.33
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	1.00	C	74.00
> 75% grass cover, Good	1.02	A	39.00
Composite Area & Weighted CN	2.02		56.33

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.3	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	16	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.19	0.00	0.00
Computed Flow Time (min) :	8.70	0.00	0.00

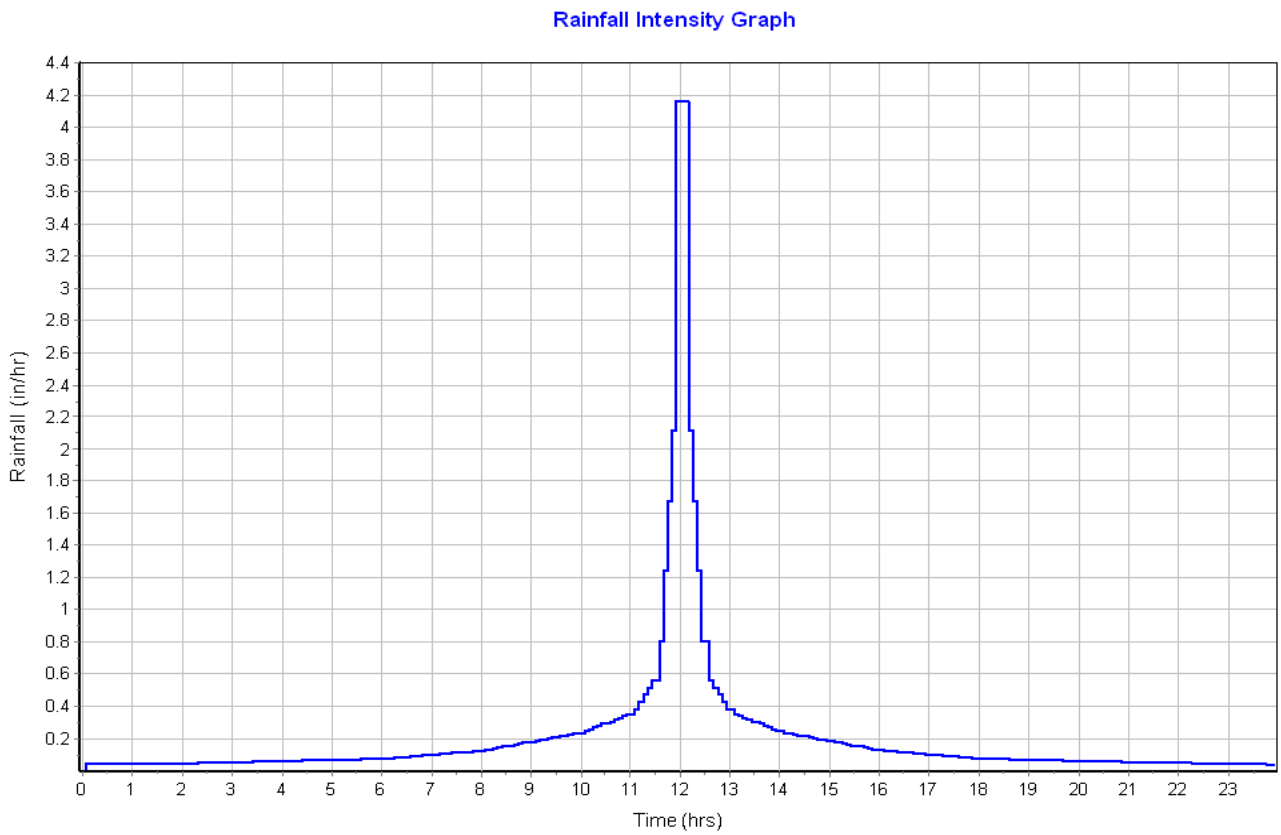
Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	20	0.00	0.00
Slope (%) :	4	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.23	0.00	0.00
Computed Flow Time (min) :	0.10	0.00	0.00

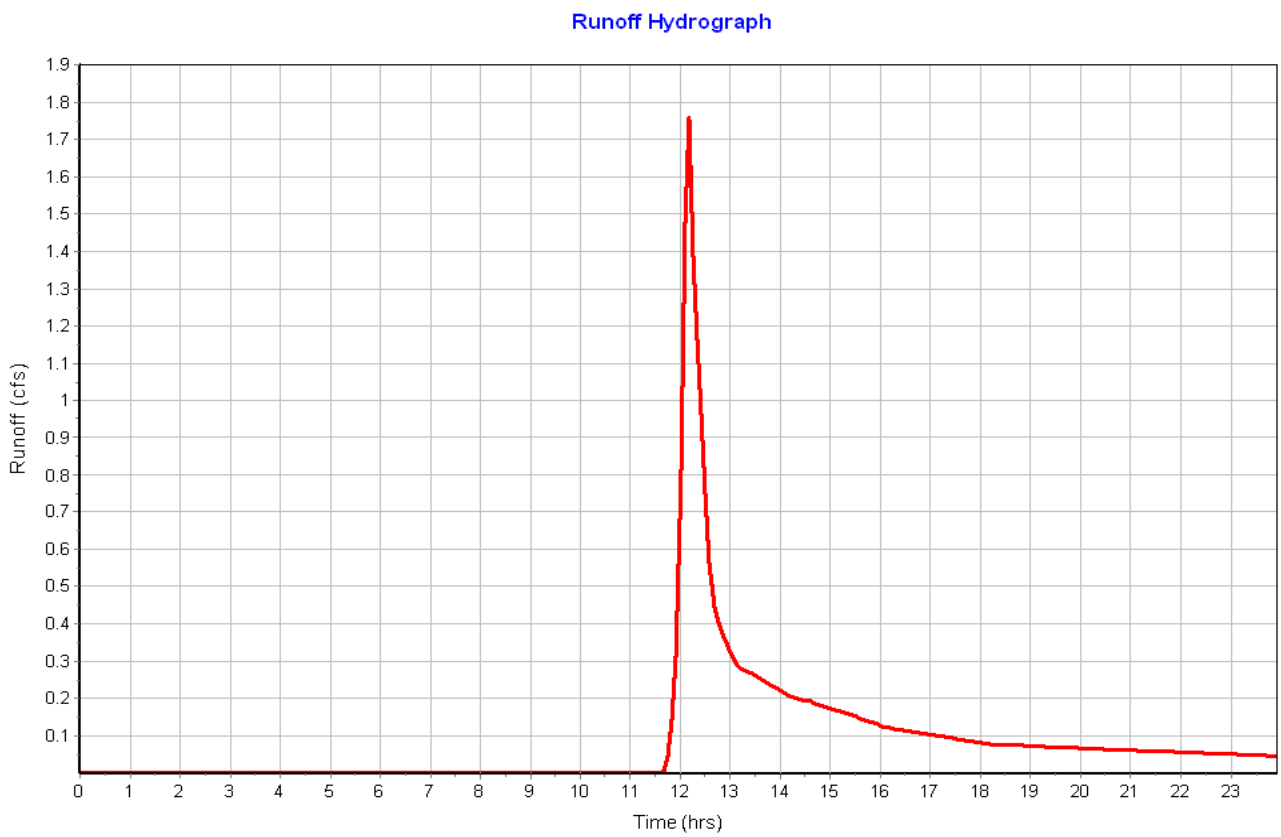
Total TOC (min) 8.81

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 1.04
Peak Runoff (cfs) 1.78
Weighted Curve Number 56.33
Time of Concentration (days hh:mm:ss) 0 00:08:49

Subbasin : Watershed B-4





Subbasin : Watershed B-5.1

Input Data

Area (ac) 3.47
Weighted Curve Number 74.00
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good, Cap	3.47	C	74.00
Composite Area & Weighted CN	3.47		74.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.032	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	2	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.50	0.00	0.00
Computed Flow Time (min) :	3.34	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	106	0.00	0.00
Slope (%) :	10	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	5.10	0.00	0.00
Computed Flow Time (min) :	0.35	0.00	0.00

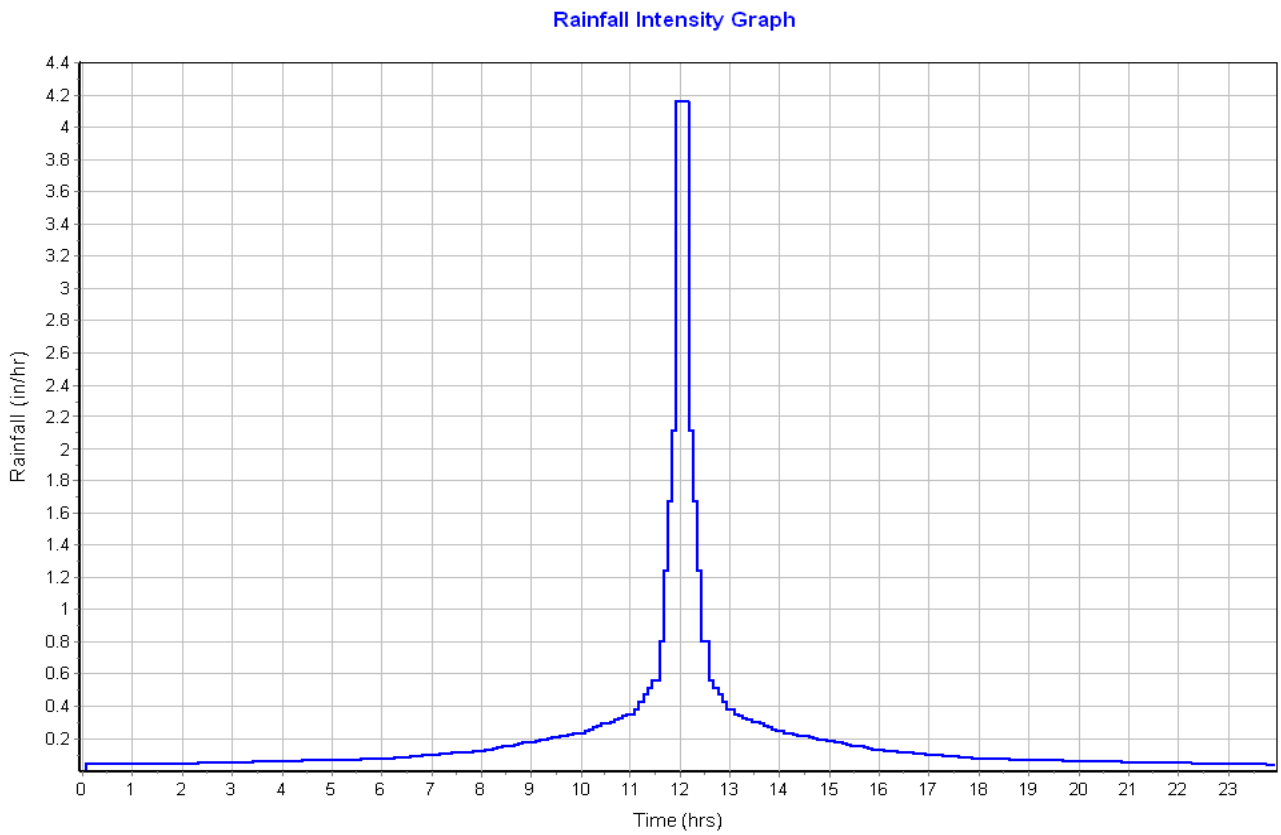
Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.033	0.00	0.00
Flow Length (ft) :	1528	0.00	0.00
Channel Slope (%) :	5	0.00	0.00
Cross Section Area (ft^2) :	2	0.00	0.00
Wetted Perimeter (ft) :	4	0.00	0.00
Velocity (ft/sec) :	6.36	0.00	0.00
Computed Flow Time (min) :	4.00	0.00	0.00

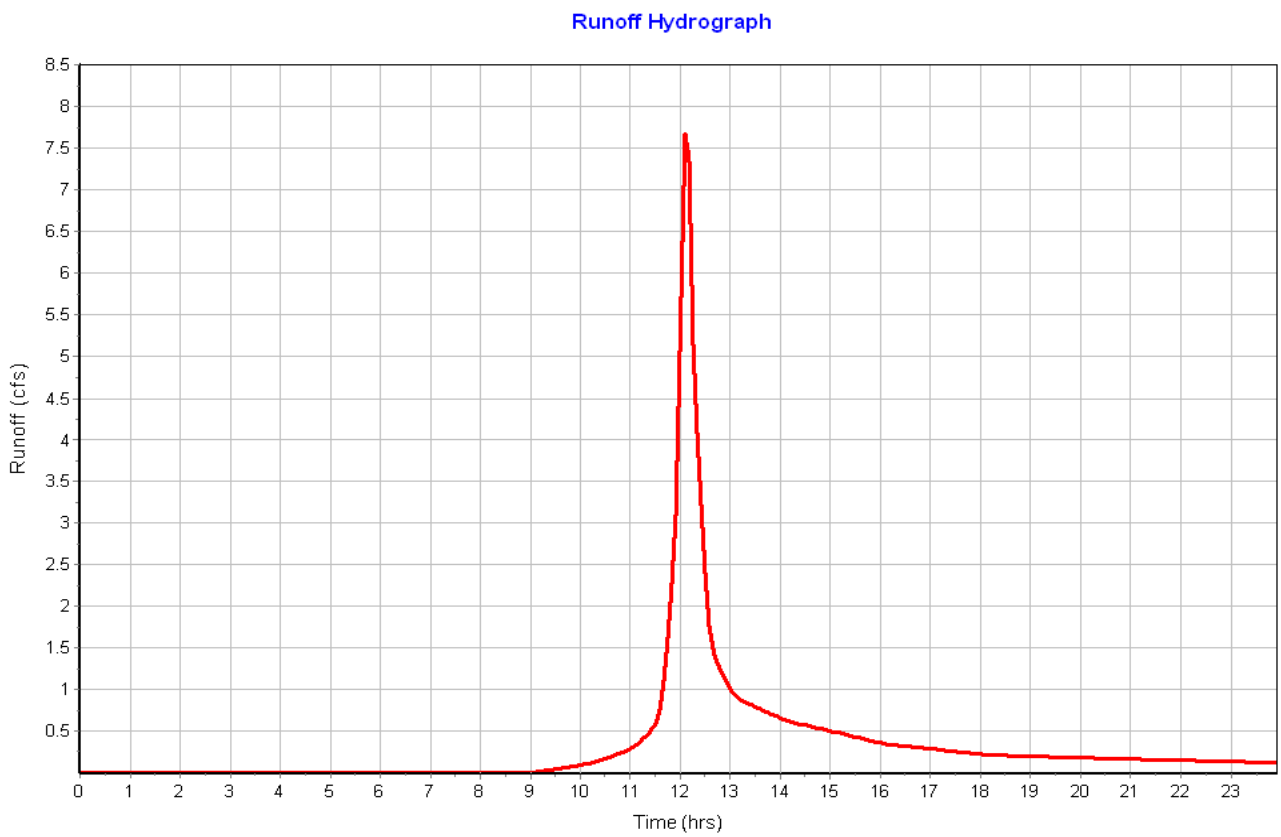
Total TOC (min) 7.69

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.32
Peak Runoff (cfs) 8.11
Weighted Curve Number 74.00
Time of Concentration (days hh:mm:ss) 0 00:07:41

Subbasin : Watershed B-5.1





Subbasin : Watershed B-5.2

Input Data

Area (ac) 1.62
Weighted Curve Number 74.00
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good, Capped	1.62	C	74.00
Composite Area & Weighted CN	1.62		74.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	2	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.07	0.00	0.00
Computed Flow Time (min) :	25.17	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	40	0.00	0.00
Slope (%) :	2	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.28	0.00	0.00
Computed Flow Time (min) :	0.29	0.00	0.00

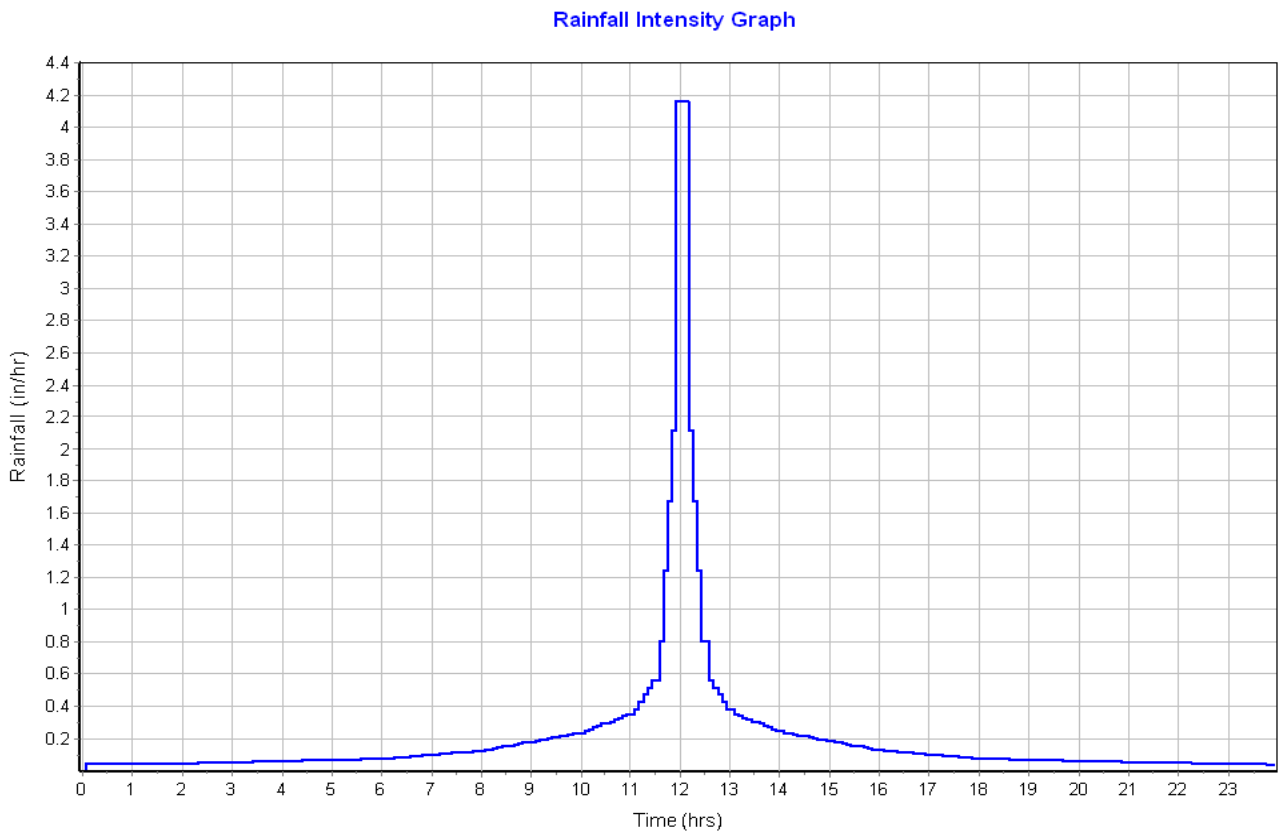
Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.033	0.00	0.00
Flow Length (ft) :	663	0.00	0.00
Channel Slope (%) :	5	0.00	0.00
Cross Section Area (ft^2) :	2	0.00	0.00
Wetted Perimeter (ft) :	4	0.00	0.00
Velocity (ft/sec) :	6.36	0.00	0.00
Computed Flow Time (min) :	1.74	0.00	0.00

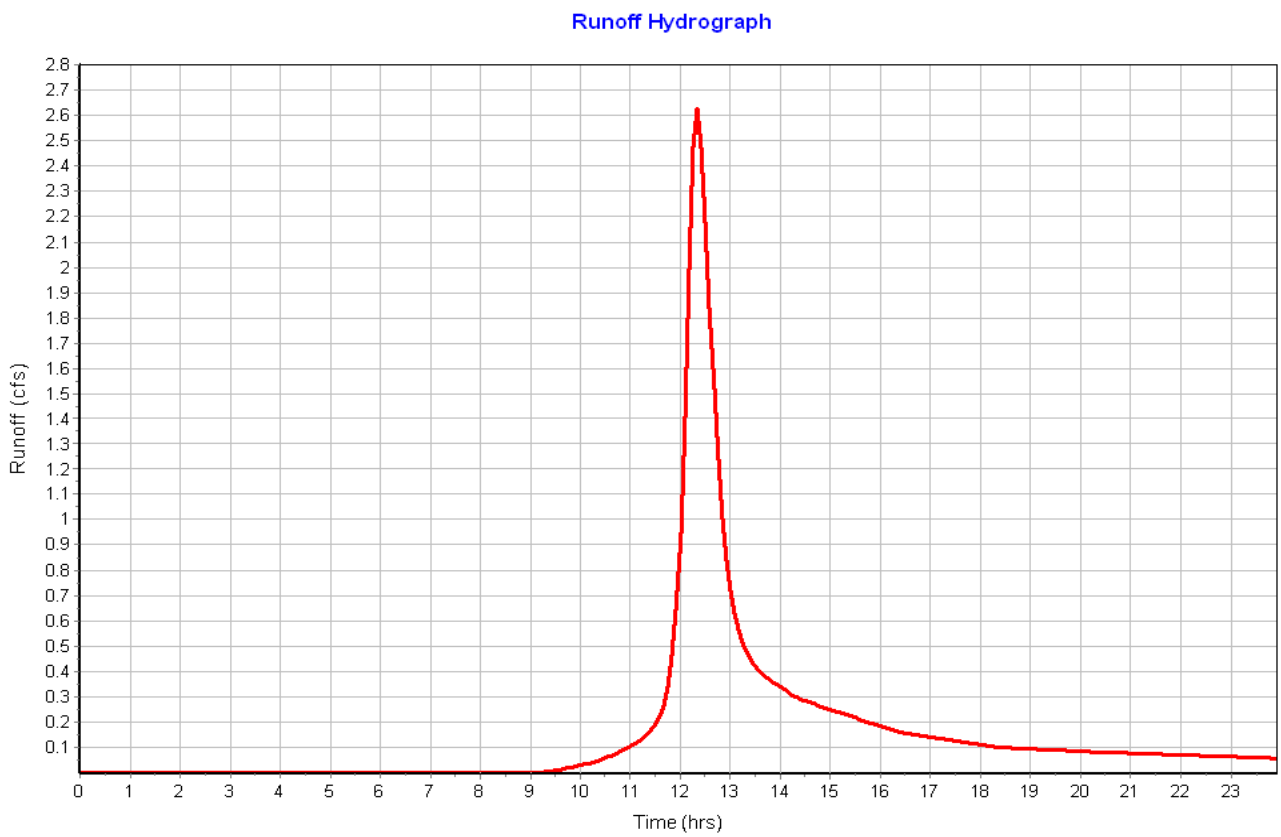
Total TOC (min) 27.20

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.32
Peak Runoff (cfs) 2.63
Weighted Curve Number 74.00
Time of Concentration (days hh:mm:ss) 0 00:27:12

Subbasin : Watershed B-5.2





Subbasin : Watershed II-1.1.1

Input Data

Area (ac) 1.42
Weighted Curve Number 74.42
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.04	C	89.00
> 75% grass cover, Good, Cap	1.38	C	74.00
Composite Area & Weighted CN	1.42		74.42

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	10	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.13	0.00	0.00
Computed Flow Time (min) :	13.22	0.00	0.00

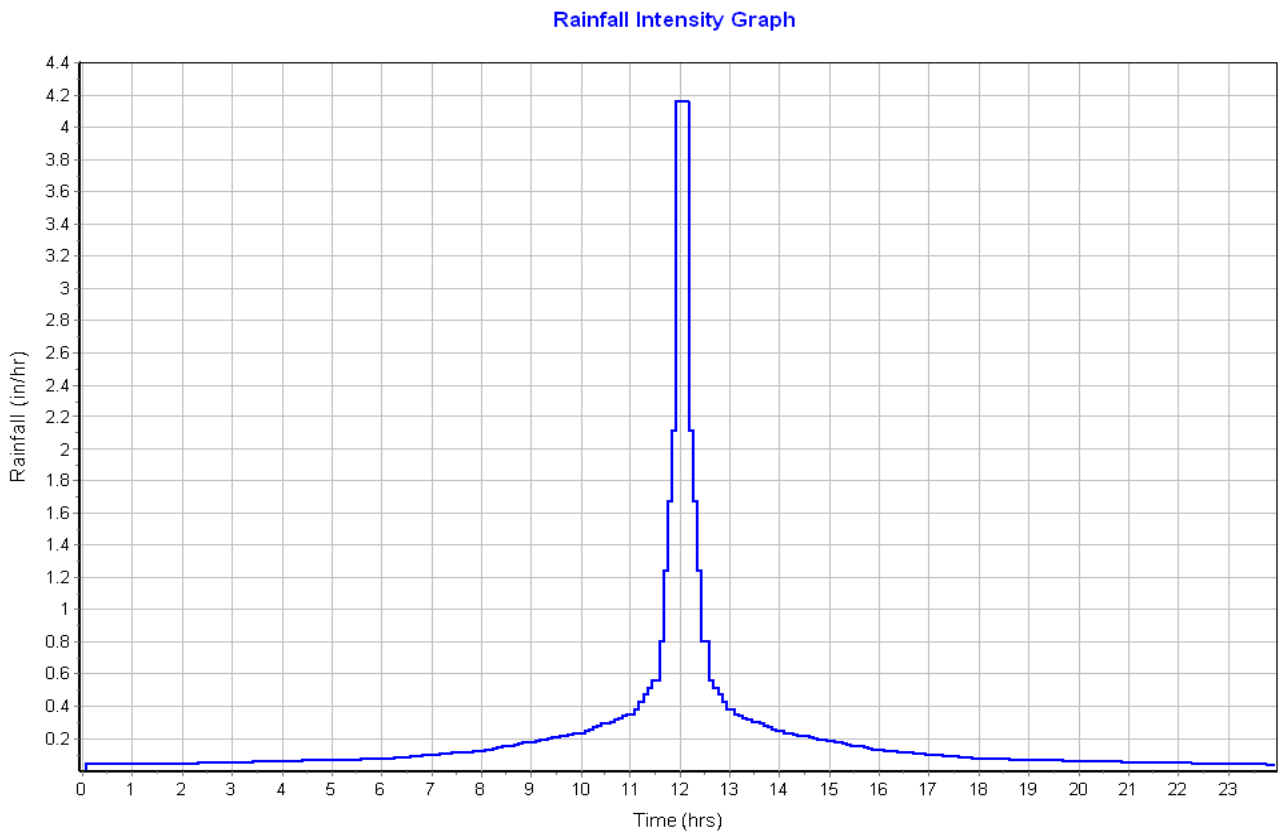
Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0.00	0.00
Flow Length (ft) :	826	0.00	0.00
Channel Slope (%) :	7	0.00	0.00
Cross Section Area (ft^2) :	10	0.00	0.00
Wetted Perimeter (ft) :	6	0.00	0.00
Velocity (ft/sec) :	18.47	0.00	0.00
Computed Flow Time (min) :	0.75	0.00	0.00

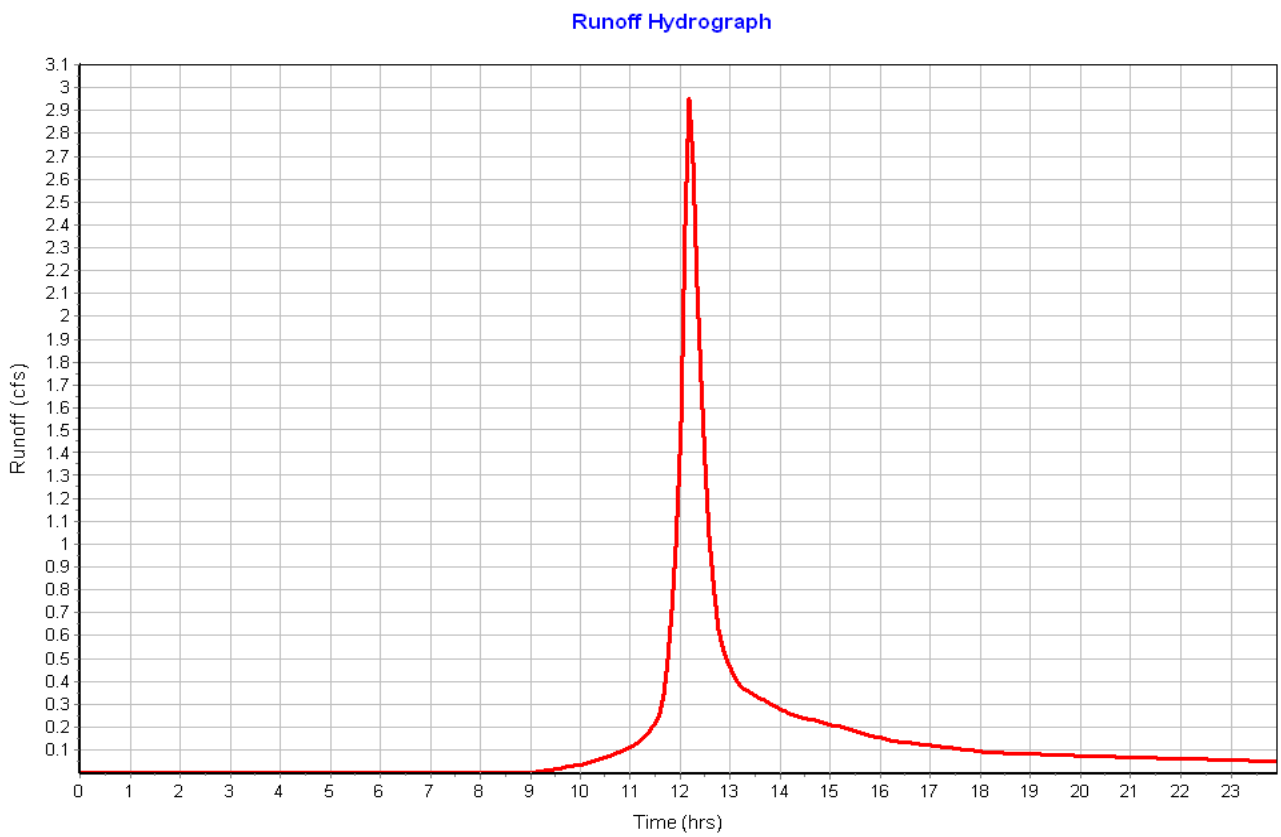
Total TOC (min) 13.96

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.36
Peak Runoff (cfs) 2.97
Weighted Curve Number 74.42
Time of Concentration (days hh:mm:ss) 0 00:13:58

Subbasin : Watershed II-1.1.1





Subbasin : Watershed II-1.1.2

Input Data

Area (ac) 2.56
Weighted Curve Number 52.26
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	1.61	A	39.00
Gravel roads	0.35	A	76.00
> 75% grass cover, Good	0.60	C	74.00
Composite Area & Weighted CN	2.56		52.26

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.3	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	.1	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.03	0.00	0.00
Computed Flow Time (min) :	66.26	0.00	0.00

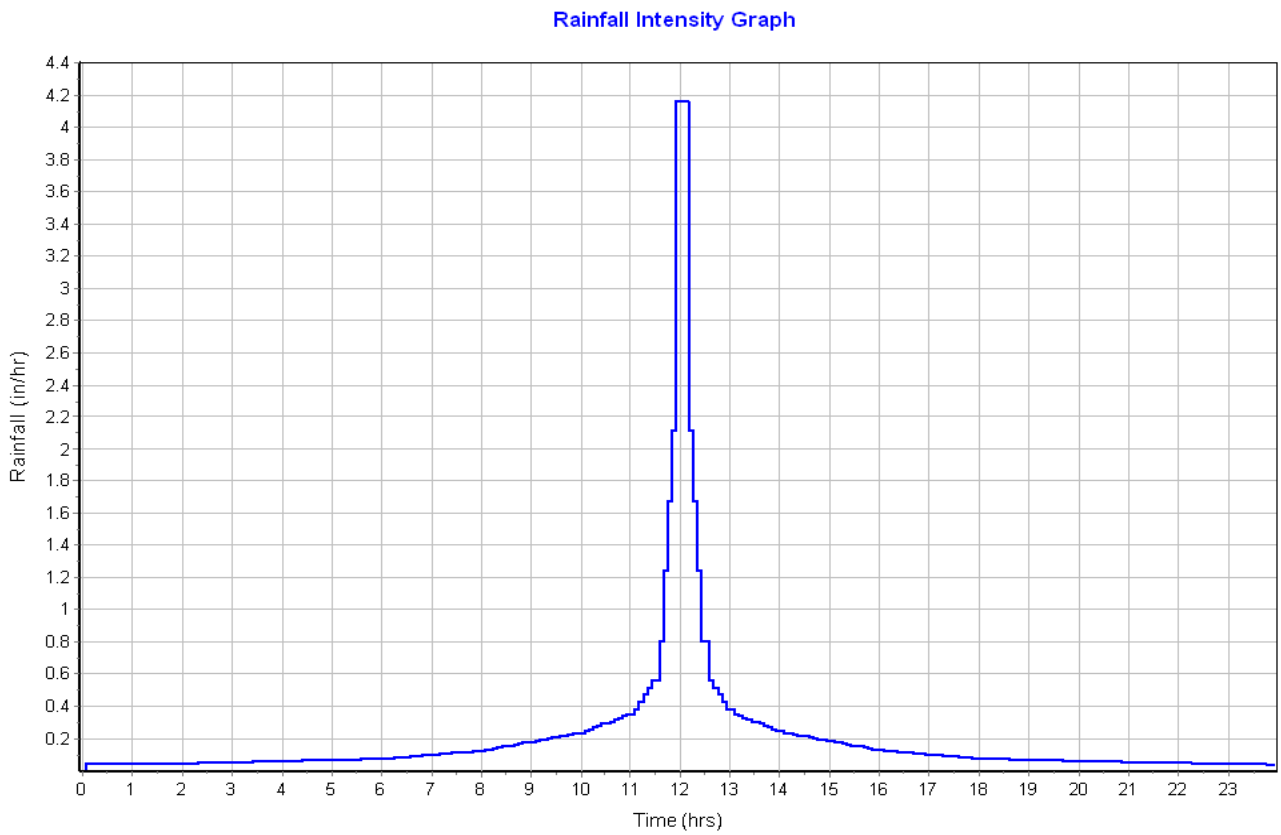
Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	425	0.00	0.00
Slope (%) :	.1	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	0.22	0.00	0.00
Computed Flow Time (min) :	32.20	0.00	0.00

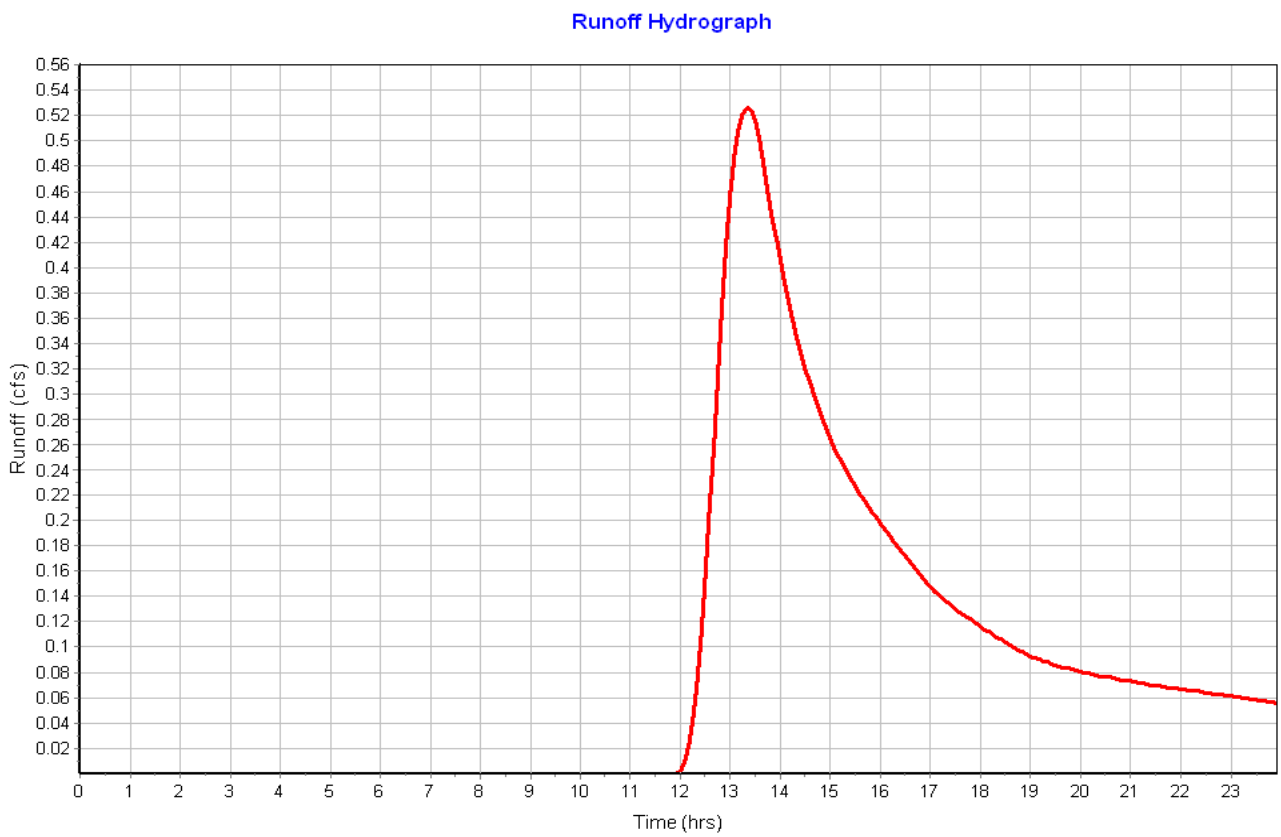
Total TOC (min) 98.46

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 0.80
Peak Runoff (cfs) 0.53
Weighted Curve Number 52.26
Time of Concentration (days hh:mm:ss) 0 01:38:28

Subbasin : Watershed II-1.1.2





Subbasin : Watershed II-1.2

Input Data

Area (ac) 0.44
Weighted Curve Number 79.45
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	0.28	C	74.00
Gravel roads	0.16	C	89.00
Composite Area & Weighted CN	0.44		79.45

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.3	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	8	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.15	0.00	0.00
Computed Flow Time (min) :	11.48	0.00	0.00

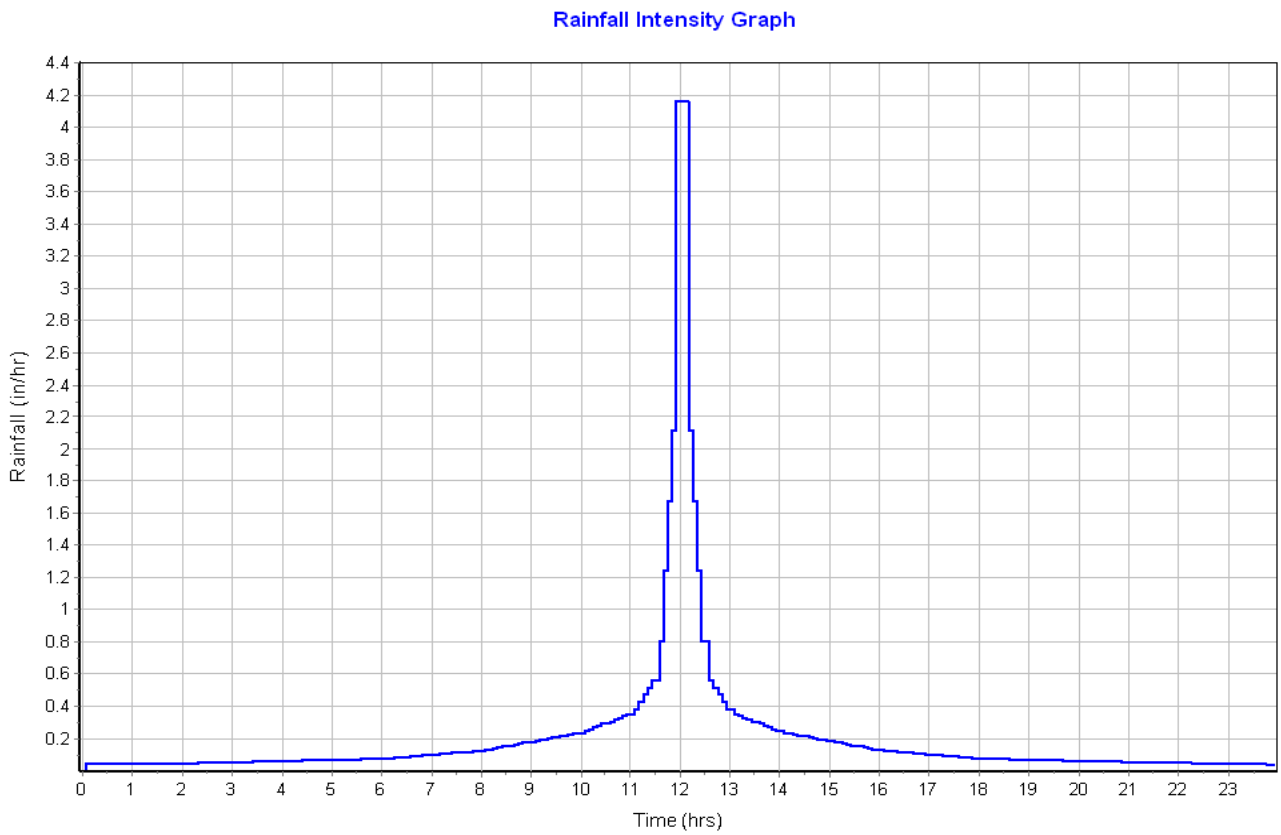
Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	136	0.00	0.00
Slope (%) :	8	0.00	0.00
Surface Type :	Grassed waterway	Unpaved	Unpaved
Velocity (ft/sec) :	4.24	0.00	0.00
Computed Flow Time (min) :	0.53	0.00	0.00

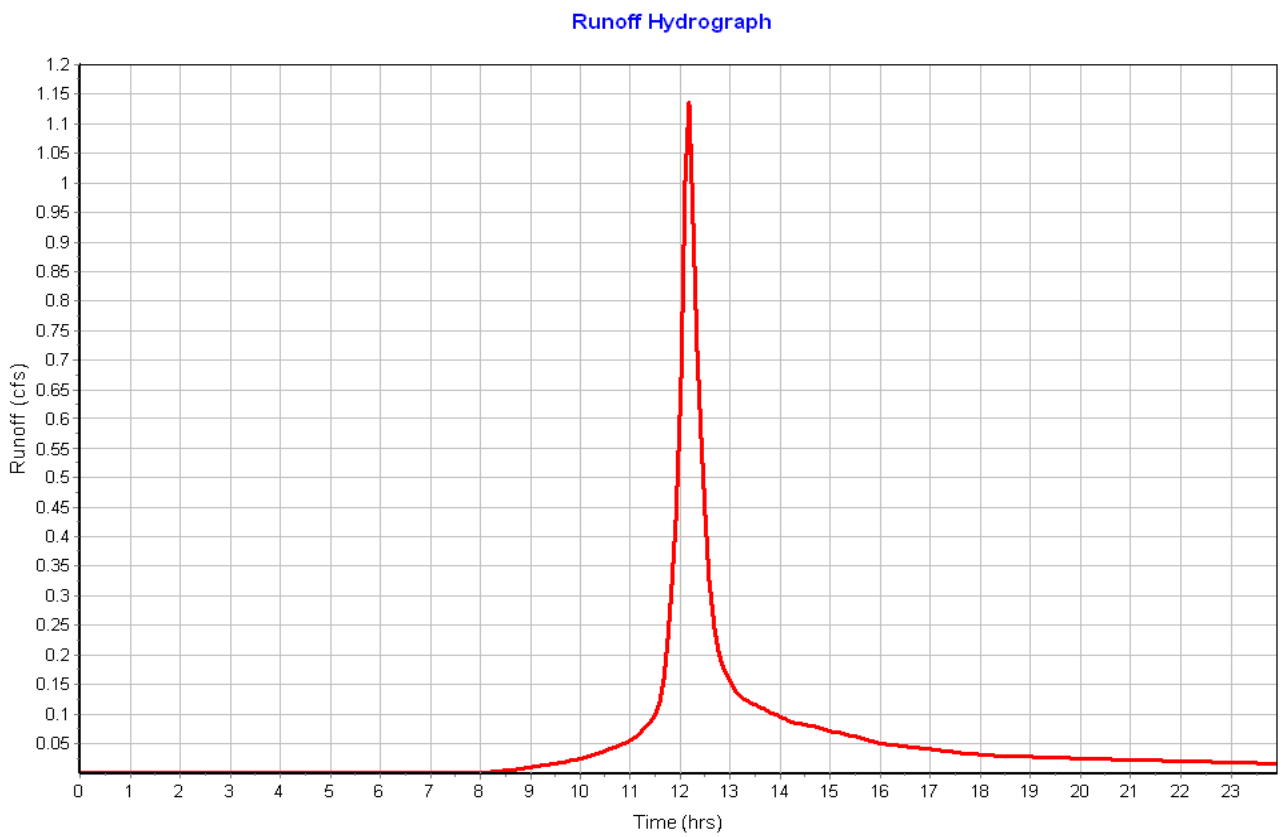
Total TOC (min) 12.02

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.80
Peak Runoff (cfs) 1.14
Weighted Curve Number 79.45
Time of Concentration (days hh:mm:ss) 0 00:12:01

Subbasin : Watershed II-1.2





Subbasin : Watershed II-1.3

Input Data

Area (ac) 1.29
Weighted Curve Number 75.40
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good, Cap	1.17	C	74.00
Gravel roads	0.12	C	89.00
Composite Area & Weighted CN	1.29		75.40

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.01	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	5	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	1.83	0.00	0.00
Computed Flow Time (min) :	0.91	0.00	0.00

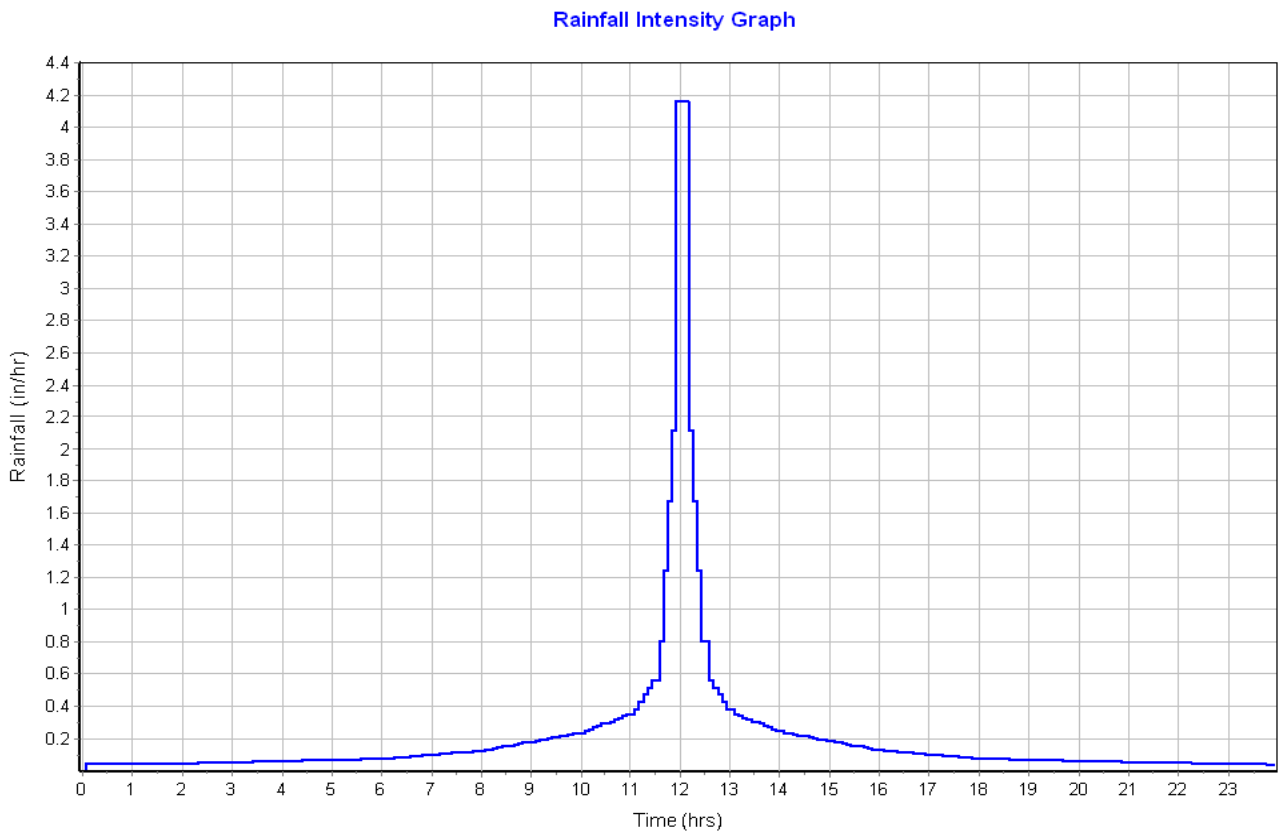
Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	600	0.00	0.00
Slope (%) :	13	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	5.82	0.00	0.00
Computed Flow Time (min) :	1.72	0.00	0.00

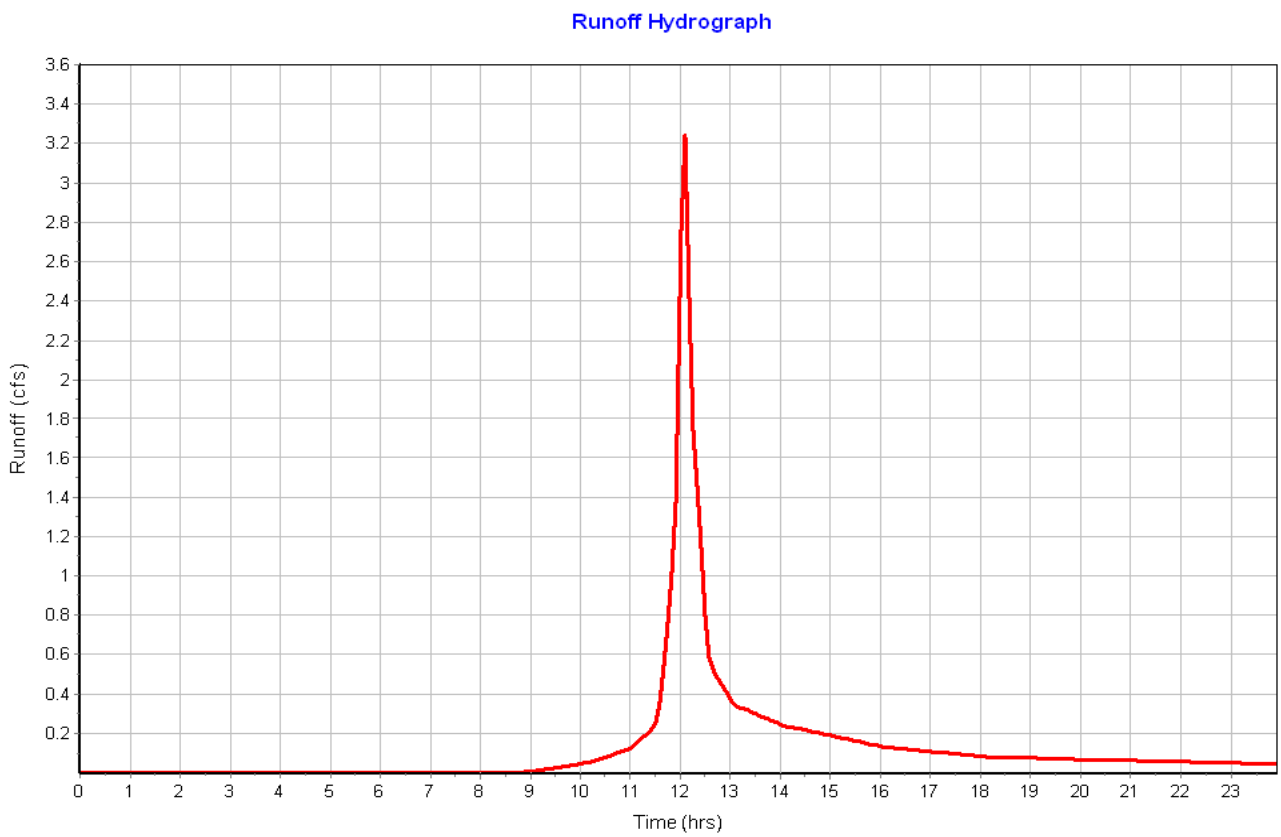
Total TOC (min) 2.63

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.44
Peak Runoff (cfs) 3.32
Weighted Curve Number 75.40
Time of Concentration (days hh:mm:ss) 0 00:02:38

Subbasin : Watershed II-1.3





Subbasin : Watershed II-2.1

Input Data

Area (ac) 2.10
Weighted Curve Number 74.78
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	0.38	C	74.00
Gravel roads	0.21	C	89.00
Woods, Fair	1.51	C	73.00
Composite Area & Weighted CN	2.10		74.78

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.3	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	10	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.16	0.00	0.00
Computed Flow Time (min) :	10.50	0.00	0.00

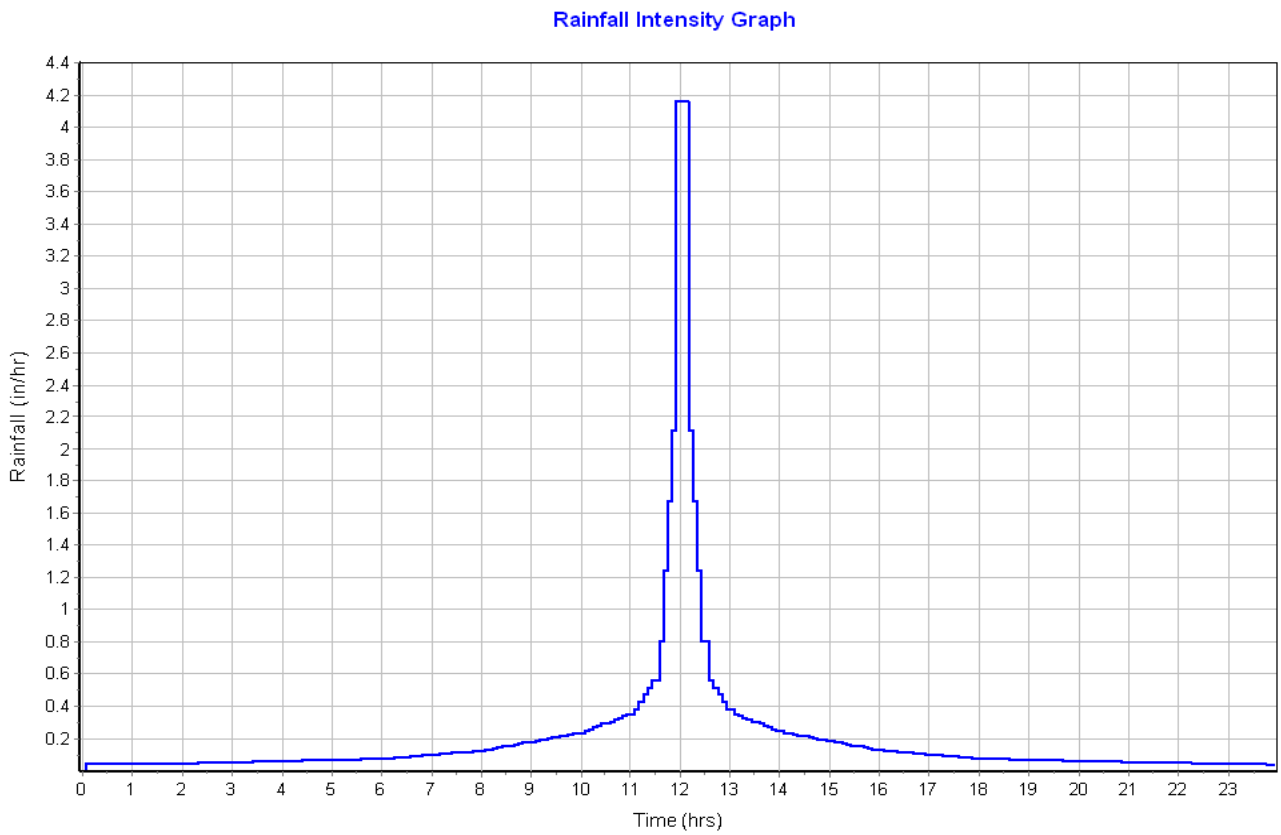
Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	106	0.00	0.00
Slope (%) :	19	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	3.05	0.00	0.00
Computed Flow Time (min) :	0.58	0.00	0.00

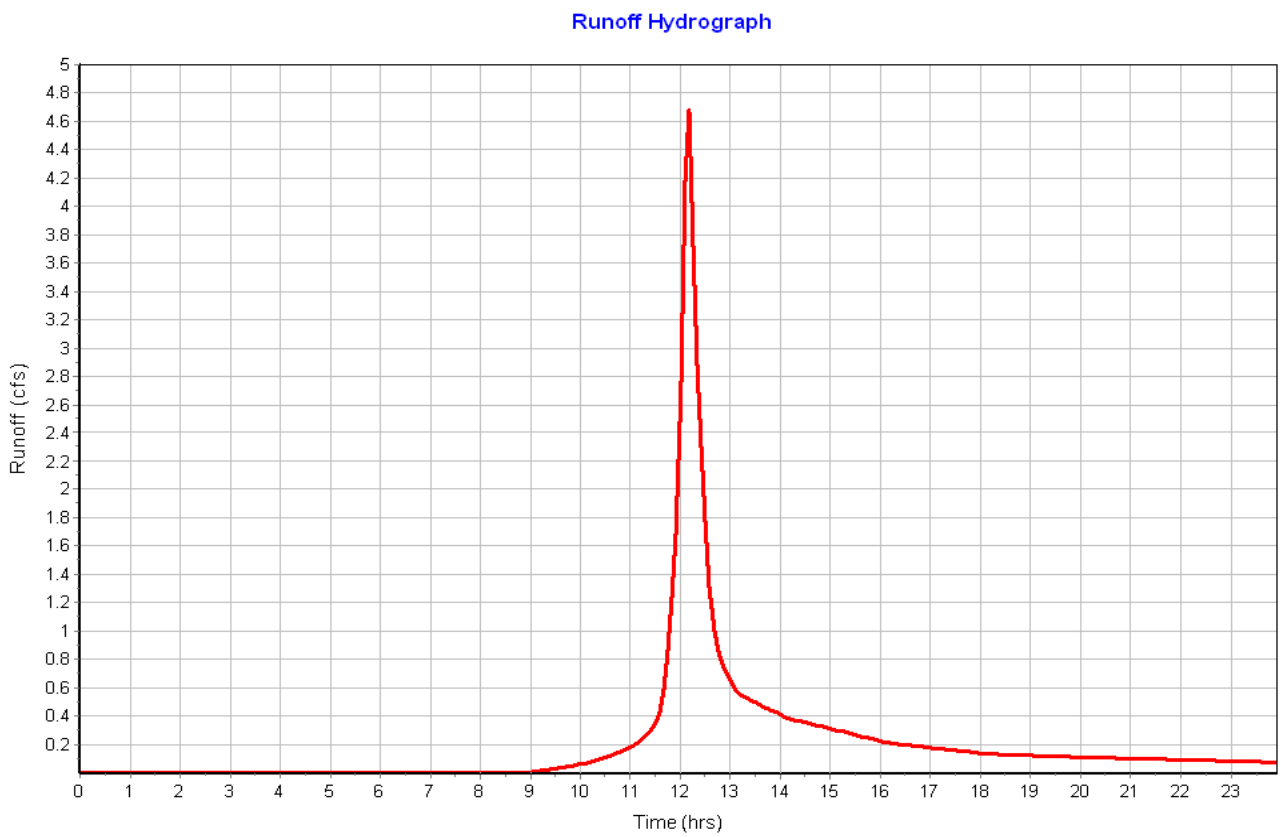
Total TOC (min) 11.08

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.39
Peak Runoff (cfs) 4.71
Weighted Curve Number 74.78
Time of Concentration (days hh:mm:ss) 0 00:11:05

Subbasin : Watershed II-2.1





Subbasin : Watershed II-2.2

Input Data

Area (ac) 0.87
Weighted Curve Number 76.59
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	0.72	C	74.00
Gravel roads	0.15	C	89.00
Composite Area & Weighted CN	0.87		76.59

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.3	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	40	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.28	0.00	0.00
Computed Flow Time (min) :	6.03	0.00	0.00

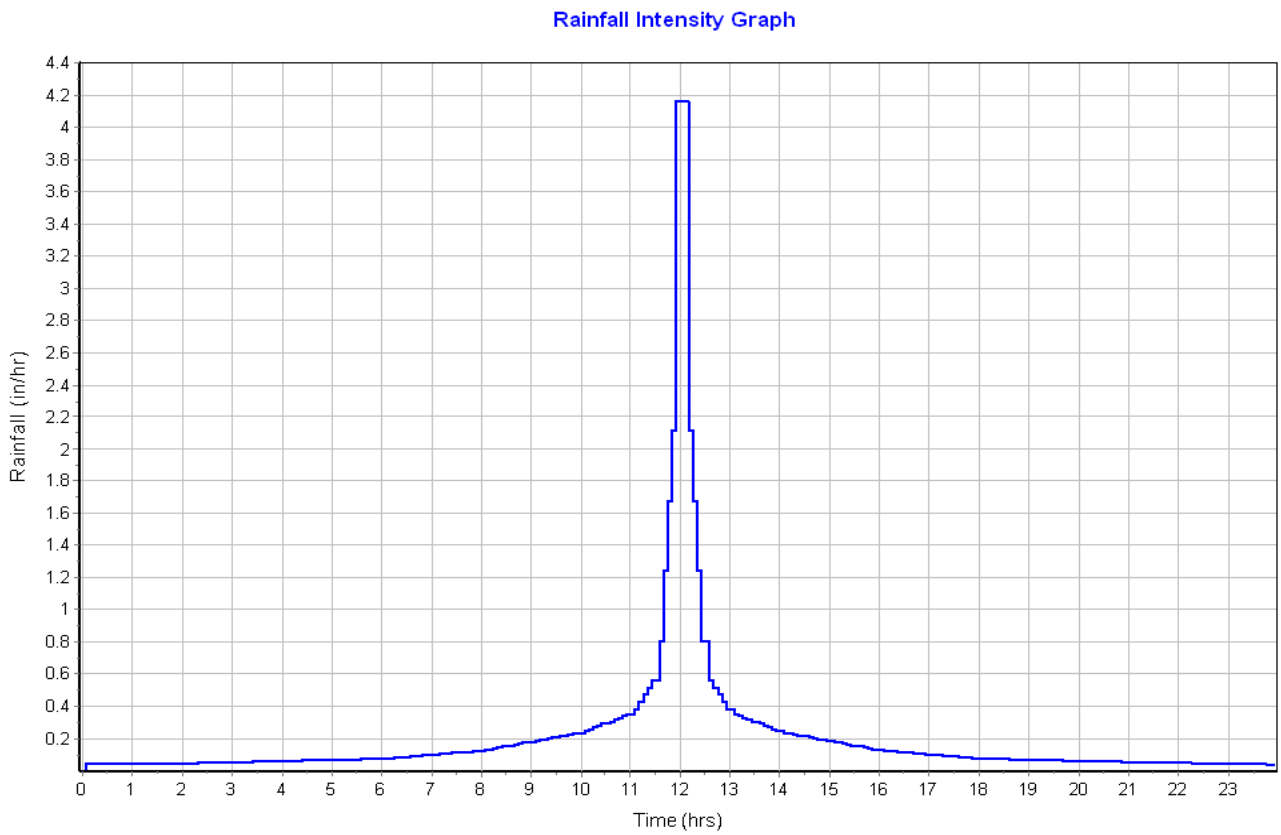
Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	73	0.00	0.00
Slope (%) :	16	0.00	0.00
Surface Type :	Grassed waterway	Unpaved	Unpaved
Velocity (ft/sec) :	6.00	0.00	0.00
Computed Flow Time (min) :	0.20	0.00	0.00

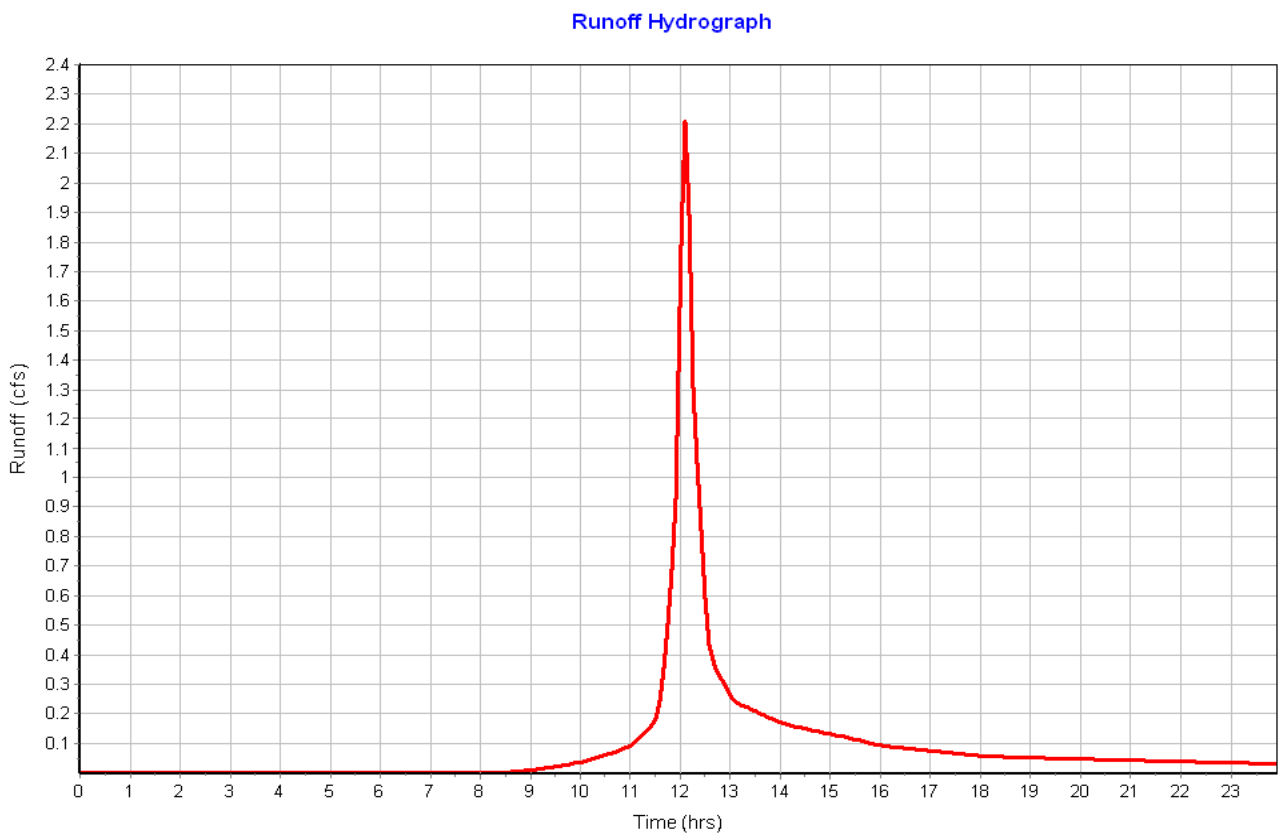
Total TOC (min) 6.23

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.55
Peak Runoff (cfs) 2.28
Weighted Curve Number 76.59
Time of Concentration (days hh:mm:ss) 0 00:06:14

Subbasin : Watershed II-2.2





Subbasin : Watershed III-1.1

Input Data

Area (ac) 0.76
Weighted Curve Number 50.20
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.23	A	76.00
>75% grass cover, Good	0.53	A	39.00
Composite Area & Weighted CN	0.76		50.20

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	51	0.00	0.00
Slope (%) :	.14	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.02	0.00	0.00
Computed Flow Time (min) :	42.54	0.00	0.00

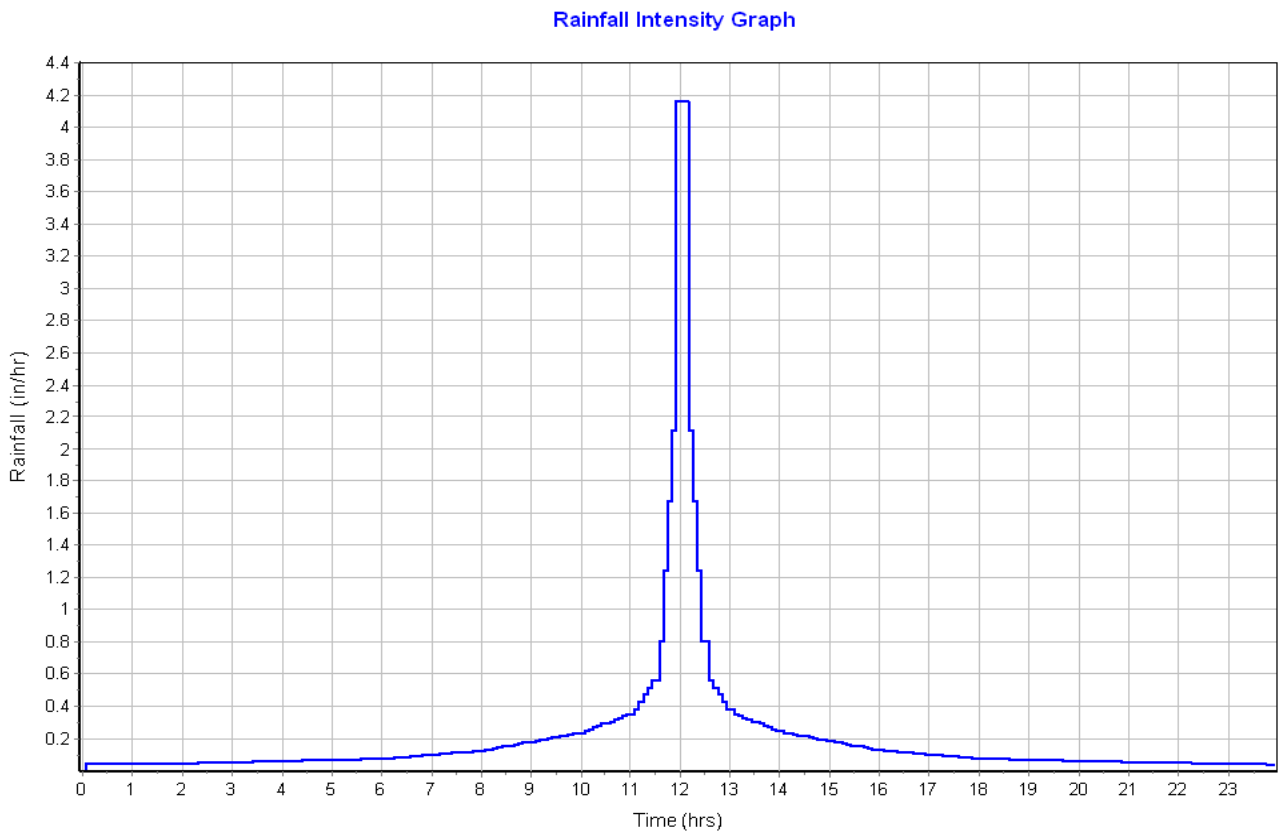
Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.032	0.00	0.00
Flow Length (ft) :	468	0.00	0.00
Channel Slope (%) :	3	0.00	0.00
Cross Section Area (ft^2) :	22	0.00	0.00
Wetted Perimeter (ft) :	15	0.00	0.00
Velocity (ft/sec) :	10.41	0.00	0.00
Computed Flow Time (min) :	0.75	0.00	0.00

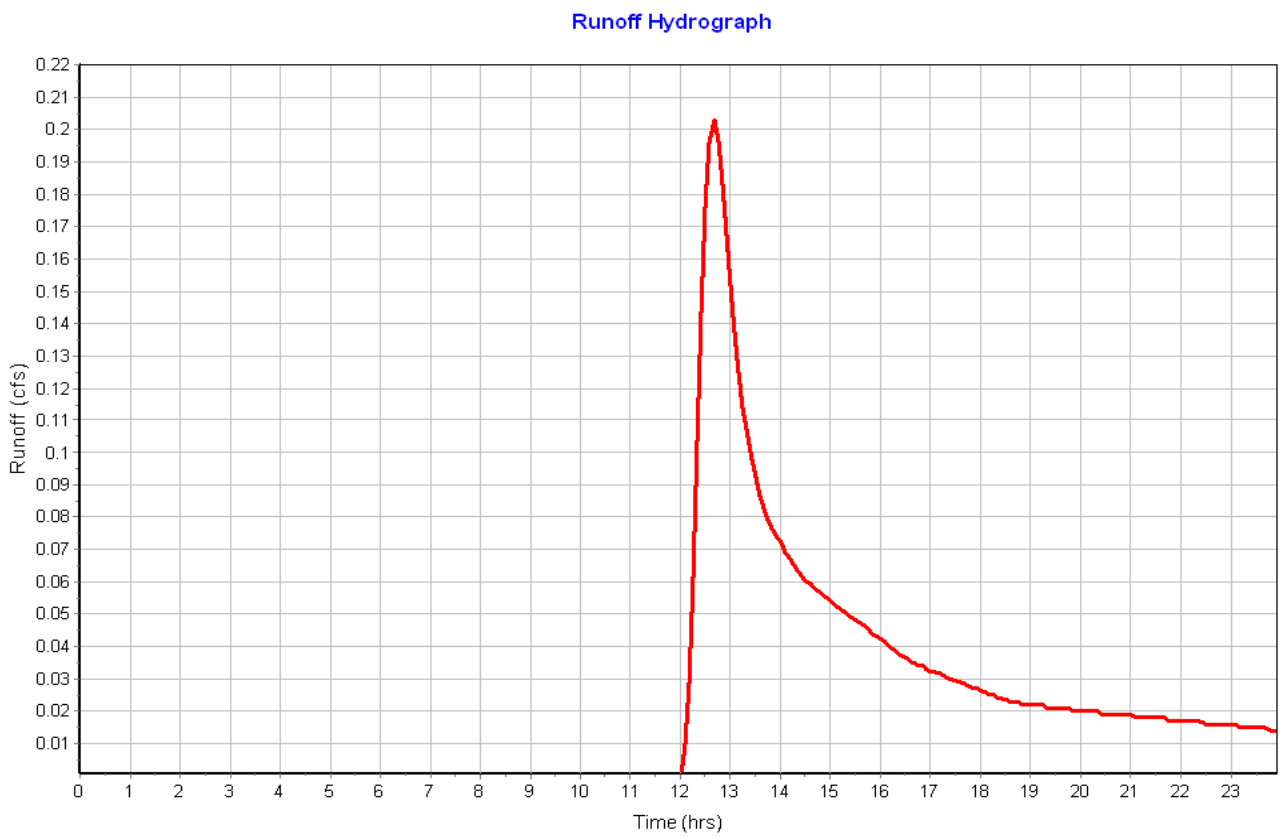
Total TOC (min) 43.29

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 0.68
Peak Runoff (cfs) 0.20
Weighted Curve Number 50.20
Time of Concentration (days hh:mm:ss) 0 00:43:17

Subbasin : Watershed III-1.1





Subbasin : Watershed III-1.2

Input Data

Area (ac) 1.12
Weighted Curve Number 84.00
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	0.49	C	74.00
Gravel roads	0.44	C	89.00
Paved parking & roofs	0.20	C	98.00
Composite Area & Weighted CN	1.13		84.00

Time of Concentration

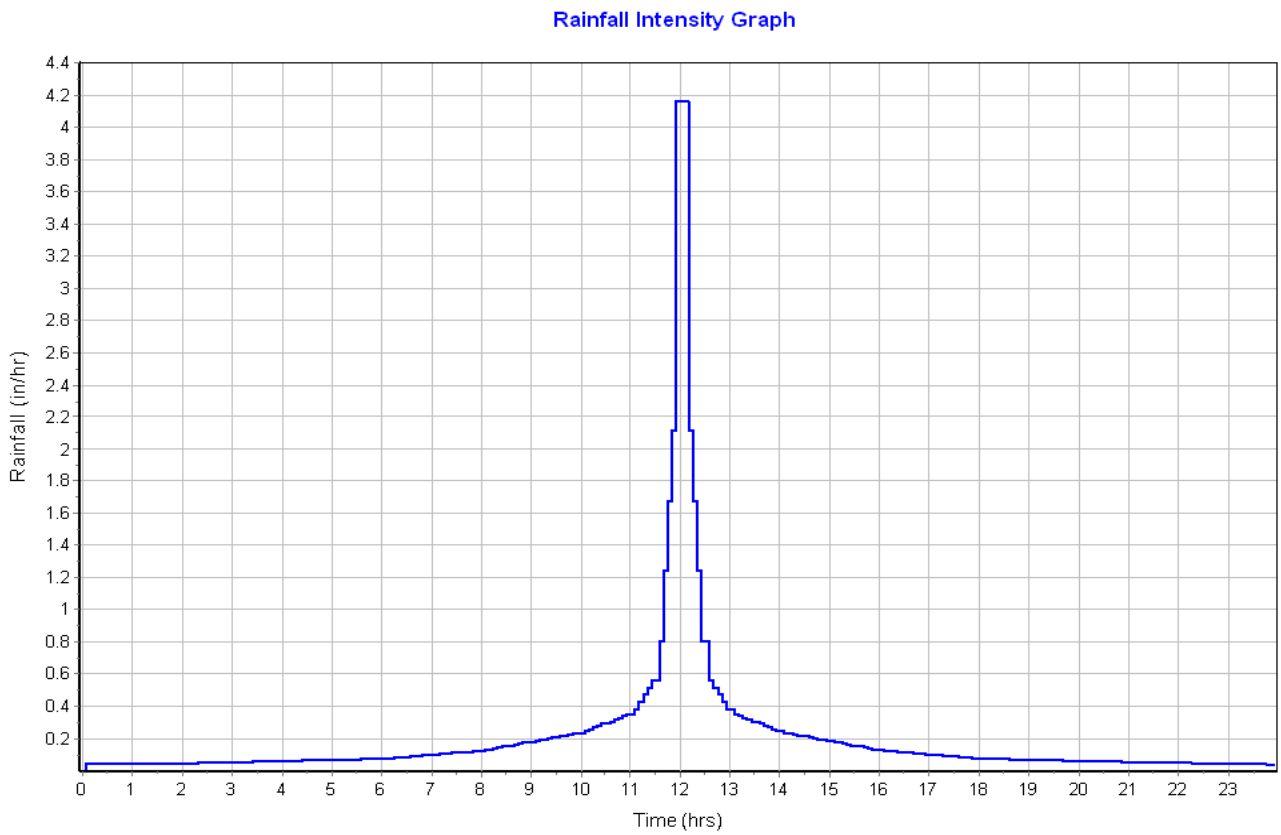
Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.032	0.00	0.00
Flow Length (ft) :	77	0.00	0.00
Slope (%) :	2	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.47	0.00	0.00
Computed Flow Time (min) :	2.71	0.00	0.00

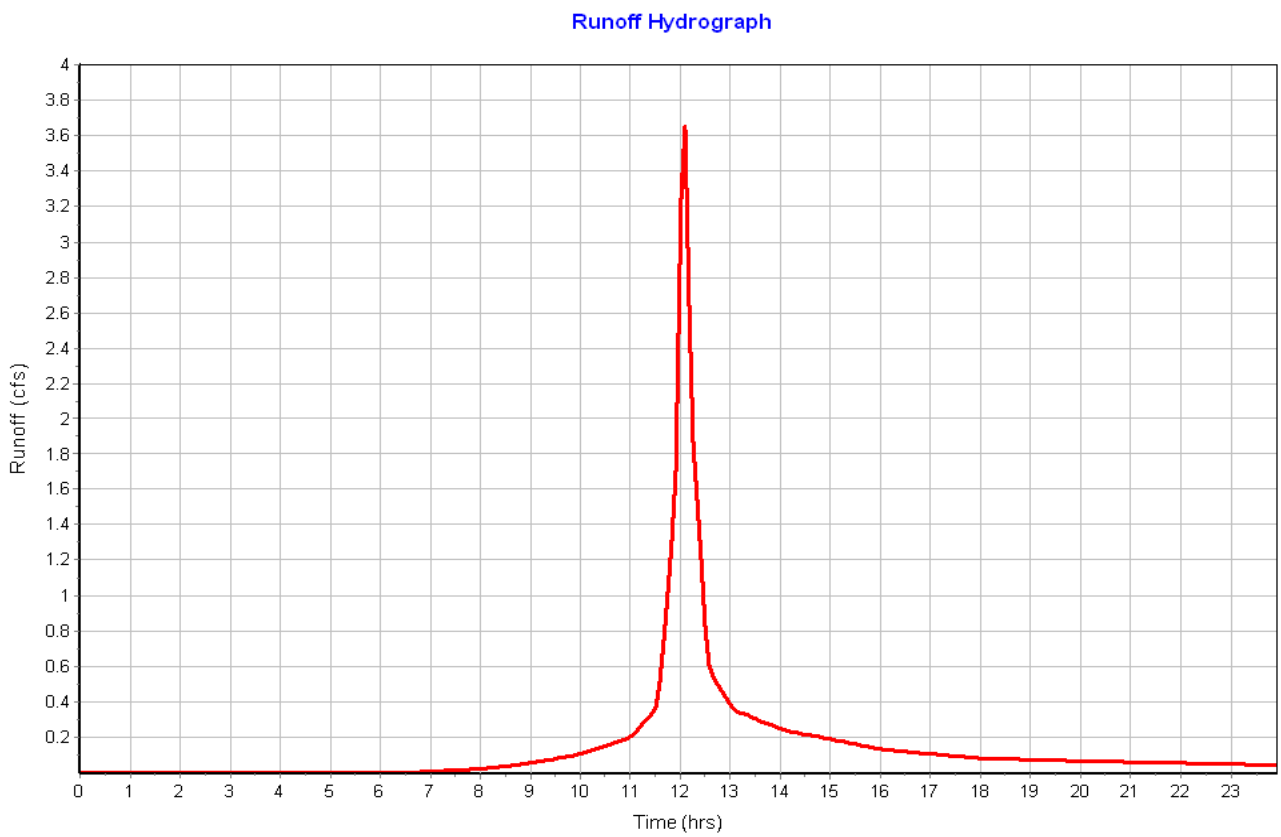
Total TOC (min) 2.71

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 3.23
Peak Runoff (cfs) 3.70
Weighted Curve Number 84.00
Time of Concentration (days hh:mm:ss) 0 00:02:43

Subbasin : Watershed III-1.2





Subbasin : Watershed III-2

Input Data

Area (ac) 2.01
Weighted Curve Number 74.00
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
>75% Grass, Good, Cap	2.01	C	74.00
Composite Area & Weighted CN	2.01		74.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.033	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	25	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	1.34	0.00	0.00
Computed Flow Time (min) :	1.25	0.00	0.00

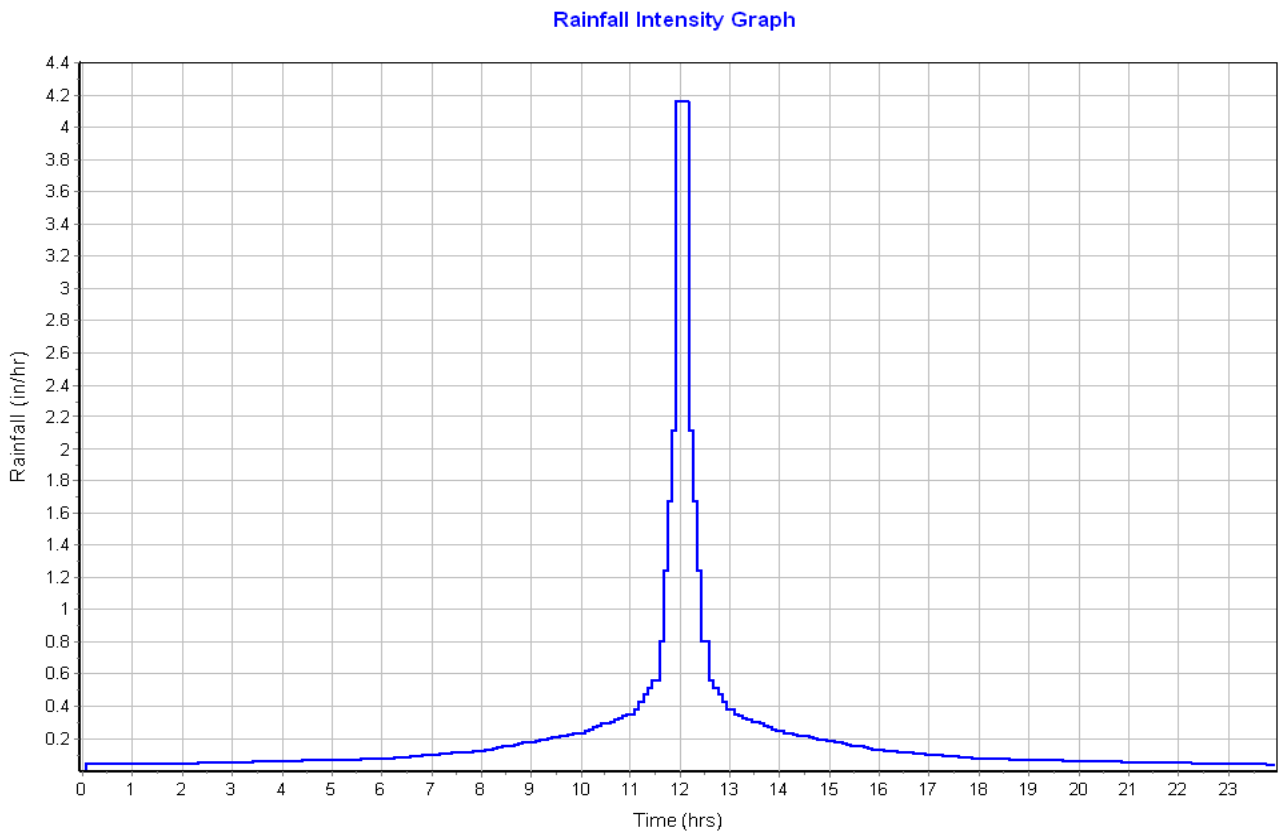
Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.032	0.00	0.00
Flow Length (ft) :	496	0.00	0.00
Channel Slope (%) :	5	0.00	0.00
Cross Section Area (ft²) :	4	0.00	0.00
Wetted Perimeter (ft) :	2	0.00	0.00
Velocity (ft/sec) :	16.53	0.00	0.00
Computed Flow Time (min) :	0.50	0.00	0.00

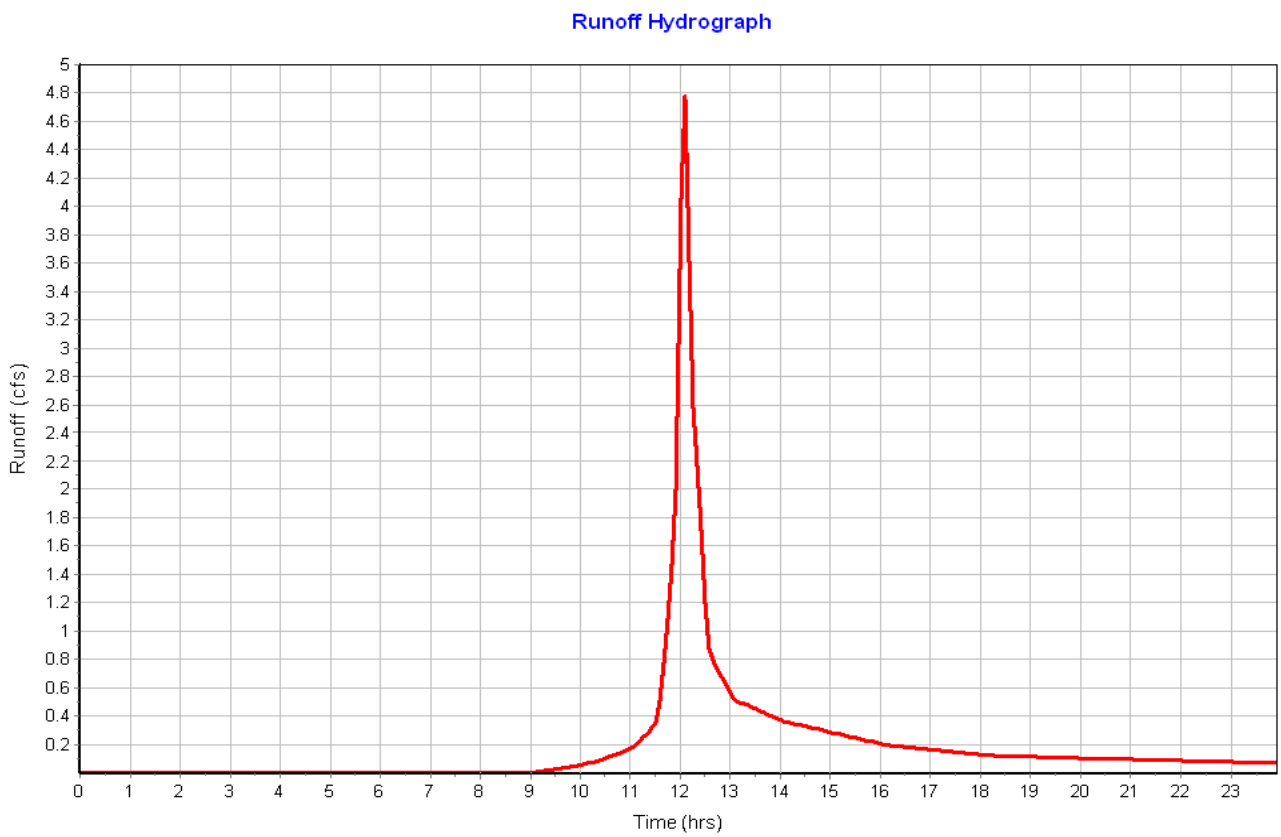
Total TOC (min) 1.75

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.32
Peak Runoff (cfs) 4.91
Weighted Curve Number 74.00
Time of Concentration (days hh:mm:ss) 0 00:01:45

Subbasin : Watershed III-2





Subbasin : Watershed III-3.1

Input Data

Area (ac) 0.56
Weighted Curve Number 74.00
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good, Cap	0.56	C	74.00
Composite Area & Weighted CN	0.56		74.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.3	0.00	0.00
Flow Length (ft) :	55	0.00	0.00
Slope (%) :	33	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.23	0.00	0.00
Computed Flow Time (min) :	4.04	0.00	0.00

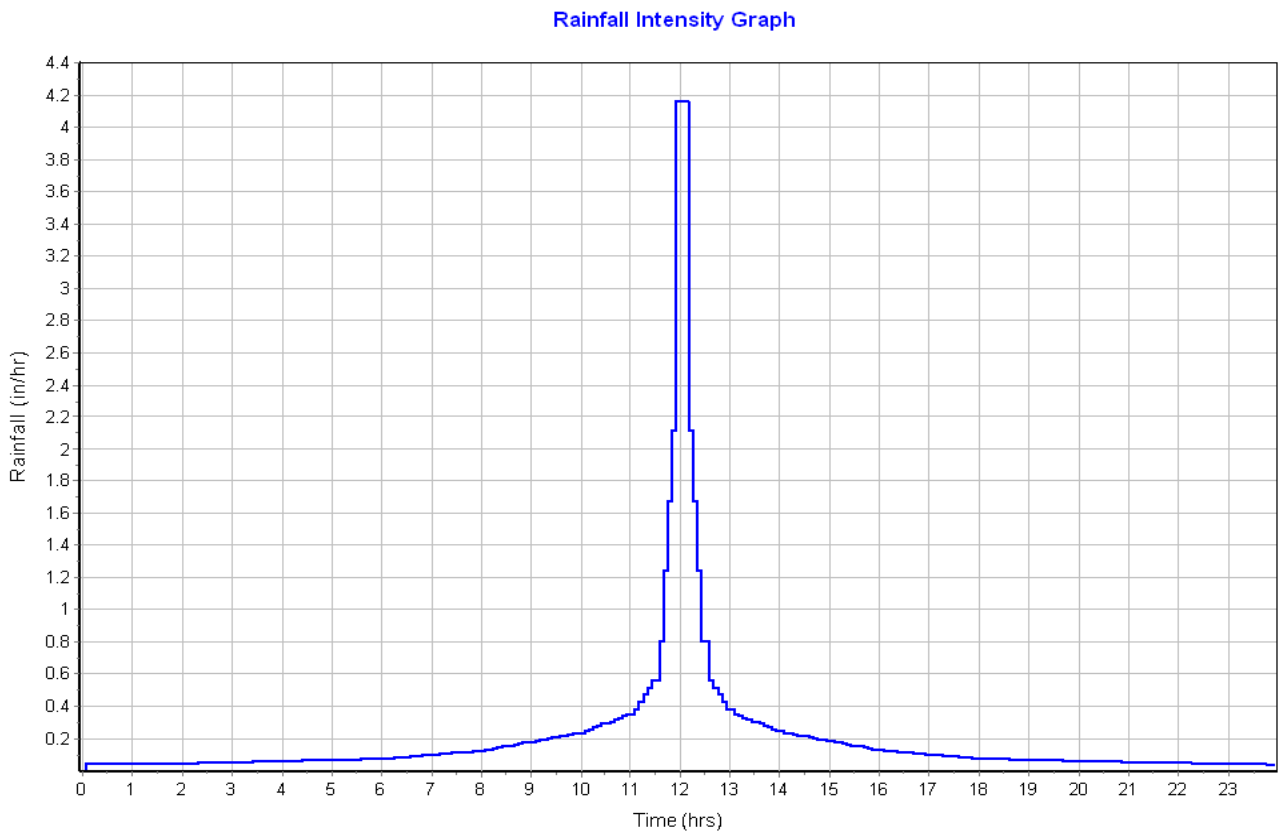
Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.033	0.00	0.00
Flow Length (ft) :	450	0.00	0.00
Channel Slope (%) :	2	0.00	0.00
Cross Section Area (ft²) :	10	0.00	0.00
Wetted Perimeter (ft) :	6	0.00	0.00
Velocity (ft/sec) :	8.98	0.00	0.00
Computed Flow Time (min) :	0.84	0.00	0.00

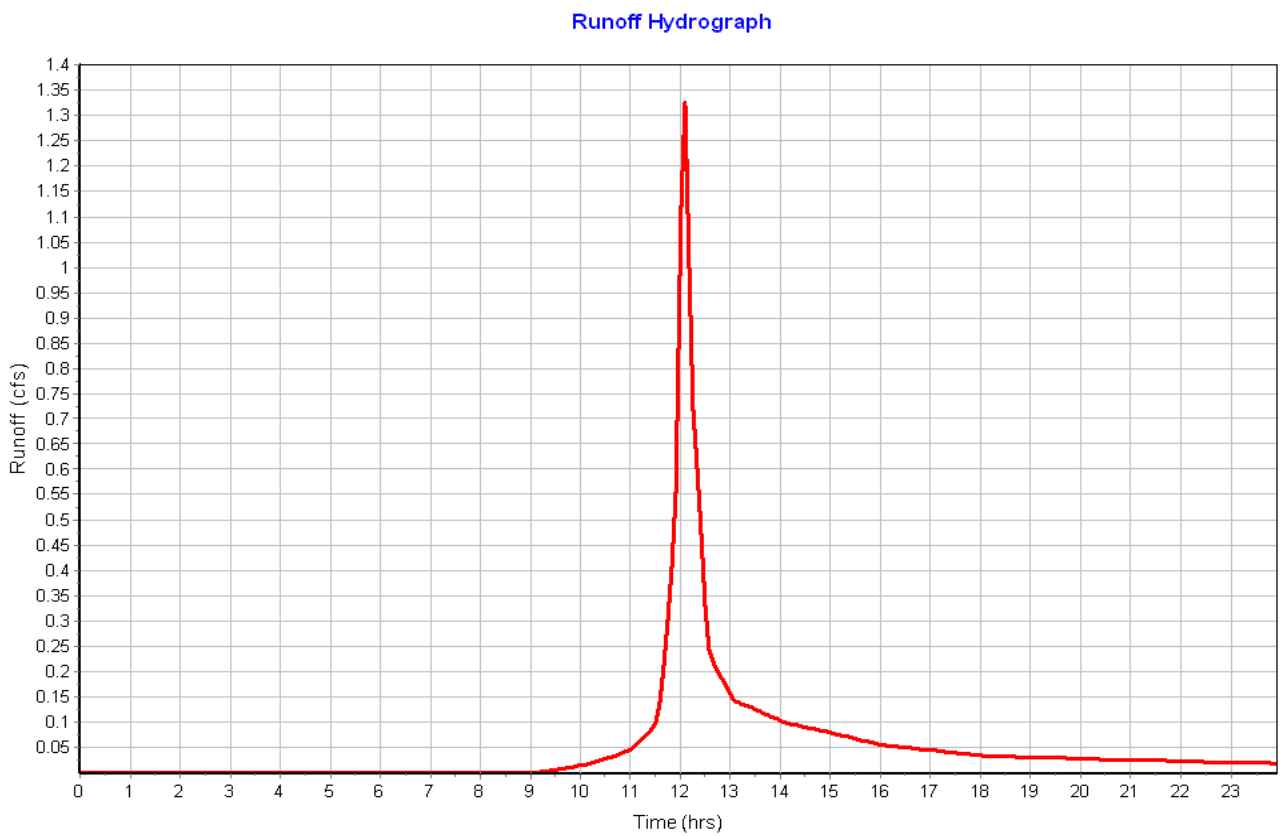
Total TOC (min) 4.87

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.32
Peak Runoff (cfs) 1.36
Weighted Curve Number 74.00
Time of Concentration (days hh:mm:ss) 0 00:04:52

Subbasin : Watershed III-3.1





Subbasin : Watershed III-3.2

Input Data

Area (ac) 1.00
Weighted Curve Number 46.40
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.20	A	76.00
> 75% grass cover, Good	0.80	A	39.00
Composite Area & Weighted CN	1.00		46.40

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.01	.4	0.00
Flow Length (ft) :	40	40	0.00
Slope (%) :	2	25	0.00
2 yr, 24 hr Rainfall (in) :	2.33	2.33	0.00
Velocity (ft/sec) :	1.05	0.15	0.00
Computed Flow Time (min) :	0.63	4.40	0.00

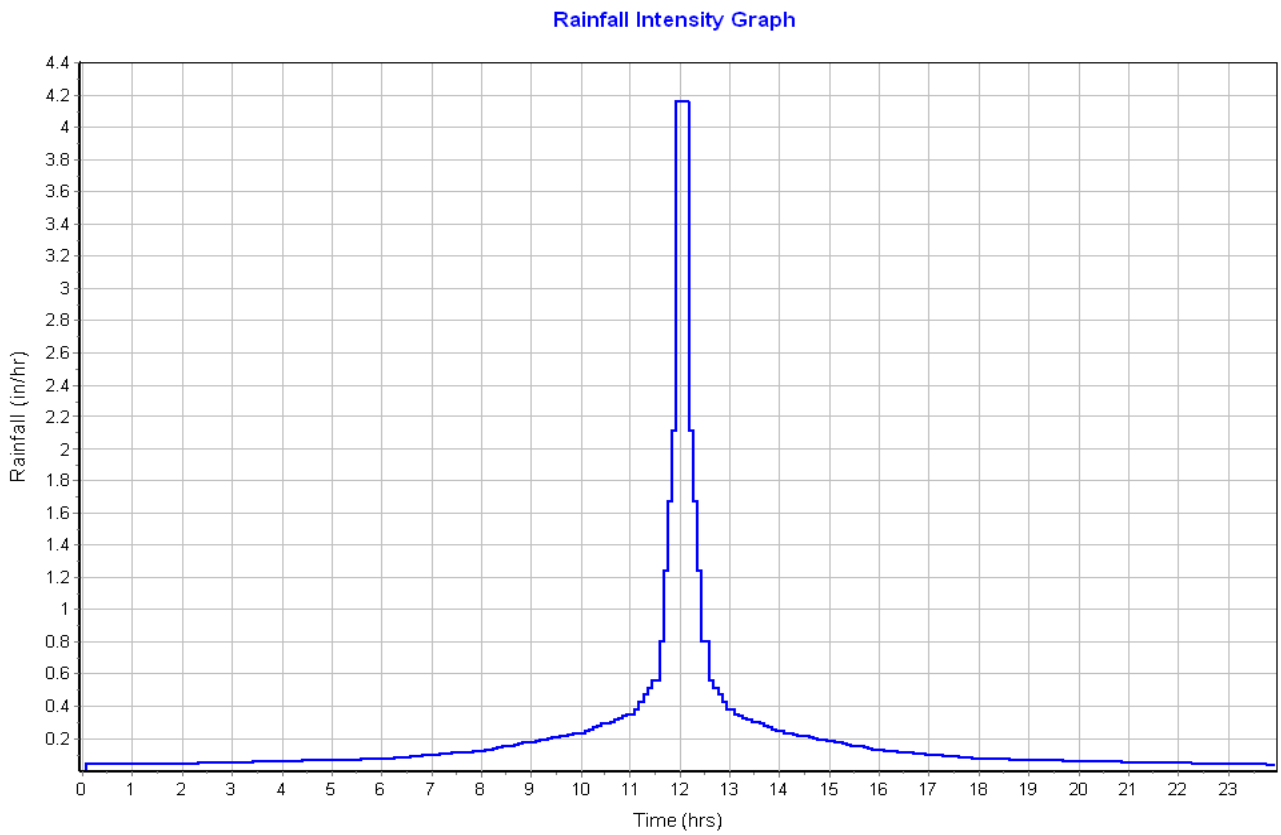
Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	166	0.00	0.00
Slope (%) :	3	0.00	0.00
Surface Type :	Grassed waterway	Unpaved	Unpaved
Velocity (ft/sec) :	2.60	0.00	0.00
Computed Flow Time (min) :	1.06	0.00	0.00

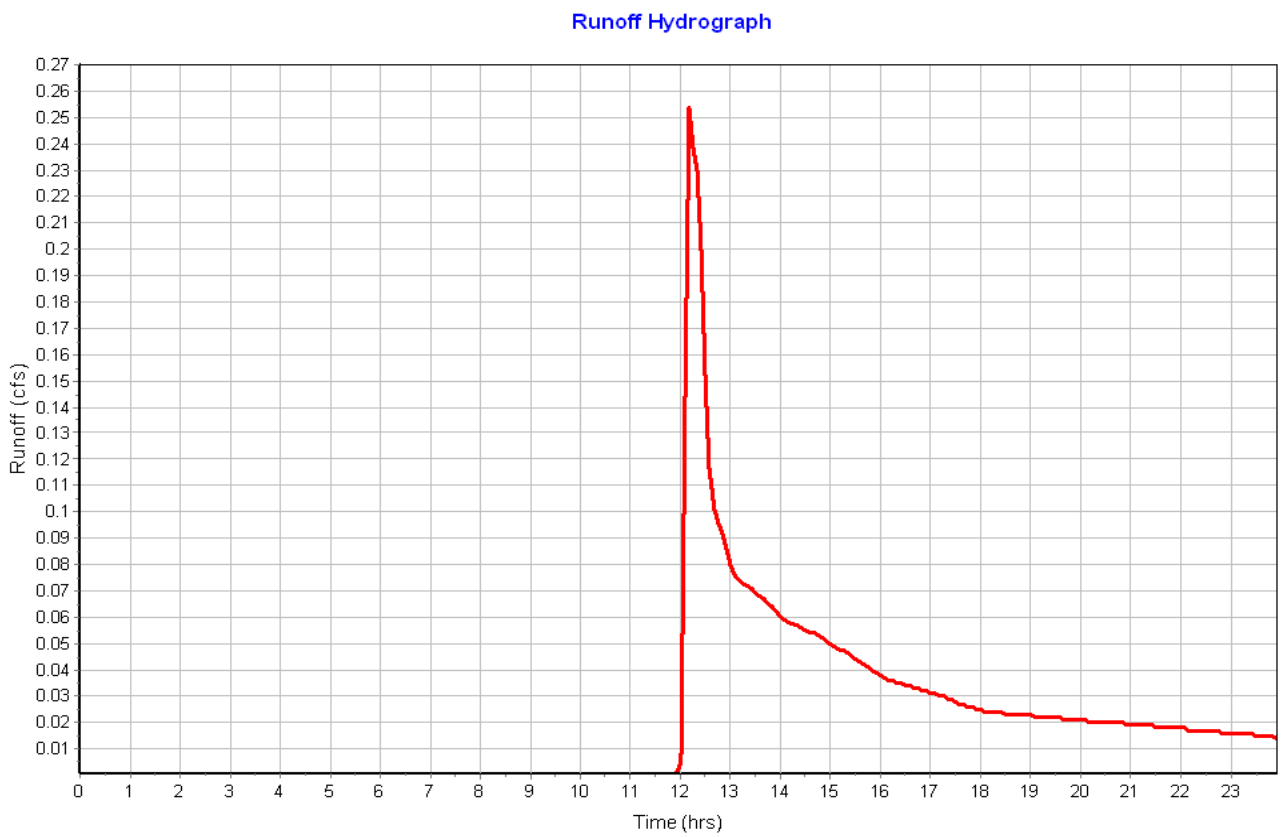
Total TOC (min) 6.10

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 0.49
Peak Runoff (cfs) 0.26
Weighted Curve Number 46.40
Time of Concentration (days hh:mm:ss) 0 00:06:06

Subbasin : Watershed III-3.2





Subbasin : Watershed III-4

Input Data

Area (ac) 3.19
Weighted Curve Number 74.00
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good, Cap	3.19	C	74.00
Composite Area & Weighted CN	3.19		74.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.032	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	28.5	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	1.45	0.00	0.00
Computed Flow Time (min) :	1.15	0.00	0.00

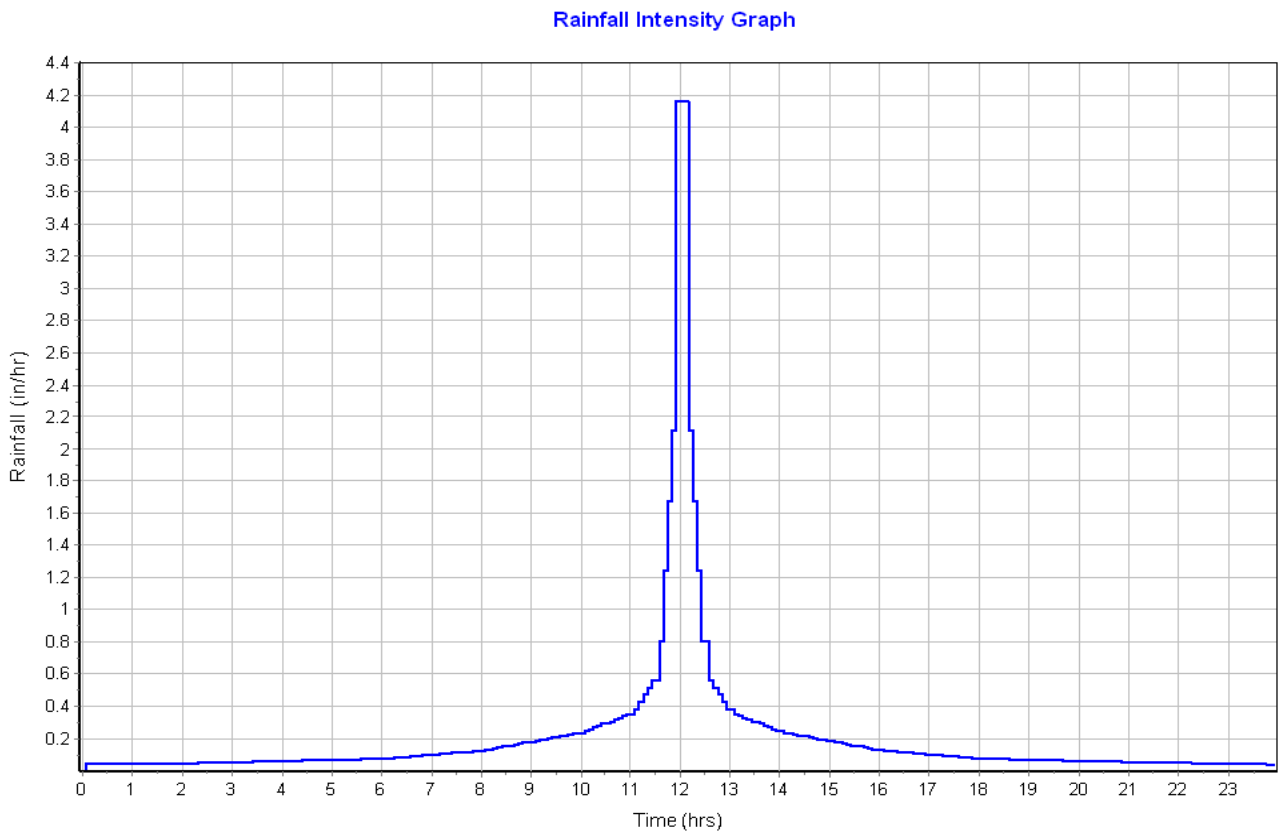
Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.033	0.00	0.00
Flow Length (ft) :	1452	0.00	0.00
Channel Slope (%) :	5	0.00	0.00
Cross Section Area (ft²) :	2	0.00	0.00
Wetted Perimeter (ft) :	4	0.00	0.00
Velocity (ft/sec) :	6.36	0.00	0.00
Computed Flow Time (min) :	3.80	0.00	0.00

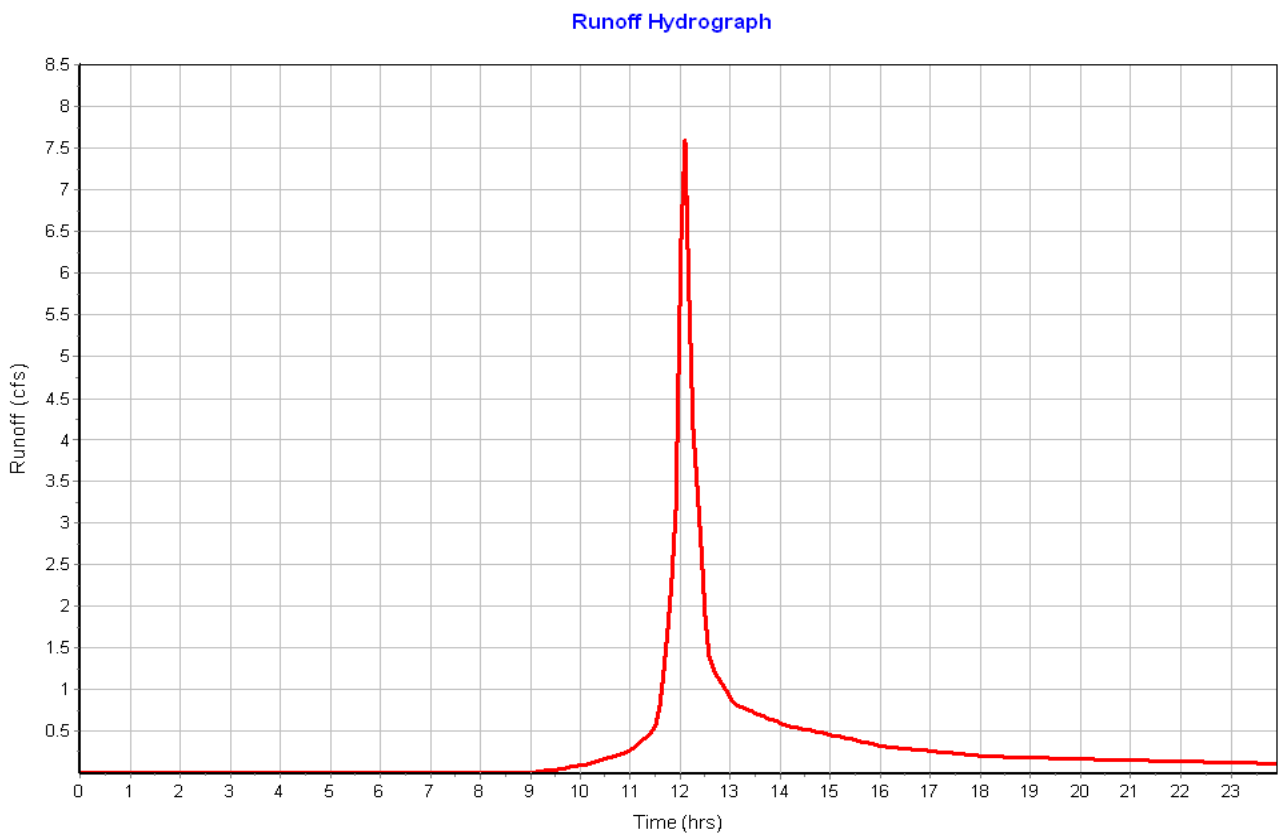
Total TOC (min) 4.96

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.32
Peak Runoff (cfs) 7.79
Weighted Curve Number 74.00
Time of Concentration (days hh:mm:ss) 0 00:04:58

Subbasin : Watershed III-4





Subbasin : Watershed III-5

Input Data

Area (ac) 2.08
Weighted Curve Number 74.00
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good, Cap	2.08	C	74.00
Composite Area & Weighted CN	2.08		74.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	33	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.20	0.00	0.00
Computed Flow Time (min) :	8.20	0.00	0.00

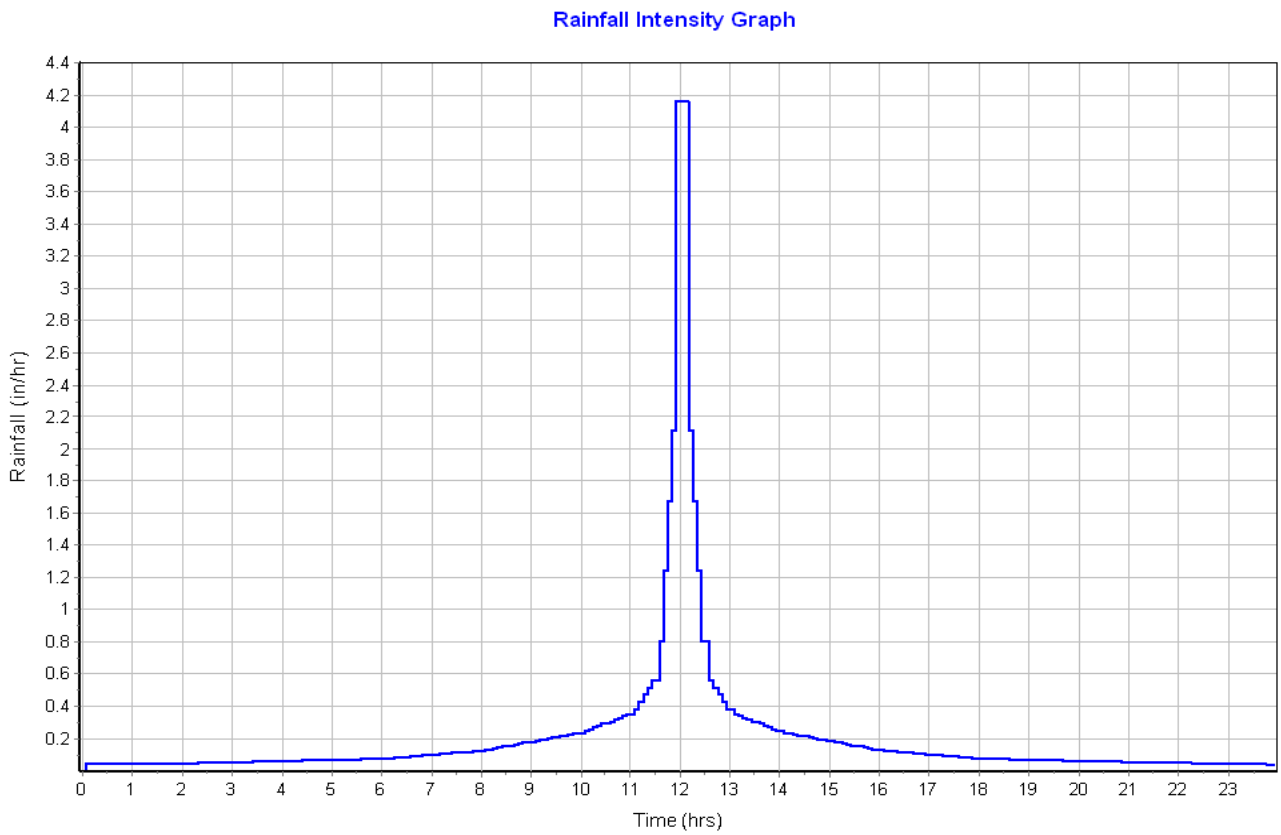
Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.033	.033	0.00
Flow Length (ft) :	680	160	0.00
Channel Slope (%) :	3	10	0.00
Cross Section Area (ft²) :	4	4	0.00
Wetted Perimeter (ft) :	4	4	0.00
Velocity (ft/sec) :	7.82	14.28	0.00
Computed Flow Time (min) :	1.45	0.19	0.00

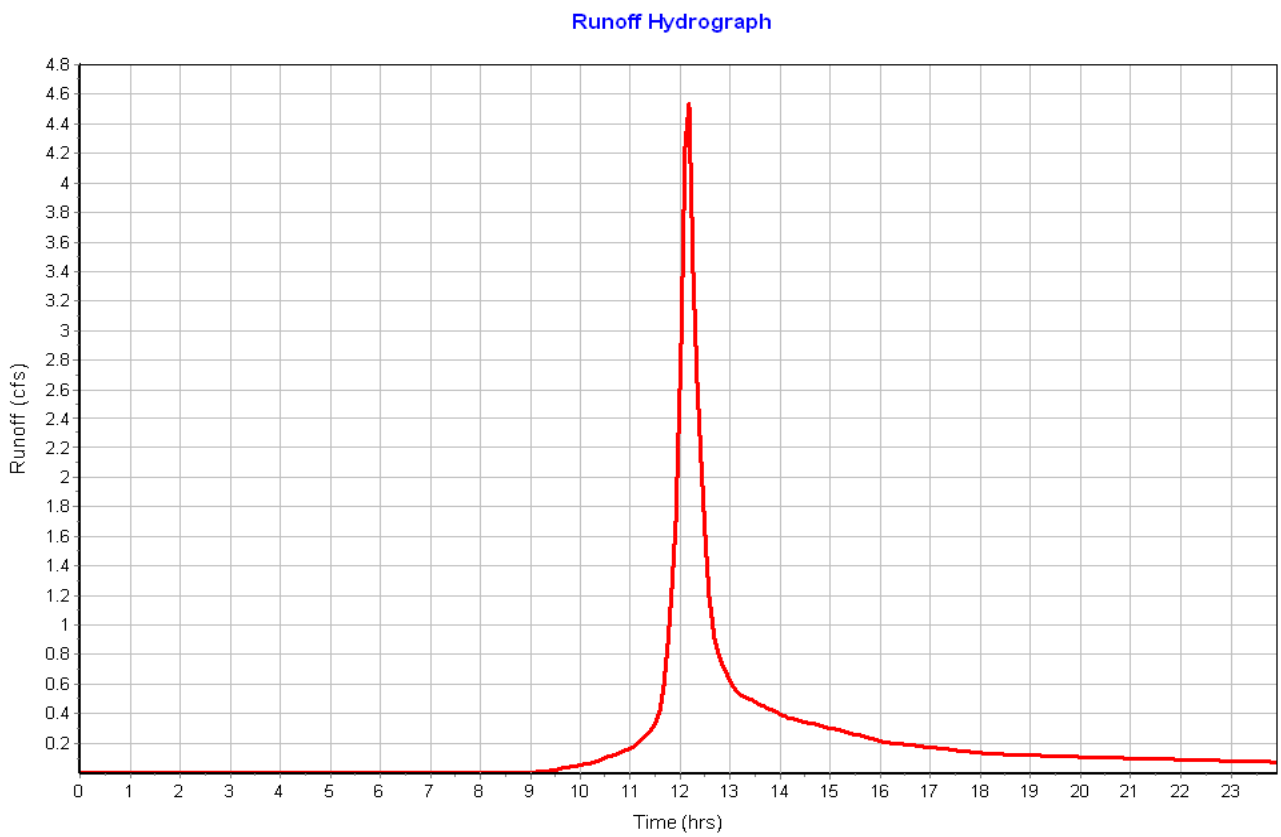
Total TOC (min) 9.84

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.32
Peak Runoff (cfs) 4.66
Weighted Curve Number 74.00
Time of Concentration (days hh:mm:ss) 0 00:09:50

Subbasin : Watershed III-5





Subbasin : Watershed III-6

Input Data

Area (ac) 1.85
Weighted Curve Number 74.00
Rain Gage ID RainGage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good, Cap	1.85	C	74.00
Composite Area & Weighted CN	1.85		74.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	33	0.00	0.00
2 yr, 24 hr Rainfall (in) :	2.33	0.00	0.00
Velocity (ft/sec) :	0.20	0.00	0.00
Computed Flow Time (min) :	8.20	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	20	0.00	0.00
Slope (%) :	33	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	4.02	0.00	0.00
Computed Flow Time (min) :	0.08	0.00	0.00

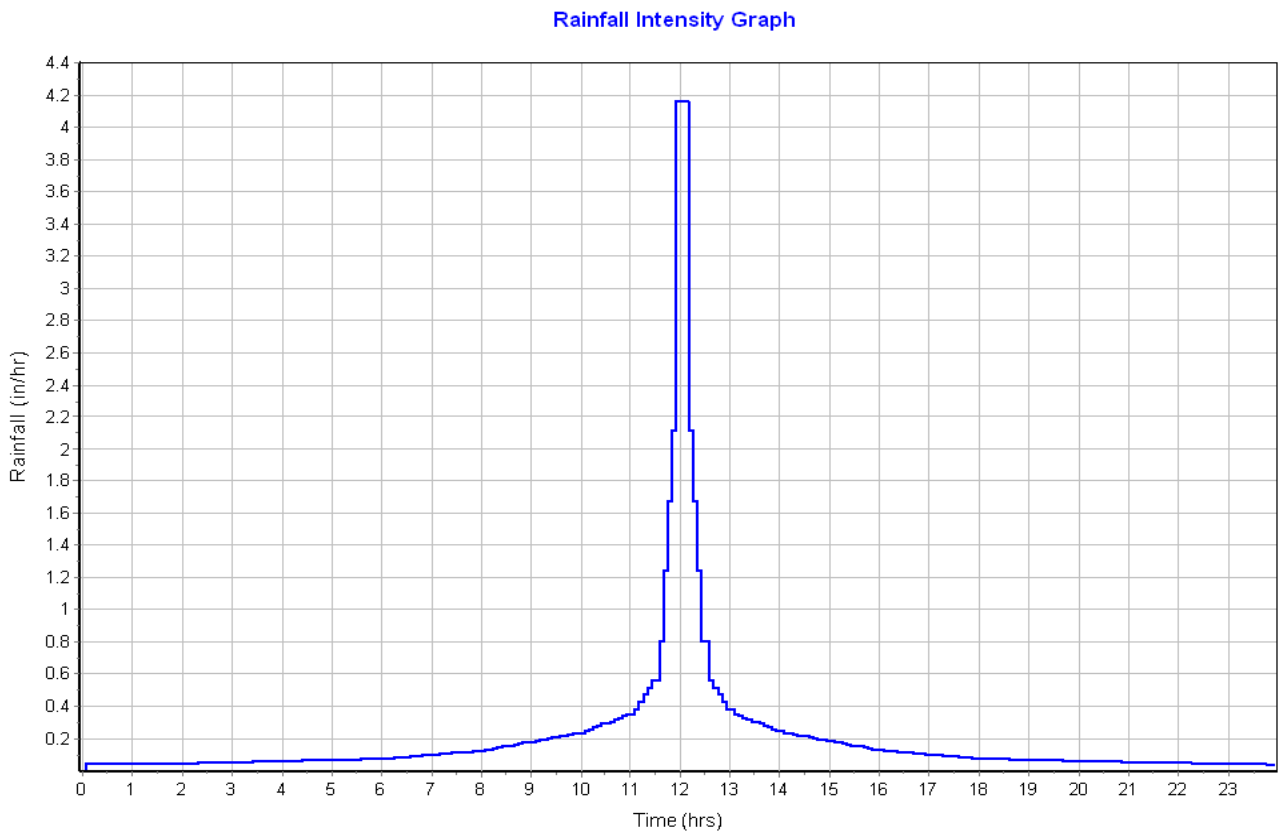
Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.033	0.00	0.00
Flow Length (ft) :	360	0.00	0.00
Channel Slope (%) :	3	0.00	0.00
Cross Section Area (ft^2) :	4	0.00	0.00
Wetted Perimeter (ft) :	2	0.00	0.00
Velocity (ft/sec) :	12.41	0.00	0.00
Computed Flow Time (min) :	0.48	0.00	0.00

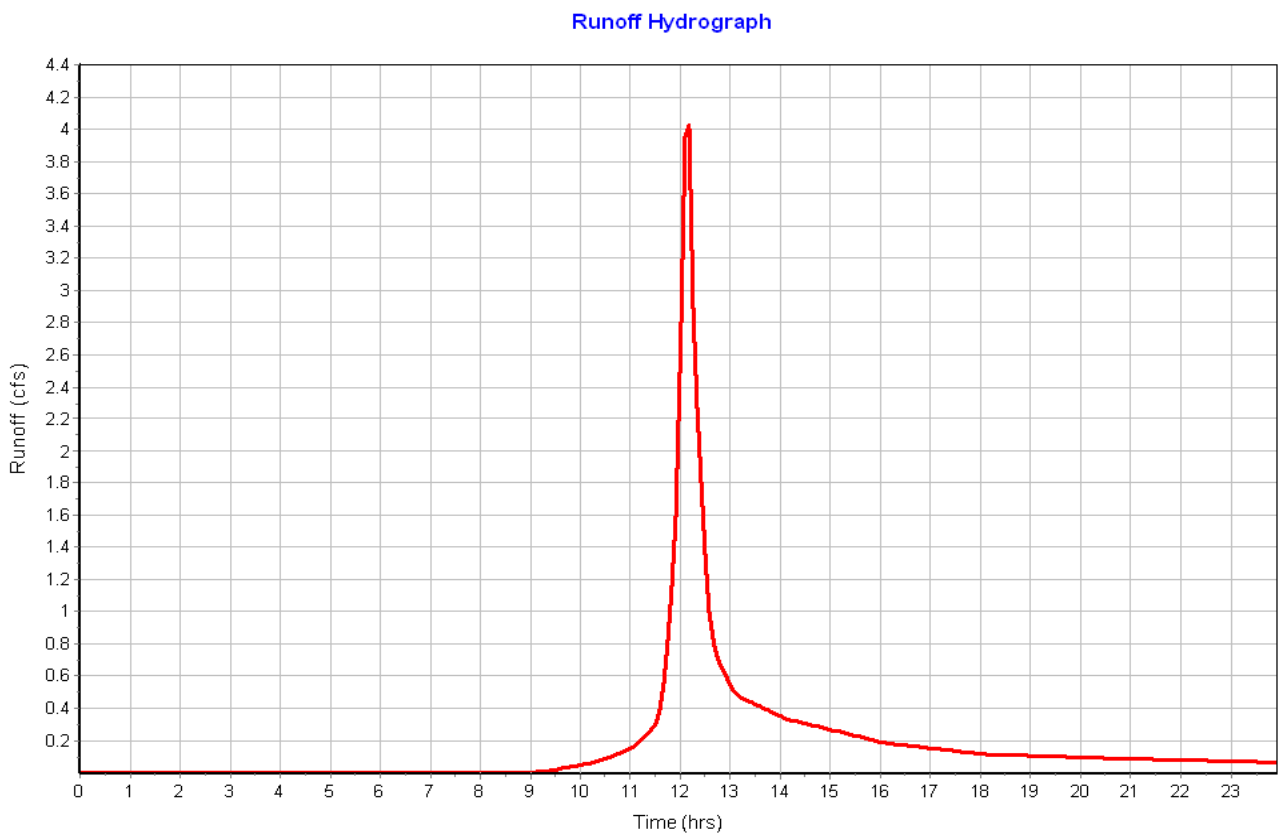
Total TOC (min) 8.77

Subbasin Runoff Results

Total Rainfall (in) 4.95
Total Runoff (in) 2.32
Peak Runoff (cfs) 4.25
Weighted Curve Number 74.00
Time of Concentration (days hh:mm:ss) 0 00:08:46

Subbasin : Watershed III-6





Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in)
1	Jun-01	486.00	0.00	-486.00	0.00	-486.00	0.00	0.00	0.00	0.00
2	Jun-02	480.00	0.00	-480.00	0.00	-480.00	0.00	0.00	0.00	0.00
3	Jun-03	413.00	0.00	-413.00	0.00	-413.00	0.00	0.00	0.00	0.00
4	Jun-05	468.00	0.00	-468.00	0.00	-468.00	0.00	0.00	0.00	0.00
5	Jun-06	450.00	0.00	-450.00	0.00	-450.00	0.00	0.00	0.00	0.00
6	Jun-07	456.00	0.00	-456.00	0.00	-456.00	0.00	0.00	0.00	0.00
7	Jun-08	466.50	0.00	-466.50	0.00	-466.50	0.00	0.00	0.00	0.00
8	Jun-13	404.00	0.00	-404.00	0.00	-404.00	0.00	0.00	0.00	0.00
9	Jun-14	399.50	415.00	15.50	0.00	-399.50	0.00	-415.00	0.00	0.00
10	Jun-16	394.94	399.30	4.36	395.30	0.36	399.30	0.00	0.00	0.00
11	Jun-17	406.00	0.00	-406.00	0.00	-406.00	0.00	0.00	0.00	0.00
12	Jun-19	400.50	405.00	4.50	0.00	-400.50	0.00	-405.00	0.00	0.00
13	Jun-22	482.00	0.00	-482.00	0.00	-482.00	0.00	0.00	0.00	0.00
14	Jun-23	408.00	0.00	-408.00	0.00	-408.00	0.00	0.00	0.00	0.00
15	Jun-24	407.80	0.00	-407.80	0.00	-407.80	0.00	0.00	0.00	0.00
16	Jun-25	486.00	0.00	-486.00	0.00	-486.00	0.00	0.00	0.00	0.00
17	Jun-26	440.00	0.00	-440.00	0.00	-440.00	0.00	0.00	0.00	0.00
18	Jun-27	410.00	0.00	-410.00	0.00	-410.00	0.00	0.00	0.00	0.00
19	Jun-28	444.00	0.00	-444.00	0.00	-444.00	0.00	0.00	0.00	0.00
20	Jun-29	411.95	0.00	-411.95	0.00	-411.95	0.00	0.00	0.00	0.00
21	Jun-30	468.90	0.00	-468.90	0.00	-468.90	0.00	0.00	0.00	0.00
22	Jun-31	414.60	0.00	-414.60	0.00	-414.60	0.00	0.00	0.00	0.00
23	Jun-32	0.00	6.00	6.00	0.00	0.00	6.00	0.00	0.00	0.00
24	Jun-33	0.00	6.00	6.00	0.00	0.00	6.00	0.00	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-01	2.21	2.21	486.42	0.42	0.00	0.58	486.05	0.05	0 12:10	0 00:00	0.00	0.00
2	Jun-02	2.17	0.00	482.42	2.42	0.00	0.58	482.05	2.05	0 12:11	0 00:00	0.00	0.00
3	Jun-03	6.78	4.68	416.28	3.28	0.00	0.72	416.03	3.03	0 12:14	0 00:00	0.00	0.00
4	Jun-05	3.24	3.24	468.48	0.48	0.00	1.02	468.07	0.07	0 12:10	0 00:00	0.00	0.00
5	Jun-06	4.22	0.00	450.48	0.48	0.00	2.52	450.05	0.05	0 12:10	0 00:00	0.00	0.00
6	Jun-07	1.14	1.14	456.23	0.23	0.00	0.77	456.03	0.03	0 12:15	0 00:00	0.00	0.00
7	Jun-08	3.22	0.00	466.97	0.47	0.00	2.53	466.57	0.07	0 12:10	0 00:00	0.00	0.00
8	Jun-13	4.02	4.02	406.59	2.59	0.00	2.61	406.26	2.26	0 12:15	0 00:00	0.00	0.00
9	Jun-14	31.69	0.25	404.64	5.14	0.00	10.36	404.31	4.81	0 12:15	0 00:00	0.00	0.00
10	Jun-16	5.98	0.00	395.58	0.64	0.00	3.72	395.14	0.20	0 13:15	0 00:00	0.00	0.00
11	Jun-17	4.78	4.78	406.39	0.39	0.00	0.86	406.05	0.05	0 12:10	0 00:00	0.00	0.00
12	Jun-19	27.69	0.00	401.84	1.34	0.00	3.16	401.55	1.05	0 12:10	0 00:00	0.00	0.00
13	Jun-22	1.28	0.00	482.31	0.31	0.00	0.69	482.05	0.05	0 12:35	0 00:00	0.00	0.00
14	Jun-23	14.21	0.00	409.16	1.16	0.00	1.34	408.18	0.18	0 12:30	0 00:00	0.00	0.00
15	Jun-24	14.22	0.00	408.96	1.16	0.00	1.34	407.98	0.18	0 12:30	0 00:00	0.00	0.00
16	Jun-25	1.28	1.28	486.31	0.31	0.00	0.69	486.05	0.05	0 12:35	0 00:00	0.00	0.00
17	Jun-26	8.33	7.51	440.67	0.67	0.00	0.33	440.11	0.11	0 12:20	0 00:00	0.00	0.00
18	Jun-27	15.44	7.34	414.67	4.67	0.00	0.33	414.11	4.11	0 12:22	0 00:00	0.00	0.00
19	Jun-28	2.35	2.35	444.17	0.17	0.00	1.83	444.02	0.02	0 12:25	0 00:00	0.00	0.00
20	Jun-29	9.92	8.24	417.48	5.53	0.00	1.83	417.33	5.38	0 12:25	0 00:00	0.00	0.00
21	Jun-30	17.99	17.99	469.24	0.34	0.00	1.16	468.95	0.05	0 12:10	0 00:00	0.00	0.00
22	Jun-31	2.95	2.95	415.44	0.84	0.00	1.16	414.72	0.12	0 12:15	0 00:00	0.00	0.00
23	Jun-32	2.94	0.00	415.33	415.33	0.00	1.17	414.62	414.62	0 12:15	0 00:00	0.00	0.00
24	Jun-33	2.96	0.20	405.28	405.28	0.00	1.02	404.88	404.88	0 12:16	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Con-3	175.00	407.80	0.00	402.00	8.00	5.80	3.3100	Trapezoidal	1.000	40.000	0.0320	0.5000	0.5000	0.0000	0.00	No
2	Con-4	567.00	482.00	0.00	440.00	0.00	42.00	7.4100	Trapezoidal	1.000	7.000	0.0320	0.5000	0.5000	0.0000	0.00	No
3	Con-5	692.59	410.00	0.00	408.00	0.00	2.00	0.2900	Trapezoidal	2.000	40.000	0.0700	0.5000	0.5000	0.0000	0.00	No
4	Link-23	88.00	466.50	0.00	450.00	0.00	16.50	18.7500	Trapezoidal	3.000	19.000	0.0320	0.5000	0.5000	0.0000	0.00	No
5	Swale 4	220.00	486.00	0.00	482.00	0.00	4.00	1.8200	Trapezoidal	1.000	7.000	0.0320	0.5000	0.5000	0.0000	0.00	No
6	Swale 4 Lower	380.00	440.00	0.00	414.00	4.00	26.00	6.8400	Trapezoidal	1.000	7.000	0.0500	0.5000	0.5000	0.0000	0.00	No
7	Swale 9	395.00	444.00	0.00	417.31	5.36	26.69	6.7600	Trapezoidal	2.000	9.000	0.0100	0.5000	0.5000	0.0000	0.00	No
8	Swale4-Lower	875.00	480.00	0.00	416.00	3.00	64.00	7.3100	Trapezoidal	1.000	7.000	0.0320	0.5000	0.5000	0.0000	0.00	No
9	Swale4-Upper	273.00	486.00	0.00	482.00	2.00	4.00	1.4700	Trapezoidal	1.000	7.000	0.0320	0.5000	0.5000	0.0000	0.00	No
10	Swale-6	426.00	450.00	0.00	416.00	4.00	34.00	7.9800	Trapezoidal	1.000	3.000	0.0320	0.5000	0.5000	0.0000	0.00	No
11	Swale-7	256.00	414.50	414.50	404.80	404.80	9.70	3.7900	Trapezoidal	1.000	7.000	0.0320	0.5000	0.5000	0.0000	0.00	No
12	Swale-8	192.00	400.50	0.00	399.75	0.25	0.75	0.3900	Trapezoidal	3.000	39.000	0.0400	0.5000	0.5000	0.0000	0.00	No
13	Swale-8-lower	243.00	399.75	0.25	395.05	0.05	4.70	1.9300	Trapezoidal	4.000	47.000	0.0400	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Con-3	14.21	0 12:31	269.80	0.05	2.61	1.12	0.18	0.18	0.00		
2	Con-4	1.28	0 12:36	33.78	0.04	3.60	2.63	0.22	0.22	0.00		
3	Con-5	14.21	0 12:30	89.10	0.16	0.88	13.12	0.71	0.36	0.00		
4	Link-23	3.21	0 12:10	791.16	0.00	6.47	0.23	0.27	0.09	0.00		
5	Swale 4	1.28	0 12:35	16.73	0.08	2.16	1.70	0.31	0.31	0.00		
6	Swale 4 Lower	8.29	0 12:22	20.78	0.40	4.13	1.53	0.67	0.67	0.00		
7	Swale 9	2.34	0 12:25	387.71	0.01	10.01	0.66	0.17	0.09	0.00		
8	Swale4-Lower	2.12	0 12:14	33.56	0.06	4.20	3.47	0.28	0.28	0.00		
9	Swale4-Upper	2.17	0 12:11	15.02	0.14	2.31	1.97	0.42	0.42	0.00		
10	Swale-6	4.19	0 12:11	17.02	0.25	5.94	1.20	0.48	0.48	0.00		
11	Swale-7	2.92	0 12:16	24.16	0.12	3.52	1.21	0.38	0.39	0.00		
12	Swale-8	27.51	0 12:12	302.35	0.09	1.83	1.75	0.82	0.28	0.00		
13	Swale-8-lower	31.63	0 12:13	1206.44	0.03	3.24	1.25	0.56	0.14	0.00		

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	No. of Barrels
1	Con-2	38.00	408.00	0.00	407.80	0.00	0.20	0.5300	CIRCULAR	30.000	30.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	Culvert 12	52.00	406.20	2.20	404.25	4.75	1.95	3.7500	CIRCULAR	36.000	36.000	0.0150	0.5000	0.5000	0.0000	0.00	No	1
3	Culvert-10	42.00	403.50	-2.50	403.00	1.00	0.50	1.1900	CIRCULAR	15.000	15.000	0.0200	0.5000	0.5000	0.0000	0.00	No	2
4	Culvert-11	84.00	402.00	0.00	400.50	0.00	1.50	1.7900	CIRCULAR	36.000	36.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
5	Culvert-13	48.00	411.95	0.00	407.44	12.44	4.51	9.4000	CIRCULAR	24.000	24.000	0.0100	0.5000	0.5000	0.0000	0.00	No	1
6	Culvert-4	57.00	413.80	0.80	413.30	1.30	0.50	0.8800	CIRCULAR	30.000	30.000	0.0130	0.5000	0.5000	0.0000	0.00	No	1
7	CuLvert-5	91.00	456.00	0.00	450.00	0.00	6.00	6.5900	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
8	Culvert-6	88.00	468.00	0.00	466.50	0.00	1.50	1.7000	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
9	Culvert-8	33.00	414.60	0.00	414.50	414.50	0.10	0.3000	CIRCULAR	24.000	24.000	0.0200	0.5000	0.5000	0.0000	0.00	No	1
10	Culvert-9	77.00	404.80	404.80	403.60	1.60	1.20	1.5600	CIRCULAR	18.000	18.000	0.0130	0.5000	0.5000	0.0000	0.00	No	1
11	Link-16	97.00	394.94	0.00	394.10	0.10	0.84	0.8700	CIRCULAR	30.000	30.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
12	Pond 1-outlet	36.70	413.70	1.70	413.00	0.00	0.70	1.9100	CIRCULAR	18.000	18.000	0.0130	0.5000	0.5000	0.0000	0.00	No	1
13	pro culvert	50.00	405.40	-63.50	401.50	1.00	3.90	7.8000	CIRCULAR	18.000	18.000	0.0100	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Con-2	14.22	0 12:30	32.24	0.44	6.36	0.10	1.16	0.46	0.00		Calculated
2	Culvert 12	4.02	0 12:15	111.94	0.04	7.49	0.12	0.39	0.13	0.00		Calculated
3	Culvert-10	4.77	0 12:10	22.44	0.21	7.26	0.10	0.39	0.31	0.00		Calculated
4	Culvert-11	10.17	0 12:12	96.56	0.11	8.87	0.16	0.64	0.22	0.00		Calculated
5	Culvert-13	9.92	0 12:15	90.15	0.11	18.89	0.04	0.45	0.22	0.00		Calculated
6	Culvert-4	6.78	0 12:15	38.42	0.18	5.89	0.16	0.71	0.28	0.00		Calculated
7	CuLvert-5	1.13	0 12:15	9.91	0.11	8.39	0.18	0.23	0.23	0.00		Calculated
8	Culvert-6	3.22	0 12:10	14.86	0.22	6.73	0.22	0.48	0.32	0.00		Calculated
9	Culvert-8	2.94	0 12:15	8.09	0.36	2.38	0.23	0.83	0.42	0.00		Calculated
10	Culvert-9	2.95	0 12:16	13.11	0.23	5.99	0.21	0.47	0.32	0.00		Calculated
11	Link-16	5.98	0 13:15	41.35	0.14	5.99	0.27	0.64	0.26	0.00		Calculated
12	Pond 1-outlet	1.44	0 13:40	14.51	0.10	5.24	0.12	0.32	0.21	0.00		Calculated
13	pro culvert	17.99	0 12:10	158.55	0.11	50.00	0.02	0.34	0.23	0.00		Calculated

Storage Nodes

Storage Node : Pond 1

Input Data

Invert Elevation (ft)	412.00
Max (Rim) Elevation (ft)	416.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	412.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

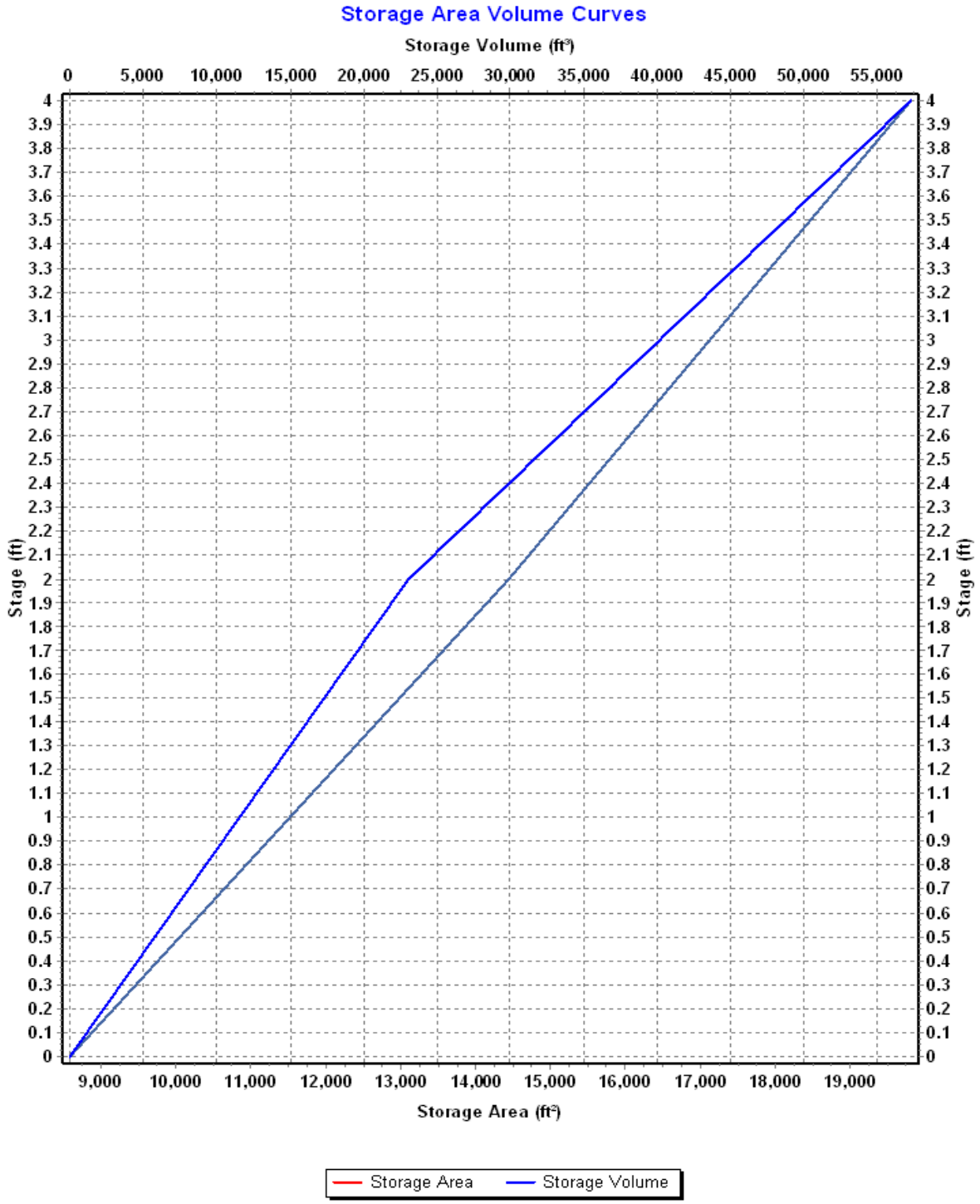
Infiltration/Exfiltration

Exfiltration Rate (in/hr)	0.5000

Storage Area Volume Curves

Storage Curve : Pond 1

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	8590	0.000
2	14434	23024.00
4	19806	57264.00


Storage Area Volume Curves
Storage Volume (ft³)
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
50,000
55,000
Stage (ft)
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
9,000
10,000
11,000
12,000
13,000
14,000
15,000
16,000
17,000
18,000
19,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : Pond 1 (continued)

Output Summary Results

Peak Inflow (cfs)	10.60
Peak Lateral Inflow (cfs)	0.53
Peak Outflow (cfs)	1.44
Peak Exfiltration Flow Rate (cfm)	10.06
Max HGL Elevation Attained (ft)	414.02
Max HGL Depth Attained (ft)	2.02
Average HGL Elevation Attained (ft)	412.93
Average HGL Depth Attained (ft)	0.93
Time of Max HGL Occurrence (days hh:mm)	0 13:40
Total Exfiltration Volume (1000-ft³)	7.856
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

Storage Node : Pond 3

Input Data

Invert Elevation (ft) 395.00
Max (Rim) Elevation (ft) 400.00
Max (Rim) Offset (ft) 5.00
Initial Water Elevation (ft) 395.00
Initial Water Depth (ft) 0.00
Ponded Area (ft^2) 0.00
Evaporation Loss 0.00

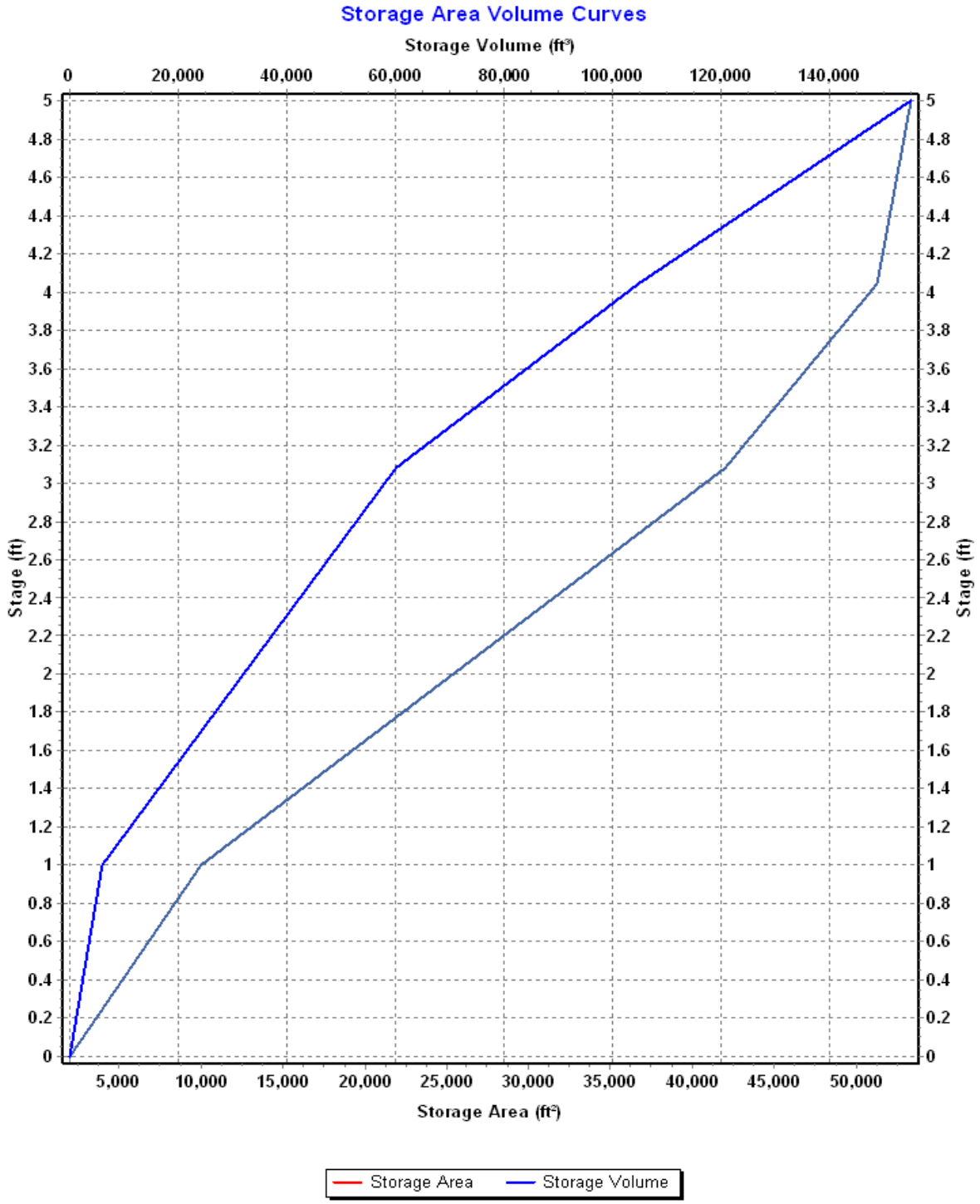
Infiltration/Exfiltration

Exfiltration Rate (in/hr) 0.5000

Storage Area Volume Curves

Storage Curve : Pond 3

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	2000	0.000
1	10000	6000.00
3.08	42000	60080.00
4.04	51218	104824.64
5	53323	155004.32


Storage Area Volume Curves
Storage Volume (ft³)
0
20,000
40,000
60,000
80,000
100,000
120,000
140,000
Stage (ft)
5
4.8
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
50,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : Pond 3 (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	Weir-01	Side	CIRCULAR	No	5.00			396.41	0.61
2	Weir-02	Bottom	CIRCULAR	No	15.00			398.08	0.61
3	Weir-03	Bottom	Rectangular	No		36.00	30.00	399.30	0.63

Output Summary Results

Peak Inflow (cfs)	42.82
Peak Lateral Inflow (cfs)	1.76
Peak Outflow (cfs)	5.98
Peak Exfiltration Flow Rate (cfm)	33.72
Max HGL Elevation Attained (ft)	398.76
Max HGL Depth Attained (ft)	3.76
Average HGL Elevation Attained (ft)	396.71
Average HGL Depth Attained (ft)	1.71
Time of Max HGL Occurrence (days hh:mm)	0 13:15
Total Exfiltration Volume (1000-ft³)	22.843
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

Storage Node : Swale-8

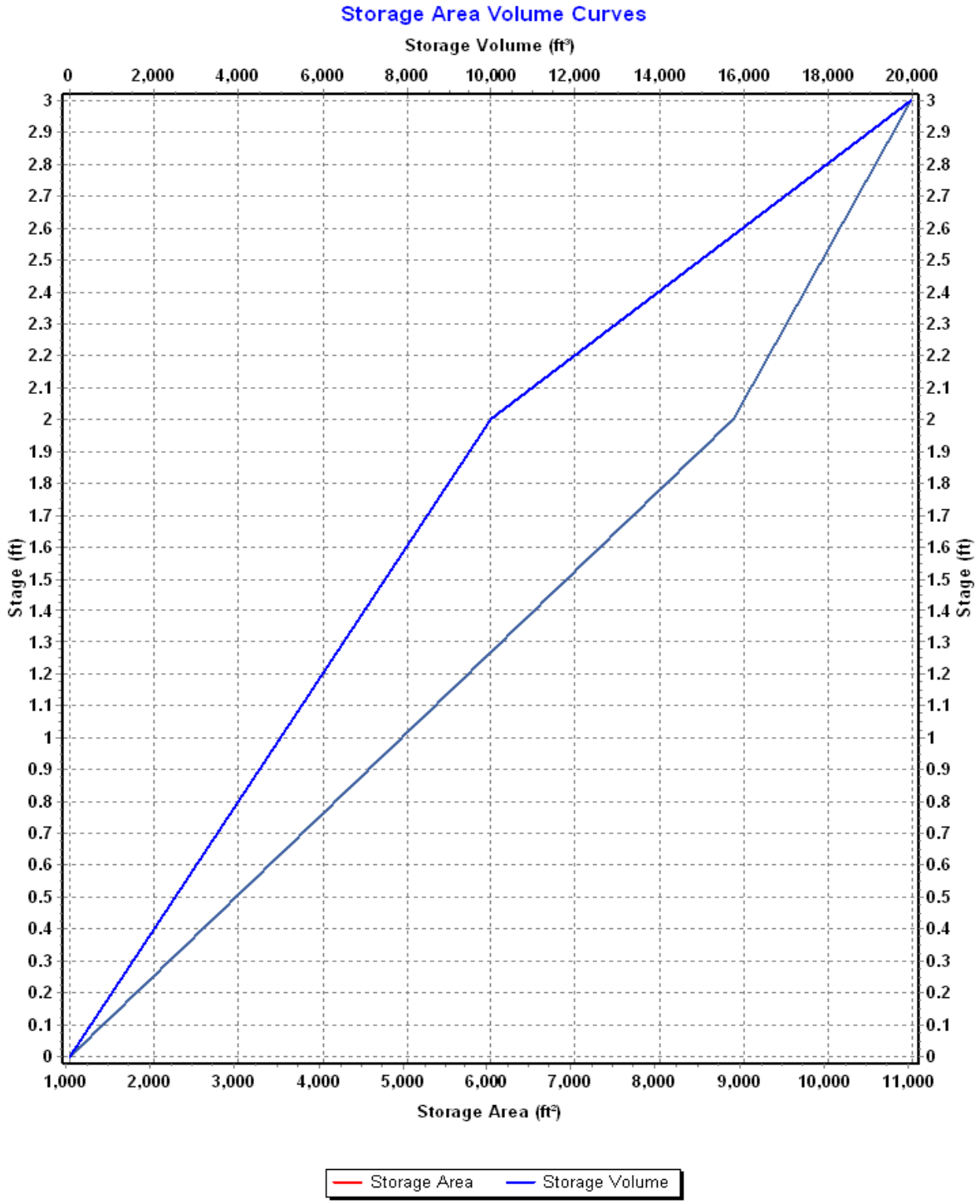
Input Data

Invert Elevation (ft)	402.00
Max (Rim) Elevation (ft)	405.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	-402.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Swale-8

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1050	0.000
2	8931.	9981.00
3	11030	19961.50


Storage Area Volume Curves
Storage Volume (ft³)
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
20,000
Stage (ft)
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : Swale-8 (continued)

Output Summary Results

Peak Inflow (cfs)	10.59
Peak Lateral Inflow (cfs)	3.65
Peak Outflow (cfs)	10.17
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	402.66
Max HGL Depth Attained (ft)	0.66
Average HGL Elevation Attained (ft)	402.10
Average HGL Depth Attained (ft)	0.1
Time of Max HGL Occurrence (days hh:mm)	0 12:12
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

APPENDIX C
TECHNICAL SPECIFICATIONS

01400	Quality Assurance/Quality Control (QA/QC)
02222	Excavation
02223	Filling
02232	Stone Fill
02234	Select Drainage Sand
02270	Erosion Control
02273	Drainage Geocomposite
02275	Non-Woven Geotextile Filter Fabric
02276	High Density Polyethylene (HDPE) Liner
02930	Loaming and Seeding
13001	Site Safety and Contingency Work Plan Outline

SECTION 01400
QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED
- A. General Quality Assurance and Quality Control
- B. Definitions
- C. QA/QC Personnel
- D. Testing Laboratory Services

1.02 RELATED REQUIREMENTS
- A. Special Conditions
- B. Supplementary General Conditions
- C. General Conditions
- D. Section 01005 - Administrative Conditions
- E. Section 01300 - Submittals
- F. Section 02223 - Filling
- G. Section 02270 - Erosion Control
- K. Section 02930 - Loaming and Seeding

1.03 GENERAL QUALITY ASSURANCE AND QUALITY CONTROL

A. The Contractor shall implement a QC plan designed to:
   - a. Control and maintain the quality of vendors, manufacturers, products, services, site conditions, and workmanship.
   - b. Produce work of the specified quality.
   - c. Maintain a safe working environment for all workers or personnel on the project site.
   - d. Fulfill the contractor's responsibilities enumerated in the Contract Documents.

B. The Owner shall pay for consultant or other services to provide QA tests or reviews in addition as identified for QA responsibilities in this section or other sections of the Contract Documents. These QA tests are in addition to tests, certifications, or other documentation that are the responsibility of the Contractor. If the results of supplemental QA testing indicate a defective or non-complying condition, the cost of removal, replacement, and follow-up tests and reviews shall be borne by the Contractor.

C. Specific QA/QC tests, procedures, reports, and responsibilities are included within appropriate sections of the Contract Documents related to the product or installation and may be included by reference to published standards.

1.04 DEFINITIONS

Construction Quality Assurance Plan: A system of activities that provide assurance that the facility was constructed as specified in the design. Construction quality assurance refers to measures taken by the QA organization to assess if the installer or contractor is in compliance with the plans and specifications for a project.

Construction Quality Control Plan: A planned system of inspections that are used to directly monitor and control the quality of a construction project. Construction quality control refers to measures taken by an installer or contractor to determine compliance with the requirements for materials and workmanship as stated in the plans and specifications for the project.

Engineer: A qualified professional engineer retained by the Owner to:

Administer the construction contract.
Provide technical coordination of the design, permitting, and construction issues.
Approve all construction contract change orders.
Monitor inspections and testing.
Provide statements and reports to regulating agencies.
Maintain construction records during the construction period.
Assure compliance with a QA Plan.

QA Inspector: A representative of the owner responsible for independent inspection of construction project materials, workmanship, systems, or components. The QA inspector may also be a representative of the project engineer.

1.05 QA/QC PERSONNEL

A. Contractor's Quality Control Manager (CQC)

1. The CQC Manager is the Contractor's representative in overall charge of the implementation of the QC Plan. The CQC Manager may have other responsibilities such as Contractor's Superintendent.

2. The CQC Manager shall be experienced in the fields of construction related to the project and may designate specific QC tasks to other Contractor's employees or Subcontractor's representatives for specialized installations.

3. The CQC Manager shall be responsible for the following:

a. Review of Contract Documents for the project.
b. Review and compilation of daily logs, test data, and other documentation.
c. Submission to the Engineer of all QC documentation required by the Contract Documents.

B. Engineer and Resident Project Representative

1. The Engineer is the Owner's representative in the administration of the Construction Contract.

2. The Engineer's Resident Project Representative works under the supervision of the Engineer, reports directly to the Engineer, and shall be experienced and knowledgeable about the project work.

3. The Engineer shall complete a certification for submittal to NHDES that based upon inspections and testing conducted or collected pursuant to the Contract Documents, the facility has been constructed in accordance with approved plans and specifications. The Contractor's full compliance with the contract documents, particularly with respect to all issues pertaining to the quality of the work, and the provision by the Contractor (and the Subcontractors) of all testing data required by the contract documents, are required in order for the Engineer to make this certification.

C. Quality Assurance Inspector

1. The Owner or Engineer may retain additional QA personnel to assist in the implementation of QA Plans.

2. The QA inspector shall have specific experience related to the assigned QA task(s).

3. The QA inspector may be the same individual as the resident project representative.

1.06 TESTING LABORATORY SERVICES

A. When required, the Owner shall retain and pay for services of an Independent Testing Laboratory to perform QC tests or other services to demonstrate acceptability or conformance of various work products with the Contract Documents.

B. Independent testing laboratory services will be performed in accordance with prevailing rules of governing authorities and with specified standards.

C. The Contractor shall comply with specified standards or protocols in the sampling, collection, documentation, and shipping of laboratory samples. The Contractor is responsible to obtain the services of qualified individuals to collect and ship samples, as necessary.

D. The Contractor shall notify the Engineer 72 hours prior to the expected time of sample collection.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 02222
EXCAVATION

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Excavation and processing of existing stockpiled materials.
B. Excavation of materials to prepare subgrade for proposed toe drain swales and storm water management systems.
C. Excavation for uncovering existing anchor trench for connection to capping system.
D. Excavation of ash residue for installation of passive gas vents and as otherwise required.

1.02 RELATED REQUIREMENTS

A. Section 01400 - Quality Assurance/Quality Control
B. Section 01500 - Construction Facilities and Temporary Controls
C. Section 02223 - Filling
D. Section 02270 - Erosion Control
E. Section 13001 - Site Safety and Contingency Work Plan

1.03 PROTECTION

A. Protect the bench-marks established for project construction.

B. Protect excavations by shoring, bracing, sheet piling, underpinning or other methods required to prevent cave-in or loose soil from falling into the excavation.

C. Notify the Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

D. Grade the perimeter to prevent surface water run-off into the excavation.

E. Barricade or otherwise protect, consistent with the project safety program, open excavations occurring as part of this work and post with warning lights.

F. Protect adjacent structures and facilities from damage caused by settlement, movement, undermining and other hazards created by earthwork operations.

G. Dust Control: Use all necessary means to control dust caused by the Contractor's operation. Prevent dust from being a nuisance to the public. The use of calcium chloride is not acceptable. Moisture addition must be limited so as not to

adversely affect soil handling. The use of other agents for dust control is subject to the approval of the Engineer.

H. Dewatering: Remove water from excavations to a point lower than the proposed subgrade of the work.

1.04 JOB CONDITIONS

A. SITE CONDITIONS: Existing intermediate cover system depicted may vary slightly from what will be encountered during the progress of the work. The existing information is made available for the Convenience of the Contractor and the Owner will not be responsible for minor deviations such as changes in depth of less than 2-feet.

1.05 DISTURBANCE OF EXCAVATED AND FILLED AREAS DURING CONSTRUCTION

A. The Contractor shall take the necessary steps to avoid subgrade disturbance during excavations, including dewatering and restricting the use of equipment in areas above optimum moisture level.

B. All areas disturbed during excavation that will not meet compaction requirements shall be removed and replaced with fill meeting structural requirements at no extra cost to Owner.

PART 2 PRODUCTS

2.01 MATERIALS

1. Loam: Loam materials to be excavated and processed from existing on-site stockpile shall be processed to 2” minus and as required to meet the requirements of Section 02930 – Loaming and Seeding.

2. Common Borrow: Soil to be excavated outside of the anchor trench for the installation of the toe drain swale and capping system termination and utilized as common borrow fill shall have all rocks and material greater than eight (8) inches in diameter removed. Common Borrow fill in contact with geosynthetic materials shall have a maximum particle size of one (1) inch. Suitable fill shall be free from combustible, organic, and frozen materials, loam, roots, topsoil, wood, trash, snow, ice and other objectionable material, or as identified by the Engineer, or laboratory analysis.

3. Buffer/Gas Sand and Select Drainage Sand Materials: Sand materials to be excavated and processed from an existing sand stockpile on-site shall be

processed as required to meet the requirements of Section 02223 – Filling and 02334 – Drainage Sand.

4. Unclassified Waste: Waste materials including soil cover and ash residue to be excavated for installation of passive gas vents, capping system termination or drainage systems as indicated on the Drawings. Waste materials may include ash residue and metals and some minor uncombusted waste materials.

5. Unsuitable Fill: Excavated material not meeting the requirements for reuse as topsoil or fill due to excess moisture, trash, organics, or other unsatisfactory materials.

PART 3 EXECUTION

3.01 PREPARATION

A. Set and verify required lines and grades prior to starting the excavation. This work should be performed and verified by a registered land surveyor or professional engineer licensed to practice in the State of New Hampshire.

B. It will be the responsibility of the Contractor to establish a construction baseline on-site. The Contractor shall perform all necessary construction layout from this baseline, maintain the baseline as necessary, and perform whatever survey is required to control his work.

3.02 EXCAVATION

A. Excavation consists of the removal and stockpiling or disposal of materials encountered when establishing required grade elevations as shown on the Plans and in accordance with these Specifications. If rock boulders greater than twelve (12) inches diameter are encountered within six (6) inches of the depth of excavation, they shall be removed and the resulting hole shall be backfilled with Common Borrow.

B. Excavation for utilities: The trench for the pipes shall be excavated to the required line and grade and of sufficient width to permit thorough compacting and tamping of the fill material under the haunches and around the pipe. In general, utility trenches shall be excavated to 6 inches below the bottom of the utility line to accommodate bedding material as specified hereinafter. Soft or unsuitable material encountered below the normal bedding line of the pipe shall be removed as directed, replaced with regular fill, and thoroughly compacted.

C. Excavation for structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 feet, and extending a sufficient distance from

structures to permit installation of service, other construction required, and for inspection.

D. Excavation of Unclassified Waste Material: Excavation of existing cover material and waste material for construction landfill gas vents or drainage systems shall be completed to the limits indicated on the Drawings. All work will be completed in accordance with the Site Safety and Contingency Work Plan developed by the Contractor, in accordance with Section 13001. Excavated waste materials shall be placed in the landfill at a location designated by the Owner.

3.03 COMPACTION OF EXCAVATED SUBGRADE

A. Upon completion of the excavation to proposed subgrade, the conditions shall be inspected by the Engineer for acceptance. The entire area shall be fine graded to remove undulations or isolated high or low spots. The subgrade shall be proof rolled, and any soft yielding areas shall be excavated and backfilled with common borrow.

B. Compaction equipment in open areas shall consist of vibratory rollers, or other equivalent compaction equipment reviewed by the Engineer.

C. Compaction equipment in confined areas (in trenches and adjacent to walls, piers, footings and standpipes) shall consist of hand-guided vibratory equipment or mechanical tampers reviewed by the Engineer.

3.04 STOCKPILING

1. Existing stockpiles from which sand and topsoil materials are removed shall be graded and shape for proper drainage following completion of the excavation work. Erosion control devices shall be used as necessary to contain sediment transport.

2. Fill unsuitable for use as regular fill and excess materials shall be handled in accordance with Part 3.05.

3.05 DISPOSAL OF UNSUITABLE and EXCESS MATERIALS

The Contractor shall dispose of all unsuitable and excess materials on-site in a location or locations designated by the Owner or as shown on the Plans. Contractor shall take no material from the site.

Unsuitable and excess materials are defined as follows:

A. Unsuitable Material: Material containing significant clay, silt, or organic material, or material greater than eight inches (8") in diameter, or other materials identified on the contract drawings.

B. Excess Materials: Materials not meeting the definition in “A” above but which do not meet any of the specifications for materials required for this project, and/or materials in excess of the total quantity of materials required for this construction project.

C. No material shall be removed from the site. Unsuitable and excess materials shall be stored at separate locations on site as directed by the Owner.

3.06 STABILITY OF EXCAVATIONS

A. Slope sides of excavations to comply with OSHA regulations and local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible due to space restrictions or instability of material excavated. Maintain the sides and the slopes of excavations in a safe condition until completion of backfilling.

B. Shoring and bracing: Provide adequate shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition. Trench shoring and bracing shall comply with local codes and authorities having jurisdiction. Maintain shoring and bracing in excavation regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses. All temporary shoring and bracing plans shall be designed and stamped by a New Hampshire licensed professional engineer.

3.07 DEWATERING

A. Control of surface water is a critical requirement of the work. All necessary actions shall be taken to minimize the effect of precipitation and runoff on the work. Upgradient runoff shall be diverted from active or completed work areas, and all work shall be graded and crowned to promote runoff.

B. The Contractor shall prevent surface water and subsurface or groundwater from flowing into excavations or onto any work and from flooding the project site and surrounding area.

C. Water shall not accumulate in excavations. Contractor shall remove water to prevent softening of subgrades and soil changes detrimental to stability of the subgrade. The Contractor shall dewater excavated areas as required to perform the work, and in such a manner as to preserve the undisturbed state of subgrade material.

D. The Contractor shall provide and maintain pumps, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

E. The Contractor shall prevent migration of sediment in accordance with erosion control requirements of this Contract.

3.08 COLD WEATHER PROTECTION

A. Protect excavation bottoms against freezing when the atmospheric temperature is less than 35º F. The Contractor shall take whatever actions are necessary during the period of construction, to prevent freezing of any areas which are to receive fill as part of this work. No fill shall be placed on areas which are frozen. The Contractor shall also comply with the requirements of Section 203, Paragraph 3.7.8 of the NHDOT Standard Specifications.

3.09 REMOVAL OF UNSATISFACTORY SOIL MATERIALS

A. Unsatisfactory soil materials shall be as defined in Paragraph 3.05 (unsuitable materials).

B. Excavate unsatisfactory soil materials encountered that extend below required elevations, to the additional depth directed by the Engineer. Do not over-excavate without prior authorization of the Engineer.

C. Such additional excavation, provided it is not due to fault or neglect of Contractor, will be measured as directed by Engineer and paid for in accordance with the measurement and payment section.

D. Material that is above or below optimum moisture for compaction of the particular material in place as determined by the Engineer, and is disturbed by the Contractor during construction operations so that proper compaction cannot be reached shall be construed as unsuitable bearing material or unsatisfactory soil material. This material shall be removed and replaced with compacted gravel fill at no additional charge to the Owner.

END OF SECTION

SECTION 02223
FILLING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Placing, and compaction of common borrow fill.
B. Furnishing, placing and compaction of moisture retention layer.
C. Coordination with the Engineer for completion of all required tests.

1.02 RELATED REQUIREMENTS

A. Section 01300 - Submittals
B. Section 01400 - Quality Assurance/Quality Control
C. Section 02222 - Excavation
D. Section 02232 - Stone Fill
E. Section 02234 - Select Drainage Sand
F. Section 02270 - Erosion Control
G. Section 02930 - Loaming and Seeding

1.03 REFERENCES

A. ASTM C136/C117 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregate and Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing

B. ASTM D1557 Method "C" - Moisture-Density Relations of Soils and Soil-Aggregate Mixture using 10 lb. (4.54 kg) Hammer and 18-inch (457 mm) Drop.

C. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.

D. ASTM D6938 - 08a Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

E. ASTM D5084 - Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

F. ASTMD5321 – Standard Test Method for Direct Shear Testing of Geosynthetic Material and Soil Interfaces.

1.04 TESTS

A. Soil testing and compaction tests shall be performed by the Engineer in coordination with the Contractor.

B. Test and analysis of fill materials shall be performed by the Engineer in coordination with the Contractor.

C. Tests and analyses of fill materials will be performed in accordance with ASTM C136/C117, ASTM D1557, ASTM D6938-08a, ASTM D5084 and ASTM D5321 and conditions set forth in Section 02223, 2.02 "Quality Control and Quality Assurance."

PART 2 PRODUCTS

2.01 FILL

A. General

For all fill materials to be used, samples, sieve analysis, and laboratory data indicating maximum dry densities and optimum moisture for field control tests shall be obtained by the Engineer prior to use as fill on site. The Contractor shall excavate, screen, and stockpile materials as required for sampling by the Engineer prior to delivery and placement.

B. Common Borrow Fill

Suitable borrow from on site excavation to be utilized as common borrow fill shall consist of soil with all rocks or material greater than 8" removed and no more than 30% passing the No. 200 sieve. Suitable fill shall be free from combustible, organic and frozen materials, loam, roots, topsoil, wood, trash, snow, ice, and other objectionable materials, or as identified by the Engineer.

D. Other

For other fill materials see Section 02234 – Select Drainage Sand and Buffer/Gas Sand and Section 02930 – Loaming and Seeding, as applicable.

2.02 QUALITY CONTROL AND QUALITY ASSURANCE

A. During earthwork operations, the Engineer will be present on the site to monitor and document the Contractor's activities relative to contract compliance.

B. The Engineer shall complete laboratory analyses of a minimum of one (1) representative sample of select drainage sand and buffer/gas sand materials. The Engineer shall conduct laboratory grain size analysis and moisture density testing on each sample in accordance with ASTM C136/C117 and ASTM D1557.

C. The Contractor shall provide a sample for Engineer's laboratory analysis of at least one (1) representative sample of common borrow fill. The Engineer shall conduct laboratory grain size analysis and moisture density testing in accordance with

ASTM C136/C117 and D1557, respectively, to demonstrate conformance with Parts 2.01 and 3.02 of this Section.

D. The results of laboratory testing shall be reviewed by the Engineer prior to placement of fill materials. Costs for re-sampling and subsequent laboratory testing of all non-complying materials shall be borne by the Contractor.

E. Field tests will be performed by the Engineer on in-place fill and backfill materials to confirm that specified densities are being achieved with the minimum required coverages and compaction equipment utilized by the Contractor. The Engineer will select locations and frequency for in-place density testing. At a minimum, the frequency of field tests shall be as follows:

1. Common Borrow Fill: 1 test per 10,000 ft^3 installed

F. Acceptable materials placed and compacted to below the specified density shall alternatively be:

1. Recompacted as required to achieve the specified density.
2. Removed and replaced with properly placed and acceptably compacted material.

G. Materials placed and compacted which do not conform to project specifications for the area placed shall be removed and replaced with suitable material by the Contractor.

H. The Contractor will bear all costs incurred in the recompaction, removal, and replacement of fill not meeting density requirements.

PART 3 EXECUTION

3.01 PREPARATION

A. Fill to be used must be reviewed by the Engineer.

B. The subgrade which is to receive the fill shall be fine-graded and compacted in accordance with Section 02222 – Excavation and reviewed by the Engineer.

C. All excavated surfaces shall be within 0.10'(+) and 0.20'(-) ft. of required line and grade.

D. Surfaces to be filled against which are steeper than 4:1 shall be scarified or stepped and compacted to provide a bond with the new material.

E. Fill materials will not be placed or compacted on frozen ground or during unfavorable weather conditions. Backfill operations will not be resumed until the moisture content and fill density are satisfactory to the Engineer.

F. All fill material shall be placed “in-the-dry” on a prepared ground surface acceptable to the Engineer. The Contractor shall drain away ponded areas as required to perform the placement of fill in-the-dry.

3.02 FILLING AND COMPACTION

A. Approved suitable material shall be installed in lifts no greater than as specified.

B. Lifts within utility trenches outside the landfill shall be compacted to at least the specified percentage of maximum dry density, within 3% of optimum moisture content. Field testing of these lifts will be performed in accordance with ASTM D6938-08a, and Paragraph 2.02 of this Section.

C. Do not proceed with the next layer of fill until the preceding layer has been tested and approved by the Engineer.

D. Areas at which tests indicate insufficient compaction shall be recompacted and retested until the areas conform to the requirements of this specification.

E. For the materials specified herein, the following placement and compaction requirements are included:

	Maximum Lift Before Compaction	Minimum % of Maximum Density per ASTM D1557
Common Borrow Fill	12"	95

3.03 BACKFILLING OF UTILITES AND PIPING

A. After pipes and joints have been inspected and approved by the Engineer, Select Drainage Sand (see Section 02234) or Crushed Stone (see Section 02232) shall be carefully placed and compacted and tamped in 6-inch layers under, around, and to the spring line of the pipe to firmly support the pipe, and prevent lateral movement.

B. Care shall be taken to provide recesses in the bedding or trench bottom, as required, to relieve each bell of any load.

C. Backfill from the top of the bedding to 12-inches above the pipe shall be completed in 12-inch layers with Select Drainage sand, evenly on both sides of the pipe.

D. The remainder of the backfill may be material removed from the trench excavation and shall be placed in approximately 12-inch layers and compacted to 95% of the maximum dry density, as demonstrated by in-place density testing completed by the Engineer.

3.03 FINAL GRADING

A. Perform all finish grading required to attain the elevations shown on the Plans, to within 0.1 feet, to eliminate all ponded water, or as otherwise indicated.

B. Areas to be seeded shall be raked to remove all stones and other unsatisfactory material, and shall be suitably compacted.

3.04 TREATMENT AFTER COMPLETION OF GRADING

A. After grading is complete and the Engineer has finished his reviews, the Contractor shall permit no further excavating, filling, grading, or vehicular access except to maintain erosion or sediment control. Use all means necessary to prevent erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

END OF SECTION

SECTION 02232
STONE FILL

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Procurement of select gravel, stone fill, and crushed stone materials.

B. Placement of stone fill for stabilization of drainage swales and slopes or as select materials around landfill gas collection piping as shown on the Drawings or as ordered by Engineer.

1.02 RELATED REQUIREMENTS

A. Section 02275 - Non-Woven Geotextile Fabric
B. Section 02270 - Erosion Control
C. Section 02273 - Drainage Geocomposite

PART 2 PRODUCTS

2.01 MATERIALS

A. Stone Fill for Stabilization of Drainage Swales, and Toe Drains:

1. Stone fill shall conform to NHDOT Specifications for Stone Fill Class C and Class D, Section 585 “Stone Fill.”

2. Stone fill shall be hard, durable, angular in shape; resistant to weathering and to water action; free from overburden, spoil, and organic material.

3. The acceptability of the processed stone will be determined by visual inspection or by suitable tests. If testing is required, suitable samples of stone shall be taken in the presence of the Engineer at least fourteen (14) days in advance of the time when the placing of stone fill is expected to begin.

4. Control of gradation will be by visual inspection. If necessary, the Contractor shall provide two (2) samples of rock, at least five tons (5T) each, meeting the gradation specified above. These samples shall be used as a reference for judging the gradation of the stone fill supplied.

5. Any difference of opinion between the Engineer and the Contractor shall be resolved by dumping and checking the gradation of two (2) random truckloads of stone. Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided by the Contractor at no additional cost of the Owner.

B. 3/4” Crushed Stone

1. Crushed stone shall be durable crushed rock consisting of the angular fragments obtained by breaking and crushing solid or shattered natural rock, and reasonably free from sand, clay, loam or deleterious material and not more than one percent (1%) of satisfactory material passing a No. 200 sieve will be allowed to adhere to the crushed stone.

2. The crushed stone shall be uniformly blended according to the grading requirements for the respective stone sizes shown in the following table:

Square Opening Sieve	% Passing by Weight
3/4”	90 - 100
3/8”	20 - 55
#4	0 - 20
#20	0 - 5

C. Select Gravel

1. The select gravel shall be composed of hard, durable stone and coarse to fine sand, free from loam and clay and undesirable organic matter.

2. The gravel shall be well-graded and contain no stone greater than one and one half inches (1½") and meet the requirements of NHDOT 304.4 (Crushed Stone Fine),including the modified gradation below.

Square Opening Sieve	% Passing by Weight
2”	100
1½”	85 - 100
¾”	45 - 75
#4	10 - 45
#40	0 - 10
#200	0 - 5

PART 3 EXECUTION

3.01 PLACEMENT OF STONE FILL STABILIZATION

A. Stone fill in the landfill shall be placed directly over the drainage geocomposite and select gravel materials as shown on the Drawings.

B. Stone fill and select gravel in drainage benches and swales shall be placed directly over a 10 oz. non-woven geotextile fabric or drainage geocomposite (as shown on the Drawings) starting at the downstream end.

C. Stone fill for culvert outlet protection shall be placed directly over a 10 oz. non-woven geotextile fabric, respectively, to the limits shown on the Plans.

D. All stone fill shall be placed in a manner which will produce a reasonably well-graded mass of stone with the minimum practicable percentage of voids. The entire mass of stone shall be placed, so as to be in conformance with the lines, grades, and thicknesses shown on the plans.

E. Stone fill shall be placed to its full course thickness at one operation and in such a manner as to avoid displacing the underlying material. Placing of stone fill in layers, or by dumping into chutes, or by similar methods likely to cause segregation, will not be permitted.

F. The larger stones shall be well distributed and the entire mass of stone shall conform to the gradation specified in paragraph 2.01. All material going into stone fill protection shall be so placed and distributed that there will be no large accumulations of either the larger or smaller sizes of stone.

G. It is the intent of these specifications to require compact stone fill protection in which all sizes of material are distributed within their proper proportions. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the results specified.

END OF SECTION

SECTION 02234
SELECT DRAIANGE SAND AND BUFFER/GAS SAND

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Processing of existing of sand materials to produce a select drainage sand and placement of the six (6) inches as the gas transmission layer and twelve (12) inch layers of select drainage sand as part of the landfill capping system, and at greater thicknesses as shown on the Drawings.

1.02 RELATED REQUIREMENTS

A. Section 01300 - Submittals
B. Section 01400 - Quality Assurance / Quality Control
C. Section 02223 - Filling
D. Section 02273 - Drainage Geocomposite

1.03 REFERENCE STANDARDS

A. ASTM C136/C117 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregate and Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing

B. ASTM D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort

C. ASTM D5084: Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

D. ASTM D5321: Test Method for Direct Shear Testing of Geosynthetic Material and Soil Interfaces

E. ASTM D4373: Test Method for Determining Calcium Carbonate Content of Soils

1.04 SUBMITTALS

A. The Contractor shall provide a sample for laboratory testing by the Engineer to determine that the select drainage sand and buffer/gas meets the specified grain size distribution for at least every 3,000 CY processed for use.

B. The Contractor shall submit all proposed low ground pressure (LGP) equipment for Engineer's review.

C. The Engineer shall complete direct shear interface tests of the select drainage sand and the proposed drainage geocomposite to demonstrate compliance of interface friction, in accordance with Part 2.01 of this Section.

D. The Contractor shall provide one sample for laboratory testing by the Engineer for calcium carbonate content from each source of select drainage sand.

PART 2 PRODUCTS

2.01 SELECT DRAINAGE SAND AND BUFFER/GAS SAND

A. Select drainage sand shall be well graded sand without excessive fines, free from loam clay, and organic matter and meeting the following grain size distribution:

U.S. Standard Sieve Size	% Finer By Weight
1 in.	100
#4	85-100
#10	60-95
#40	20-60
#100	0-20
#200	0-12

B. Select drainage sand shall not contain more than 15 percent calcium carbonate as determined by ASTM D 4373. At least one test shall be performed on a representative sample from each source.

C. The interface shear strength testing requirements for the select drainage sand and drainage geocomposite are specified in Section 02273, 2.04.D.

D. The interface shear strength testing requirements for the buffer/gas sand and geomembrane are specified below.

1. Contractor shall provide samples of the proposed materials required for interface testing, as specified below, to the Engineer for testing prior to shipment to the site. Laboratory testing shall demonstrate that the interface shear strength is equal to or greater than a strength envelope of 26.5° or a total interface shear strength of 114 psf at a 240 psf overburden load.

2. The interface shear strength shall be determined by an interface shear test performed in accordance with ASTM D5321. The normal stresses applied shall be 1, 2 and 3 psi, all under inundated conditions. The strain rate shall not exceed 0.04 inches per minute. The 40-mil textured HDPE geomembrane shall be tested in the machine direction. The tests shall be continued until residual shear strengths are achieved, or to a maximum 2-inch displacement.

The laboratory test reports shall include plots of shear strength versus normal stress for peak and large displacement values, and stress versus strain plots for tests run at each normal load application. A minimum of two (2) tests shall be completed for each interface.

3. Test results that do not meet the minimum requirements are to be reviewed by the Engineer for possible conformance with the overall design objectives.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that the stockpiled select drainage sand is reviewed by the Engineer.

B. Verify the lines and grades to which the select drainage sand is to be placed and compacted.

C. Verify that the area on which select drainage sand is to be placed is free from debris, snow, ice, or water and that the ground surface is not frozen.

3.02 PLACEMENT OF MATERIALS

A. Placement of the select drainage sand over geomembrane and drainage geocomposite materials shall be by "low ground pressure" (LGP) rated equipment having a bearing pressure of no greater than 4.7 pounds per square inch measured at 12 inches above the geomembrane. No equipment will be allowed at any time directly on the liner or geotextile fabric.

B. Select drainage sand shall be placed by LGP equipment in lifts no less than the proposed minimum thickness for that area. In no case shall this be less than 12 inches.

C. Non LGP equipment which is necessary to operate over the landfill shall be operated on additional depths of sand or other materials to provide an equivalent bearing pressure of 4.7 pounds per square inch at 12 inches above the geomembrane.

D. Select drainage sand shall be placed on side slopes steeper than 4:1 starting from the bottom of the slope and proceeding in an upward direction. The Contractor shall exercise caution when operating on side slopes and shall limit turning and braking.

E. Coordinate placement and compaction of the select drainage sand with the installation of other components of work shown on the Plans, taking all measures to prevent damage to these materials while placing the select drainage sand.

F. The select drainage sand layer will be spread to a consistent depth and uniform surface, being compacted only by passage of the low ground pressure machinery. No vibratory equipment is to be used in compacting the select drainage sand.

G. The select drainage sand layers may not require testing for compaction densities if the Engineer believes that the sand is being placed in layers and compacted as required. If requested by Engineer, Contractor shall coordinate for testing by the Engineer to demonstrate a minimum 90% of maximum dry density is achieved.

END OF SECTION

SECTION 02270
EROSION CONTROL

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Installation and maintenance of temporary erosion control devices.

B. Erosion control measures to fully manage runoff and potential erosion conditions which may develop during construction and prior to the functioning of completed permanent erosion control devices.

C. Compliance with federal, state and local regulations pertaining to erosion control, and the Alteration of Terrain Permit, and NPDES Construction General Permit conditions for this project.

1.02 RELATED REQUIREMENTS

A. Section 02222 - Excavation
B. Section 02223 - Filling
C. Section 02232 - Stone Fill

1.03 DESIGN CRITERIA

A. Conduct all construction in a manner and sequence that causes the least practical disturbance of the physical environment.

B. Stabilize disturbed earth surfaces in the shortest practical time and employ any and all such temporary erosion control devices as may be necessary until such time as adequate soil stabilization has been achieved.

C. The erosion control devices shown on the Drawings and as specified herein represent the minimum required work for erosion control. The Contractor shall add to these minimum devices any and all measures to effectively prevent migration of sediment from the work area.

PART 2 PRODUCTS

2.01 BALED HAY

20” x 20” x 30” – 40 lbs/bale minimum, free from primary noxious week seeds and rough or woody materials.

2.02 SAND BAGS

Heavy cloth bags of approximately one cubic foot capacity filled with sand or gravel.

2.03 MULCH

Mulch shall consist of cured hay. When air dried in the loose state, the contents of a representative bale shall lose not more than 15 percent of the resulting air dry weight of the bale. It shall be free from primary noxious weed seeds and rough or woody materials.

2.04 EROSION CONTROL BLANKET

A. Erosion control blankets shall be Curlex II, manufactured by American Excelsior Company, DS75 manufactured by North American Green, or approved equal.

B. The Contractor shall store the blanket in a manner which protects them from damage by construction traffic and extended ultraviolet exposure.

C. Type of fasteners and their spacing shall be in accordance with the manufacturer's recommendations.

2.05 STONE FILL

As defined in Section 02232 – Stone Fill and as required by the Plans. Stone used for stone check dams shall be crushed stone as defined in Section 02232.

2.06 SILT FENCE

A. The silt fence shall be Propex Silt-Stop sediment control fabric or approved equal.

B. Support poles and fastenings to be used shall be as specified by the manufacturer.

C. Spacing and location of poles and fastenings shall be in accordance with the manufacturer's recommendations, or more frequently if required.

2.07 TEMPORARY SEEDING

Prior to establishment of the final vegetation on disturbed areas, placement and establishment of temporary grasses will be completed if required. Seed for temporary control shall be annual or perennial ryegrass. Hay mulch shall be applied to temporary seeded areas at a rate of 1½ to 2 tons per acre.

2.08 BONDED FIBER MATRIX

A. Bonded fiber matrix shall be installed on all vegetated slopes steeper than 4:1. Acceptable manufacturers include:
   1. Mat Inc. (Soil Guard);
   2. Central Fiber Corporation (Spray Matt);
   3. Terra Novo (Earthguard Fiber Matrix); or
   4. Approved equal.

PART 3 EXECUTION

3.01 TEMPORARY EROSION CHECKS

A. Construct temporary erosion checks in ditches and other locations required to effectively control erosion.

B. The erosion control procedures shall conform to NHDOT Specifications, Division 600, Section 645 – Erosion Control.

C. Construct temporary barriers along the toe of embankments when necessary or as designated by the Engineer.

D. Construct temporary side drains in intervals as necessary or as designated by the Engineer.

E Hay bale barriers and stone check dams shall be installed in drainage swales where shown on the Plans. Hay bales will be staked and maintained prior to and during construction until disturbed areas have a healthy stand of grass and sediment transport has ceased. Additional hay bale barriers may be required as conditions dictate, and shall be placed as necessary.

F. Silt fence shall be installed along the limits of work where shown on the Plans, and at any other locations as necessary to control erosion as conditions dictate.

3.02 BONDED FIBER MATRIX

A. Contractor shall apply a Bonded Fiber Matrix on vegetated slopes steeper than 4H:1V in accordance with the manufacturers' recommendations for long-term erosion control.

3.03 INSTALLATION OF EROSION CONTROL BLANKET

A. CHANNEL INSTALLATION

1. Erosion control blankets shall be installed as directed by the Engineer in accordance with manufacturer's instructions. The extent of erosion control blankets shall be as shown on Drawings.

2. Erosion control blankets shall be installed parallel to the flow of water. The first roll shall be centered longitudinally in mid-channel and anchored with staples, as required by the manufacturer. Subsequent rolls shall follow from channel center outward and be abutted to allow installation of a common row of staples.

3. Successive lengths of erosion control blankets shall be overlapped ("shingled") sufficiently for a common row of staples with the upstream end on top. Staple the overlap across the end of each of the overlapping lengths.

4. A trench shall be located at the upstream termination. Erosion control blanket shall be stapled to the bottom of the trench. Backfill and compact the trench.

B. SLOPE INSTALLATION

1. Erosion control blankets shall be installed as directed by the Engineer in accordance with manufacturer's instructions. The extent of erosion control blankets shall be as shown on Drawings, where required.

2. Erosion control blankets shall be oriented in vertical strips and anchored with staples, as required by the manufacturer. Adjacent strips shall be abutted to allow for installation of a common row of staples. Horizontal joints between erosion control blankets shall be overlapped sufficiently for a common row of staples ("shingled") with the uphill end on top.

3. Where exposed to overland sheet flow, a trench shall be located at the uphill termination. Erosion control blanket shall be stapled to the bottom of the trench. Backfill and compact the trench.

4. Where terminating in a channel, slope erosion control blanket shall overlap channel erosion control blanket sufficiently for a common row of staples.

3.04 EROSION CONTROL IMPLEMENTATION

A. During construction and thereafter, erosion control measures are to be implemented as shown on the Plans, and additionally as may be necessary to manage conditions as they occur. The smallest practical areas of land should be exposed at any one time during development. When the land is exposed during development, the exposure should be kept to the shortest practical period of time as approved by the Engineer.

B. Erosion rills or gullies in the Work area or in areas topographically below the work area shall be regraded and seeded at no additional cost to the Owner until an accepted vegetative stand is established.

END OF SECTION

SECTION 02273
DRAINAGE GEOCOMPOSITE

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnishing and installation of drainage geocomposite materials, consisting of an HDPE drainage net bonded on both sides to non-woven polypropylene geotextile fabrics.

1.02 RELATED REQUIREMENTS

A. Section 01300 - Submittals
B. Section 01400 - Quality Assurance/Quality Control
C. Section 02223 - Filling
D. Section 02234 - Select Drainage Sand
E. Section 02276 - High Density Polyethylene (HDPE) Liner

1.03 QUALITY CONTROL

A. Provide the manufacturer's certification that the drainage geocomposite has been manufactured and successfully tested in accordance with the appropriate ASTM standards.

B. Drainage geocomposite shall be supplied in rolls marked or tagged with the following:
1) Name of manufacturer.
2) Product identification.
3) Lot number.
4) Roll number.
5) Roll dimensions.

1.04 SUBMITTALS

A. The Contractor shall submit manufacturer or laboratory data indicating that the proposed materials meet the specifications outlined in Part 2.02, 2.03 and 2.04 A, B and C of this section.

B. The Contractor shall submit quality control certificates issued by the manufacturer for the geonet and geotextile components of the drainage geocomposite. The certificates shall include roll numbers and identification, and results of quality control tests completed at the minimum frequency specified in Part 2 of this section.

C. The Contractor shall submit representative samples form the proposed drainage geocomposite to the Engineer for transmissivity testing and interface shear strength testing per Part 2.04 of this section.

D. Requirements for testing of interface shear strength between the drainage geocomposite and the textured HDPE geomembrane and the drainage geocomposite and the proposed select drainage sand are included in Part 2.04 of this section.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. GSE Fabrinet HF Geocomposite
B. SKAPS Transnet 270-2-8
C. Approved equivalent

2.02 NON-WOVEN POLYPROPYLENE GEOTEXTILE FILTER FABRIC

A. The filter fabric on all of the geocomposite materials shall consist of an 8 oz non-woven continuous polypropylene filament fibers. It shall be tear resistant and be capable of conducting water.

B. The fabric shall retain its durability and strength when it is wet.

C. The Contractor shall provide quality control certificates from the manufacturer for the fabric used in the manufacturing of the drainage geocomposite. The filter fabric shall have the following minimum physical properties as determined by the appropriate test method.

Physical Property	**Test Method**	**Frequency**	**Minimum Average Roll Values Physical Properties**
Fabric Weight	ASTM D5261	1/90,000 SF	8.0 oz./yd^2
Water Flow Rate	ASTM D4491	1/540,000 SF	95 gpm/ft^2
Grab Strength[1]	ASTM D4632	1/90,000 SF	220 lbs
CBR Puncture Resistance	ASTM D6241	1/90,000 SF	600 lbs
Apparent Opening Size[2]	ASTM D4751	1/540,000 SF	Sieve Seize #80

1. Weakest Principal Direction
2. AOS sieve # must be ≥ #80

2.03 HIGH DENSITY POLYETHYLENE (HDPE) DRAINAGE NET

A. The Contractor shall provide quality control certificates from the manufacturer for the drainage net used in the manufacturing of the drainage geocomposite. The HDPE drainage net shall have the following minimum physical properties as determined by the appropriate test method.

Physical Property	Test Method	Frequency	Minimum Average Value
Polymer Density	ASTM D1505	1/50,000 SF	0.94 g/cm^3
Carbon Black Content	ASTM D4218	1/50,000 SF	2%
Nominal Thickness	ASTM D5199	1/50,000 SF	250 mil
Tensile Strength MD	ASTM D5035	1/50,000 SF	50 lb/in

2.04 DOUBLE-SIDED DRAINAGE GEOCOMPOSITE

A. The double-sided drainage geocomposite shall be manufactured by heat bonding geotextile filter fabric to both faces of the HDPE drainage net. No burn through geotextiles shall be permitted. No glue or adhesive shall be permitted.

B. The bond between the geotextile and HDPE drainage net shall exhibit a minimum average peel strength of 1 lb. per inch and a minimum per roll of 0.5 lb. per inch (ASTM D7005). Peel strength of the manufactured geocomposite shall be tested at a minimum of every 50,000 square feet, by the Manufacturer.

C. The primary and secondary drainage geocomposite shall have a minimum transmissivity of 5.0×10^{-4} m^2/s when tested with ASTM D4716 between select sand and textured HDPE liner at a normal load of 300 psf and a gradient of 0.33 with a seat time of 100 hours in accordance with GRI-GM8.

D. Transmissivity tests shall be completed by the Engineer at a minimum frequency of 1 per 200,000 square feet and at least one per lot.

E. Contractor shall provide samples of geocomposite materials to the Engineer for transmissivity testing prior to shipment to the site.

F. Interface Shear Strength – Testing Completed by Engineer

1. Contractor shall provide samples of the proposed materials required for interface testing, as specified below, to the Engineer for testing prior to shipment to the site. Laboratory testing shall demonstrate that the interface shear strength is equal to or greater than a strength envelope of 26.5° or a total interface shear strength of 114 psf at an overburden load of 240 psf between the following surfaces:

   a. The double-sided drainage geocomposite and the proposed 40-mil textured HDPE geomembrane.

b. The double-sided drainage geocomposite and the proposed select drainage sand.

1. The interface shear strength shall be determined by an interface shear test performed in accordance with ASTM D5321. The normal stresses applied shall be 1, 2 and 3 psi, all under inundated conditions. The strain rate shall not exceed 0.04 inches per minute. The drainage geocomposite and the 40-mil textured HDPE geomembrane shall be tested in the machine direction. The tests shall be continued until residual shear strengths are achieved, or to a maximum 2-inch displacement.

   The laboratory test reports shall include plots of shear strength versus normal stress for peak and large displacement values, and stress versus strain plots for tests run at each normal load application. A minimum of two (2) tests shall be completed for each interface.

3. Test results that do not meet the minimum requirements are to be reviewed by the Engineer for possible conformance with the overall design objectives.

2.05 STORAGE

A. Materials shall be stored on-site in a manner consistent with the manufacturer's recommendations.

B. Damaged materials will not be used for installation.

PART 3 EXECUTION

3.01 INSTALLATION

A. The installer shall handle all geocomposite rolls in such a manner as to ensure they are not damaged in any way, and the following shall be complied with:

   The geocomposite shall be placed as shown on the plans and with the preferential flow direction (if any) perpendicular to the topographic contours. Wherever possible, the geocomposite shall be rolled down the slope over the "textured" HDPE in such a manner as to continually keep the geocomposite in tension. If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles. The geocomposite cannot be placed in the horizontal direction (i.e., across the slope and mid-slope seams are unacceptable).

   In the presence of wind, all geocomposite rolls in place shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

Installation of geocomposite shall be done in a manner to protect underlying geomembrane, as applicable. No cutting of geocomposite shall be allowed directly on geomembrane. Use of four or six wheel ATV's weighing less than 650 lbs may be permitted to operate directly over the geocomposite provided that they do not exceed a speed of 5 mph, and refrain from abrupt starts, stops and turns. If operation of ATV is not done in a manner to protect the geocomposite and the integrity of the geotextile, the Engineer may prohibit their use, at no additional cost to the Owner, and require that damaged areas be repaired. Any other equipment used shall provide protection of the geomembrane and geocomposite and meet low ground pressure requirements.

B. When joining two pieces along the roll length, the white or yellow geotextile filter fabric and net shall be lapped a minimum of 4 inches, and plastic ties shall secure the net at intervals no greater than every 5 feet. The spacing of the ties within anchor trenches shall not exceed 6 inches. The bottom layers of the geotextile shall be overlapped and the top layers shall be stitched along the entire length of the seam. Metallic ties are unacceptable. The composite shall not be welded to this geomembrane. Heat fusion of seams will not be allowed.

C. When joining two pieces end to end, the net shall be lapped a minimum of 12 inches, and shall be secured by plastic ties approximately every 12 inches. The geotextile shall be overlapped a minimum of 6 inches, shingled in a downslope manner consistent with the direction of flow, and sewn or heat bonded to each other. Any exposed edge of geonet shall be covered with a continuous strip of geotextile (same as geocomposite), sewn to the top geotextile and folded under the geocomposite a minimum of 6 inches.

D. Care shall be taken to keep the composite clean and free from debris prior to installation. If composite is not free of soil and debris before installation, it shall be cleaned by the Contractor just prior to installation. Geocomposite damaged during or prior to installation shall be removed and replaced at no additional cost to the Owner.

E. The Contractor shall sequence construction so that select sand or other geosynthetics can cover the geocomposite within 14 days of deployment. Areas that have been exposed for longer than 14 days shall be protected from UV degradation with an acceptable material (i.e., sacrificial geotextile, or opaque plastic).

F. The Contractor shall limit the dust accumulation on the upper geotextile after installation and prior to placement of select sand, stone or geosynthetics. Excessive dust accumulation, as determined by the Engineer, may require replacement of geocomposite materials.

3.02 REPAIR

A. Any holes or tears in the geocomposite shall be repaired by placing a patch extending a minimum of twelve (12) inches beyond the edge of hole or tear. The patch shall be secured by tying fasteners through the patch material and to the geotextile and geonet of the installed panel at a minimum spacing of 6 inches. A geotextile cap shall be heat bonded to the geotextile of the panel and patch shall extend a minimum of 6 inches beyond the patch.

3.03 PLACEMENT OF OVERLYING MATERIALS

A. The Contractor shall place all overlying sand, stone and geosynthetic materials in a manner so that the underlying material is not damaged, excessive stresses are not introduced, and wrinkles are minimized. Installation of select sand directly above the geomembrane and geocomposite shall be completed with LGP equipment (See Section 02276).

B. Contractor shall utilize hand placement of materials or casting of materials in advance of dozer grading of cover soils or stone to minimize wrinkles and to prevent geocomposite from folding over on itself.

END OF SECTION

SECTION 02275
NON-WOVEN GEOTEXTILE FILTER FABRIC

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnishing and installation of non-woven geotextile filter fabric.

1.02 RELATED REQUIREMENTS

A. Section 02232 - Stone Fill

1.03 QUALITY CONTROL

A. Provide the manufacturer's certification that the geotextile filter fabric has been manufactured and successfully tested in accordance with the appropriate ASTM standards.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Propex Geosynthetics
B. Skaps Industries
C. TNS Advanced Technologies
D. Approved Equivalent

2.02 GEOTEXTILE FILTER FABRIC

A. The filter fabric shall consist of non-woven continuous filament fibers which are formed into a sheet by heat bonding. It shall be tear resistant and be capable of conducting water. Fabric materials provided shall be 10oz. beneath NHDOT “C” or “D” Stone, or as indicated on the Drawings.

B. The fabric shall retain its durability and strength when it is wet, and shall be non-biodegradable.

C. The fabric shall be capable of withstanding direct exposure to sunlight for 30 days without measurable deterioration.

D. The filter fabric shall have the following minimum physical properties as determined by the appropriate test method:

Physical Property	Test Method	Minimum Average Roll Value
Fabric Weight	ASTM D5261	10 oz./S.Y.
Water Flow Rate (through fabric)	ASTM D4491	95 gpm/S.F.
Grab Strength (Weakest Principal direction)	ASTM D4632	250 lbs.
Grab Elongation (Weakest principal direction)	ASTM D4632	50%
Trapezoid Tear (Weakest principal direction)	ASTM D4533	95 lbs.
CBR Puncture Resistance	ASTM D6241	650 lbs.
Apparent Opening Size	ASTM D4751	Sieve Size #70

PART 3 EXCECUTION

3.01 INSTALLATION

A. Fabric shall be hand placed in all locations as shown on the Plans, and where specified. The fabric shall be deployed on slopes in continuous lengths, parallel to slope direction. Mid-slope seams are not allowed.

B. When jointing two pieces, the filter fabric shall be lapped a minimum of 18 inches, shingled to shed water.

C. Filter fabric damaged during or prior to installation or during placement of overlying soil or stone shall be removed and replaced at no additional cost to the Owner.

END OF SECTION

SECTION 02276
HIGH DENSITY POLYETHYLENE (HDPE) LINER

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnishing of Textured 40-mil HDPE liner
B. Quality Control for liner materials
C. Field installation of the liner
D. Leak location survey

1.02 RELATED REQUIREMENTS

A. Section 01400 - Quality Assurance/Quality Control
B. Section 01720 - Project Record Drawings
C. Section 02223 - Filling
D. Section 02232 - Stone Fill
E. Section 02234 - Select Drainage Sand
F. Section 02273 - Drainage Geocomposite

1.03 APPLICABLE STANDARDS, CODES, AND REGULATIONS

A. ASTM Standards for High Density Polyethylene Geomembrane
B. Geosynthetics Research Institute – GRI-GM13 – latest revision
C. ASTM D5321 - Test Method for Direct Shear Testing of Geosynthetic Material and Soil Interfaces
D. ASTM D6747 - Standard Guide for Selection of Techniques for Electrical Detection of Potential Leak Paths in Geomembranes

1.04 QUALIFICATIONS

A. Liner Manufacturer:

The liner manufacturer shall have at least five (5) years' continuous experience in the manufacture of HDPE geomembrane rolls and/or experience totaling 10,000,000 sq. ft. of manufactured HDPE geomembrane. The manufacturer shall permit the owner or his authorized representatives to visit the manufacturing plant.

B. Liner Installer:

The liner installer shall have successful experience in the installation of HDPE sheet using the dual hot wedge seaming method on projects with similar requirements to this project; and which is acceptable to, or licensed by the manufacturer of the primary materials for the installation of these materials.

Installer shall have a minimum of five (5) years' experience performing this type of work.

C. Supervisor:

Installation shall be performed under the direction of a single competent English speaking installation supervisor who shall remain on-site and be in responsible charge throughout the liner installation, including subgrade acceptance, liner layout, seaming, testing and repairs, and all other related activities. The installation supervisor shall have supervised the installation of at least 3,000,000 sf of polyethylene geomembrane. Actual seaming shall be performed under the direction of a master seamer who may be the same person as the installation supervisor, and who has a minimum of 1,000,000 sf polyethylene geomembrane seaming experience using the same type of seaming apparatus as that specified in this project. The installation supervisor or master seamer must be on-site whenever seaming is being performed.

D. Quality Control:

The Contractor shall establish a Quality Control (QC) Representative who shall be responsible in the field for the quality and integrity of the HDPE liner installation. This responsibility shall include the inspection, testing, and documentation of all liner installation work as performed by the installer. The QC Representative shall have performed these duties on a minimum of 3,000,000 sf of HDPE membrane installation.

E. Laboratory:

The Engineer shall engage a qualified, independent laboratory acceptable by the Owner for use in completing the off-site tests of destructive samples specified herein.

Results of independent laboratory testing shall be transmitted directly from the lab to the Engineer and Contractor as soon as the data is available.

F. Contractor Responsible for Subcontractors:

The roles of any subcontractor shall not relieve the Contractor of any responsibilities whatsoever under this contract. The Contractor shall be responsible for the actions and performance of the manufacturer, installer, supervisor, and QC representative under this contract. A Contractor's representative shall be on-site during all geomembrane installation activities.

1.05 SUBMITTALS

A. Prior to release of the geomembrane for shipment to the job site, the Contractor shall submit the following to the ENGINEER:

1. Written certification that the material was manufactured and tested in accordance with the requirements of GRI-GM13.

2. Quality control certificates for each batch of resin and production of geomembrane in accordance with the testing requirements of GRI-GM13.

3. Quality control certificates shall be signed by the responsible Quality Assurance (QA) personnel employed by the Manufacturer.

4. Conformance testing shall be performed in accordance with the requirements and standards specified in GRI-GM13 and as specified herein for the HDPE membrane and its installation. Certificates of compliance shall be submitted for each roll to be used on the project prior to its release for shipment to the job site. Certificates of Compliance for HDPE welding rod to be used on the project shall be submitted.

5. Shop Drawings showing the following:

   a. Proposed layout of the HDPE membrane system.

   b. Details of jointing the HDPE membrane, anchoring, penetrations, repair, testing, areas of slack for anticipated thermal contraction, locations of leak detection electrodes and wiring, and other construction details

6. Manufacturer's completed projects resume.

7. Installer's completed project resume.

8. Installer's crew identification list and resumes.

9. Installation schedule.

10. Manufacturer's and installer's warranty as described in Part 1.07.

11. The Contractor shall provide representative samples of the proposed geomembrane to the Engineer to complete direct shear box testing of the proposed 40-mil textured HDPE geomembrane and select drainage sand to demonstrate compliance of interface friction as required in Section 02234 (Select Sand).

12. The Engineer shall complete direct shear box testing of the proposed 40-mil textured HDPE geomembrane and drainage geocomposite to demonstrate compliance of interface friction as required in Section 02273 (Drainage Geocomposite).

B. Roll Identification:

1. Each roll shall have a permanently affixed label with the following information:
   a. Name of manufacturer
   b. Date of manufacture
   c. Thickness of material (actual)

d. Roll number
e. Roll length
f. Roll width

C. Record Drawings and QC Reports (See Parts 3 and 4)

1.06 QUALITY ASSURANCE

A. General:

Quality of the liner installation shall be the responsibility of the Contractor. The Contractor, in fulfilling this responsibility, will be assisted by his designated Manufacturer, Installer, and QC representative. The Contractor will be responsible for performing the Quality Assurance/Quality Control tasks outlined herein. The Engineer may conduct additional independent testing and inspections. These actions will not remove any responsibility of the Contractor under this Contract.

B. Lines of Authority:

The Contractor shall establish an Installation Supervisor and a QC Representative who will assist the Contractor in his responsibilities in the quality of the liner installation. The QC Representative shall assist in coordinating the timing and sequencing of liner installation and testing with the Engineer.

1.07 MATERIAL AND WORKMANSHIP WARRANTY

A. Contractor shall provide a written material warranty signed by the Manufacturer and a workmanship warranty signed by the Installer, both for the repair/replacement of defective materials and workmanship characterized by leakage, abnormal aging or deterioration of materials, and other failures of the flexible membrane to perform as required. The specified warranty period is ten (10) years for materials and two (2) years for workmanship after date of final acceptance. The terms and conditions of the warranties are presented in Exhibits D and E to the Agreement. Alternative standard company language may be acceptable, but the period, notification time, and legal jurisdictions shall remain as stated in the Exhibits.

B. The warranty shall be a direct warranty from the Manufacturer (or Installer as the case may be) to the Owner. The warranties shall be signed and presented to the Owner prior to Substantial Completion. No payment in excess of 90 percent of all payments to be due under the appropriate payment items for HDPE liner shall be made until the warranties, in their correct form hereunder, are received and approved by the Owner.

1.08 SUBGRADE CERTIFICATION

A. Prior to installation of liner materials, the Contractor shall submit a certification, signed also by the installer, that they have inspected the subgrade and accept the conditions for liner installation.

1.09 GEOMEMBRANE PRE-CONSTRUCTION MEETING

A. As soon as practical after the Contractor mobilizes the installation crew, but before any installation activities occur, a specific pre-construction conference shall be held.

The following persons shall be present:

1. Engineer Project Manager and Resident Engineer
2. General Contractor and Superintendent
3. Engineer Subconsultant QA Representative (if applicable)
4. Geomembrane Installer Site Superintendent and Quality Control Representative
5. Affected Subcontractors

B. Agenda:

1. Introductions and Explanation of Roles
2. General Overview of Specifications and Plans
3. Review Proposed Installation Schedule
4. Review of Installer/Contractor QC Procedures
5. Review of Engineers QA Procedures
6. Destructive Test Sites
7. Review of Contractor Personnel - Roles and Responsibilities
8. Reports and Record Drawing Information
9. Site Cleaning

PART 2 PRODUCTS

2.01 MATERIALS

A. Properties:

1. The geomembrane shall be manufactured from new, first quality polyethylene resin of the type specified. Polyethylene geomembrane shall meet all requirements for the specified end use. Reclaimed polymer shall not be added to the resin except for regrind, reworked or trim polymer of exactly the same formulation as the geomembrane produced during the manufacturing process. “Regrind” polymer shall not exceed 10% by weight. Recycled or reclaimed sheet materials shall not be included in the manufacturing process.

B. Resin - all batches or resin shall be tested for the following characteristics:

Resin Density	ASTM D 1505/D 792	.932
Melt Index	ASTM D 1238 E	<1.0 g/10 min.

Any resin not meeting the above specification shall not be used in the manufacture of material. The Contractor shall furnish results of all such tests to the Engineer and shall certify the quality of the raw material.

C. The double sided textured geomembrane shall demonstrate the following typical properties.

PROPERTY	**TEST**	**VALUE**	
Thickness	ASTM D5994	min avg	38 mils
		lowest for 8 of 10	36 mils
		lowest for 2 of 10	34 mils
Asperity Height	ASTM D 7466		15 mils
Tensile Strength (Yield) (lbs/in.)	ASTM D6693 Type IV		80
Tensile Strength (Break) (lbs/in.)	ASTM D6693 Type IV		100
Elongation at Yield (%)	ASTM D6693 Type IV (1.3" gauge)		12%
Elongation at Break (%)	ASTM D6693 Type IV (2.0" gauge)		100%
Tear Resistance (lbs)	ASTM D1004 Die C		28
Puncture Resistance (lbs)	ASTM D4833		70
Carbon Black Content	ASTM D1603/4218		2% by weight
Oven Aging at 85°C High Pressure OIT	ASTM D5721 ASTM D5885	% retained after 90 days	80%
UV Resistance High Pressure OIT	GRI-GM11 ASTM D5885	% retained after 1600 hours	50%

D. The geomembrane shall be produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter, and shall not have striations, non-uniform texturing, pinholes or bubbles on the surface. Texturing shall be on both sides.

Rolls which have evidence of surface defects such as undispersed resin, incomplete texturing, creases, pinholes, non-uniform texturing or other defects, based upon the judgement of the Engineer, shall be rejected and removed from the site.

E. The Contractor shall provide quality control certificates from the manufacturer for each roll of material. These QC certificates shall match the resin lot numbers with the roll numbers for the 40-mil geomembrane.

1. Samples shall be taken evenly spaced across the entire width of the roll, if no sampling protocol is stipulated in the particular test method, and shall not include the first wrapping or outer layer of the roll (about 3 feet).

2. Quality Control testing of the manufactured geomembrane shall be performed as a minimum in accordance with GRI-GM13, and at the following frequency for the following material properties. Where the following differs from GRI-GM13, the more stringent shall apply. A QC certificate shall be provided for each roll, which documents the following testing:

TEST	PROCEDURE	FREQUENCY
Thickness	ASTM D5944	Each Roll
Specific Gravity	ASTM D1505	500,000 sf
Yield Strength	ASTM D6693-Type IV	50,000 sf
Yield Elongation	ASTM D6693-Type IV	50,000 sf

TEST	PROCEDURE	FREQUENCY
Tensile Strength (1.3" gauge)	ASTM D6693-Type IV	50,000 sf
Tensile Elongation (2.0" gauge)	ASTM D6693-Type IV	50,000 sf
Carbon Black Content	ASTM D1603	50,000 sf

HDPE extrusion welding rod or beads shall exhibit the same properties as the geomembrane.

F. Minimum width of manufactured flexible membrane sheets shall be 22 ft. The edge of the 40-mil rolls shall not have textured material (4-in min) to enable seaming of smooth, non-contaminated product.

G. Shipping and Storage

Material shall be packaged, handled, stored, transported, re-stored, re-handled, and deployed in a manner so as not to cause any damage.

1. Unloading of rolls or pallets at the site should be such that no damage to the geomembrane occurs.
2. Pushing, sliding, or dragging of rolls or pallets of geomembranes shall not be permitted.
3. Offloading at the site shall be performed with cranes or fork lifts in a workmanlike manner such that damage does not occur to any part of the geomembrane.
4. Suitable means of securing the rolls or pallets shall be used such that shifting, abrasion, or other adverse movement does not occur.

H. Storage

1. If storage of rolls or pallets of geomembranes at the site is to occur longer than 6 months, a sacrificial covering or temporary shelter should be provided to protect against precipitation, ultraviolet exposure, and accidental damage.
2. Temporary storage at the site should be in an area where standing water can not accumulate at any time.
3. Geomembranes shall be stored on-site in a manner consistent with the manufacturer's recommendations.
4. Geomembranes shall be stored to avoid deformation of rolled goods or contamination from foreign substances. Rolls shall be fully supported over their entire length. Rolls may be stacked no more than three rolls high.

    a. Appropriate handling equipment shall be used when moving rolled material, such as slings and spreader bars.

    b. Damaged rolls will not be used for installation.

I. Other materials: All welding material shall be of a type recommended and supplied by the Manufacturer and shall be delivered in the original sealed containers - each with an indelible label bearing the brand name, manufacturer's mark number and complete directions as to proper storage.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Conditions: Surfaces to be lined shall be smooth and free of vegetation, rocks, stones, sticks, roots, sharp objects or debris of any kind. Rounded corners shall be provided in all directional changes and in the anchor trench to avoid sharp bends in the membrane. No standing water or excessive moisture shall be allowed on the subgrade.

B. Acceptance: The Installer shall certify in writing that the surface to be lined is acceptable. Submittal of written acceptance may proceed incrementally according

to the installation schedule. No geomembrane liner shall be placed on subgrade deemed unsuitable by the Engineer.

3.02 INSTALLATION

A. The liner shall be placed over the prepared subgrade in such a manner as to minimize handling. The sheets shall be placed to minimize field seaming. Horizontal field seams on the slopes shall not be acceptable. Only those sheets of liner material which can be seamed in one day shall be unpackaged and placed in position. Slope seams shall be minimized and run as close to the line of slope as possible particularly in corners.

B. Each panel of HDPE membrane shall be laid out and installed in accordance with the approved Shop Drawings. Any changes must be submitted to the Engineer in writing for approval prior to installation of liner.

C. Installation of the HDPE liner shall be done in the presence of the Engineer or his designated representative. Deployment shall proceed between ambient temperatures of 40°F to 104°F. Geomembrane placement shall not be done during any precipitation, or in the presence of excessive winds.

D. Bridging of the liner will not be accepted. The liner shall be installed to accommodate thermal contraction at the lowest anticipated operating temperature. Areas that exhibit bridging shall be temporarily ballasted. If the temporary ballast fails to mitigate the bridging, the panel will be cut and additional compensating geomembrane installed and tested.

E. Deployment:

1. No equipment or tools shall damage the geomembrane or subgrade by handling, traffic or other means. Subgrade ruts or ridges shall be removed prior to final positioning of the geomembrane.

2. No personnel working on the geomembrane shall smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane.

3. The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the supporting soil or underlying geomembrane.

4. Methods used to place panels shall minimize wrinkles, (especially differential wrinkles between adjacent panels or sheets).

5. Adequate loading (e.g., bagged drainage sand or similar items that will not damage the geomembrane) shall be placed to prevent uplift by wind. Continuous loading may be required along edges of panels during periods of high winds.

6. Direct contact by machinery or deployment vehicles (4 or 6-wheel cart) with the geomembrane shall be avoided, i.e., the geomembrane in traffic areas to be protected by geotextiles, extra geomembrane, or other suitable materials. Proposed protection plan shall be reviewed by Engineer.

F. Penetrations: The membrane shall be installed around pipes as shown on the Drawings. Install to provide an effective, watertight seal. Construction and installation of the pipe boot shall be performed in the presence of the Engineer or his designated representative. Testing of all pipe boots shall be required.

Liner installer shall coordinate with Contractor on space required for extrusion welding and vacuum testing around pipe/boot penetrations.

Boot fabrication and testing shall be as follows:

1. Boots shall be fabricated in the field to fit the pipe penetration.

2. The boot shall be temporarily removed, skirt attached to a temporary base sheet with the barrel of the boot welded shut, and air tested to 2-3 psi (min/max); apply soapy water to all prefabricated seams to locate any leaks.

3. If no leaks are found, remove temporary base sheet, open boot barrel, and reinstall on pipe.

4. Extrusion weld boot flap to liner, and boot barrel to HDPE pipe.

5. Place liner sleeve over boot barrel covering end of boot and weld sleeve to boot barrel and pipe.

6. Air test sleeve (2-3 min/max psi) for 5 minutes to evaluate boot barrel seal. If no pressure drop is observed, grind and extrude air test penetration and vacuum test extrusion.

7. Vacuum test extrusion seams of boot and skirt joint with liner.

All pipe boots, vents, and patches shall be of the same material as the membrane sheet. Gaskets, sealing materials, or other means used to secure the membrane shall be compatible with and have a lifespan at least equal to that of the HDPE membrane.

3.03 SEAMING METHODS

A. Approved process for seaming is fusion welding for all seams. Wherever possible, the split hot wedge seaming method shall be used to allow air pressure testing of the liner seams.

1. Extrusion welding may be allowed for repairs and around penetrations through the liner. All proposed extrusion weld locations shall be approved by the Engineer.

2. Proposed alternatives and locations must be submitted for review to the Engineer.

3. Details of the specific apparatus to be used for seaming, including seaming using approved methods, shall be submitted for approval by the Engineer prior to commencement of seaming.

B. Fusion Process: Fusion seams will be produced by self-propelled wedge welding apparatus.

1. The apparatus shall be equipped with gauges to monitor weld temperature.

2. Weld temperature and machine speed shall be varied according to ambient conditions to maintain and demonstrate a consistent acceptable weld, as described in Section 4.01.B.

3. All welding surfaces shall be kept clean and dry.

C. Extrusion Process: Extruded seams will be produced by extruding molten resin between or at the edge of two preheated overlapped sheets of geomembrane to affect a homogeneous bond.

1. The extrusion apparatus shall be equipped with gauges to monitor extrudate and operating temperatures.

2. Temperature and flow rates shall be varied according to ambient conditions to maintain and demonstrate a consistent acceptable weld, as described in Section 4.01.B.

3. The extruder shall be purged of all heat degraded or cooled extrudate prior to the commencement of each seaming sequence, and disposed of off the geomembrane surface.

4. The extrudate rod shall be certified by the Manufacturer and certification supplied as in Section 1.05, Submittals.

5. Following heat tacking, the weld area shall be prepared by grinding to a depth of less than 0.005 in in the sheet surface to be in contact with the extrudate. Extrudate shall cover all grind marks.

6. The weld area shall be kept clean and dry.

D. The installer shall maintain at least one spare operable seaming unit of each type on site at all times.

3.04 SEAMING PROCEDURES

A. To achieve the proper support and cleanliness of fusion welded seams, the installer shall use a temporary support surface or shield between the geomembrane and the subgrade.

At swales, drainage benches, anchor trenches, or other similar abrupt vertical changes, the installer shall provide temporary shoring or support systems to allow linear seaming of the geomembrane and prevent unnecessary damage. Temporary shoring or bridging shall be adequate to allow proper overlap of adjacent panels and adequate strength to support the weight of materials, equipment and personnel.

B. Seams shall be aligned so as to create a smooth and wrinkle free surface in the overlap area.

C. Extrusion Welding

1. Grinding required along a seam shall be done concurrent with or within ten minutes of the seaming operation and shall not damage the geomembrane, as in Section 3.02.

2. Installer shall determine preheat requirements and wind effects on extrusion seaming operations.

3. Artificially induced cooling of extrudate welds, by water or any other means, shall not be allowed. Care shall be taken during vacuum testing that extruded welds being vacuum tested are at ambient temperatures.

D. Cross Seams : The top and bottom excess overlap shall be removed and the top and bottom edge of the cross-seam shall be ground to a smooth transition prior to seaming.

E. No seaming shall be attempted in wet weather where the geomembrane is exposed to the elements.

F. Geomembrane deployment or seaming shall proceed between ambient temperatures of 40°F to 104°F.

G. Where possible, seam overlaps shall be shingled to shed water.

H. Where possible, low areas shall be patched, tested and inspected first to prevent interference of ponded water with testing procedures.

I. All patches shall have rounded corners, shall consist of the approved geomembrane material and shall extend beyond the edge of any defect a minimum of 4 in. in all directions.

J. All seams shall be labeled on the geomembrane with the following information:

1. Machine identification number
2. Operator, date, time
3. Direction of travel of seaming equipment

K. No “fish mouths” shall be allowed within the seam area. Where “fish mouths” occur, the material shall be cut, patched, and welded.

L. Any membrane area showing injury due to scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional piece of HDPE membrane at no cost to the Owner.

3.05 PANEL LAYOUT

A. Proposed

1. The Contractor shall submit shop drawings showing proposed placement of panels and seams, and these shall be reviewed by the Engineer, prior to commencement of installation.
2. Seams shall be numbered on an accepted plan and include dimensions.
3. Slope seams shall be run as close to the line of the slope as possible.
4. Penetrations and irregular configurations shall be detailed and submitted to the Engineer for review prior to installation.

B. Record Drawings

1. The Contractor shall provide final record layout drawings of the 40-mil liner to reflect any changes from proposed layout.
2. Record drawings shall include the identification by number and location of all panels, patches and detail work, including the location and identification of areas chosen for destructive test sampling.

   All panels, seams, repair patches, cap strips and penetrations shall be documented by field survey performed by a land surveyor licensed to practice in the project state.

   The survey shall be certified by the surveyor and submitted to the Engineer as an AutoCAD 2009, or higher version, drawing on a compact disk. The geomembrane survey information shall be submitted prior to covering the geomembrane.

   Repair locations of leaks discovered during the leak location survey of the primary geomembrane shall be documented by field survey performed by a land surveyor licensed to practice in the project state. Surveyor services are considered subsidiary to the geomembrane installation and repair and the costs of survey documentation shall be the responsibility of the Contractor.

3. Copies of the installer’s field QC documentation shall be submitted to the Engineer prior to covering the geomembrane. The installer’s report is

required prior to acceptance of the geomembrane system. The Contractor shall not be allowed to place soil or geosynthetic materials over any installed geomembrane until full, written field QC documentation is submitted to the Engineer.

Copies of the installer's field QC documentation shall be submitted to the Engineer prior to covering repair locations following the leak location survey of the primary geomembrane. The Contractor shall not be allowed to replace soil materials over repaired geomembrane until full, written field QC documentation is submitted to the Engineer.

PART 4 QUALITY CONTROL

4.01 QUALITY CONTROL DURING INSTALLATION

A. Site Test Equipment: The Contractor shall maintain on-site, in good working order, the following items:

1. Field Tensiometer

   a. The tensiometer shall be motor driven and have jaws capable of traveling at a measured rate of 2 in/min.
   b. The tensiometer shall be equipped with a gauge which measures the force in unit pounds exerted between the jaws.
   c. The tensiometer shall be calibrated and certified for use on this project. A copy of the calibration certificate shall be submitted to the Engineer.

2. Coupon Cutter

   A die cutter machined to cut 1" x 5" liner sample coupons for field testing shall be provided and maintained in good working condition.

3. Vacuum Box

   a. The vacuum box shall consist of a rigid housing with a transparent viewing window on the top and a soft, closed-cell neoprene gasket completely attached to the bottom of the housing.
   b. The housing shall be equipped with a bleed valve.
   c. A separate vacuum source shall be connected to the vacuum box such that a negative pressure of 2 – 3 psi (5" – 6" mercury) can be created and maintained inside the box.
   d. A solution consisting of soap and water shall be dispensed on the seam immediately ahead of the vacuum box.
   e. Vacuum box testing shall not proceed when temperatures are below 32°F.

4. Air Pressure Test Equipment - This method shall apply when the split hot wedge seaming method is used.

   a. Equipment shall consist of an air pump capable of generating and maintaining a positive pressure of between 20 and 30 psi.
   b. A manometer capable of reading up to 30 psi attached to a needle or nipple shall be used to pressurize the air channel in the seam.

5. Spark Testing - This method shall be completed on welds in areas where both air pressure testing and vacuum testing are not possible.

   a. Equipment shall consist of a hand held device capable of generating a high voltage.
   b. Conductive aluminum tape shall be placed beneath the seam prior to welding.

6. Alternatives shall be submitted for review to the Engineer. All testing methods shall be submitted to the Engineer for review prior to commencement of testing.

B. Non-Destructive Testing

1. Test Seams

   a. Test seams shall be made to verify that adequate conditions exist for field seaming to proceed.
   b. Each seamer shall produce a test seam at the beginning of each shift and every four hours thereafter.
   c. If a seaming operation has been suspended for more than one hour or if an equipment failure occurs for any reason, a test seam shall be produced prior to resumption of seaming operations.

2. Test seams shall be made in the field on pieces of the approved membrane. Each test seam shall be at least 4 ft. long by 1 ft. wide and with sufficient overlap in the seam for peel and sheer testing in the field tensiometer.

3. Pass/Fail Criteria: With the Engineer or his representative present, the Contractor shall cut six coupons 1” x 5” from the test seam for field testing. The coupons shall be cut in pairs from both ends and the center of the test seam. From each pair, one coupon shall be tested in the field tensiometer in peel and one in shear. 100% of samples shall pass.

   a. Shear Strength: Both top and bottom of the coupon shall be tested in shear and shall register not less than 90% of the tensile strength at yield of the field parent material as determined in 4.01. B.3.d, and exhibit an acceptable location of break code as defined in 4.01 B.3.c. The shear percent elongation at break shall exceed 50% and is defined as follows:

$E = L/L_o * 100$

where

E = elongation %
L = extension at end of test
L_o = original average length (usually 1.0 in)

b. Peel Adhesion: Both sides of wedge welded seam coupons and one side of extrusion welded seams shall be tested in peel. Acceptable samples tested in peel shall register equal to or more than the greater of 60% of the manufacturer's specified minimum yield strength of the parent sheet or 60% of the tensile strength at yield of the parent material as determined in paragraph 4.01. B3c, and exhibit an acceptable location of break code as defined in 4.01.3.b. The peel separation (incursion) shall not exceed 25% and is defined as follows:

$$S = A/A_o * 100$$

where

S = separation %
A = average are of separation or incursion
A_o = original bonding area

The peel adhesion for the welded tie-in seam connection of new geomembrane to existing geomembrane materials shall register equal to or more than the 60% of the manufacturer’s specified minimum shear strength and exhibit an acceptable break code. The parent material strength is not an appropriate comparison for a tie-in seam, due to differing materials.

c. As defined by GRI-GM13 and ASTM D6392 the following location of break codes are not acceptable and shall result in failure of the test:

Hot Wedge: AD, AD-BRK >25%
Extrusion: AD1, AD2, AD-WLD (unless strength is achieved)

d. The parent material yield strength shall be determined as follows:

One 1” x 5” coupon will be cut from each sheet (both sides of seam) which makes up the "test seam" and "test sample." The coupons will be cut no less than 4 inches from the center line of the seam with the long dimension of the coupon perpendicular to the

line of the seam. Each sample will be tested in tension to determine its yield strength. The minimum of the two yield strength value obtained will be used as the parent material yield strength.

For the laboratory testing required in paragraph 4.02.A.6, the testing laboratory will be required to record and document the two test coupon's yield strength results and the results of the five shear and ten peel test series required in paragraph 4.02.A.6.a. The test samples shall be of sufficient length to accommodate this testing.

As a result of this testing and as specified in paragraph 4.02.A.3, the CQA inspector may increase the amount of destructive testing at no additional cost to the Owner.

e. If the seam fails to pass, the welder and seaming apparatus shall not be used for field seaming until acceptable pre-weld tests are achieved.

4. Vacuum Testing

a. 100% of all vacuum testing shall be observed by the Engineer or his representative.
b. All extrusion welded and non-air channel seams of the 40-mil liner shall be evaluated using vacuum box testing. The seams of the 40-mil rub sheet shall not require non-destructive testing.
c. The solution shall be applied to the test section and the vacuum box placed over the section. The bleed valve is then closed and the vacuum valve opened.
d. Once a tight seal and a negative pressure of 2 – 3 psi has been established, the test section shall be visually examined for a period of not less than 10 seconds to determine whether bubbling of the soapy solution is occurring.
e. The vacuum box is then moved and the process is repeated on the next adjacent section. A minimum 3 inch visible overlap shall be provided between all test sections.
f. All locations where bubbling of the solution was observed shall be clearly marked for repairs with a high visibility marker and recorded by number on field test reports.
g. Any failed portion of seam shall be repaired in accordance with Section 3.03 and 3.04 and re-tested.

5. Air Pressure Testing

a. The air channel shall be sealed off at both ends.

b. If the end of a seam will be an integral part of the geomembrane, the sealing shall be done in such a way that it does not harm the geomembrane.

c. The pressure feed device shall be inserted into the air channel at one end of the seam and pressurized to 30 psi.

d. The feed valve shall be closed and the pressure sustained for a period of not less than 5 minutes. The pressure shall then be released by opening the air channel at the opposite end of the seam.

e. The drop in pressure on the manometer shall verify the continuity of the air channel. If there is no pressure drop, the seam shall be checked for air channel blockage(s). If more than three problem areas are revealed, the seam shall be removed and a cap strip installed. The cap strip testing shall follow normal air channel test protocols.

f. If a pressure loss of greater than 2 psi is observed or if the required pressure cannot be reached then the seam shall be rejected.

g. All faulty areas along the seam shall be identified and repaired in accordance with Sections 3.03 and 3.04 and re-tested by non-destructive means.

h. Vacuum testing shall be allowed on split wedge welds only when the faulty area cannot be isolated using air pressure testing.

i. All holes created during air pressure testing shall be sealed on completion of the test and vacuum tested.

6. Spark Testing

a. Spark testing shall only be completed in areas where both air pressure testing and vacuum testing are not possible.

b. Conductive aluminum tape shall be placed beneath the seam prior to welding. Copper wire shall not be used.

c. Upon completion of weld, enable spark tester and hold approximately 1 inch above the weld and move slowly along the entire length of the weld. Spark will indicate a hole in the seam which shall be marked and repaired with an additional weld.

d. Spark testing shall not be completed if flammable gases are present in the area to be tested.

7. All liner seams shall be non-destructively tested by the Installer over their full length to verify the integrity of the seam.

a. Non-destructive testing shall be performed concurrently with field seaming.

b. Prefabricated field seams which will be inaccessible after installation, such as those under structures or fastened to penetrations, shall be tested prior to final installation.

c. All non-destructive testing shall be observed and documented by the Engineer or his representative.

8. Approved non-destructive testing procedure is as above. Alternate procedures shall be submitted for review to the Engineer prior to the commencement of non-destructive testing. Contractor shall notify the Engineer at least 48 hours prior to commencement of any field testing.

C. Destructive Testing

1. Destructive testing of field seams shall be performed at selected locations in order to verify the criteria given in Section 4.01.B.

   a. All sampling and testing shall be done concurrently with field seaming so that verification of field seam properties is made as the work progresses and corrective action implemented.

2. Test samples shall be randomly selected with a minimum of one test location occurring within each 500 ft of seam. The Engineer may require a minimum of one destructive sample per day, and retains the option of increasing the number of samples in suspect areas.

   a. Sample locations shall be determined by the QC Representative and the Engineer, with consideration to the difficulty of subsequent repair and testing of the test site.
   b. The Installer shall not be informed in advance of the locations where the seam sample will be taken.

3. The Engineer may increase the amount of destructive testing if the results of previous testing indicate a failure rate of 10% or more, at no additional cost to the Owner.

   a. Additional samples may also be required when Installer or Engineer have reason to suspect the presence of excess crystallinity, contamination, faulty seaming or any other reason affecting seam quality.

4. The test sample shall measure a minimum of 12” wide by 40” long with seam centered lengthwise along the sample.

   a. Prior to cutting the laboratory sample, two (2) one inch wide sample strips shall be cut using an approved template from each end of the sample. Two additional sample strips will be cut to determine parent material yield strength.
   b. These strips shall be tested by the Installer in the field tensiometer. Parent, peel, and shear yield strength will be recorded in accordance with Section 4.01.B.
   c. If acceptable, the sample shall be cut into <u>three</u> 12” lengths.

5. Samples shall be cut by the Installer, indelibly numbered and identified, and the locations recorded and submitted to the Engineer for laboratory testing.

6. The results of laboratory testing shall be faxed directly to the Engineer and Contractor not more than 48 hours after the samples have been received by the testing facility. Laboratory testing results shall determine the acceptability of a seam.

   a. Laboratory testing shall be performed in accordance with the methods given in ASTM D6693 or ASTM D6392-99 and meet the criteria given in Section 4.01.B.3. In addition to the 2 parent strength coupons, 10 test coupons shall be cut with from 5 coupons for shear and 5 coupons for peel tests. 100% of samples shall pass.

7. The area from which the destructive test sample was taken shall be repaired without delay in accordance with the procedures given in Section 3.03 and 3.04 and shall be non-destructively tested in accordance with Section 4.01.B.

D. Inspection and Acceptance

1. As the work progresses, the QC Representative shall document all locations requiring repair work and verify all repairs have been successfully made by the Installer.

2. The QC Representative shall field verify functional ability and accuracy of Installer's equipment on a daily basis.

3. A field seam shall only be considered acceptable when all destructive test locations on that seam have passed laboratory testing and acceptable non-destructive testing has been performed. The following procedures shall apply in the event that a seam fails field or laboratory testing.

   a. The Installer may reconstruct the seam between the previous passing test location and the next passing test location and retest, or

   b. The Installer may elect to trace the extent of an unacceptable seam to some intermediate location. This shall involve taking 1 inch template-cut cross-sections from the seam at a minimum distance of 10 feet in both directions from the failed test location.

      (1) These samples shall be tested in the field tensiometer in both shear and peel in accordance with Section 4.01.B.3.

      (2) If one or both of these samples fail the field test, tracing along the seam shall continue at minimum 10 feet increments until a passing result is recorded in both directions from the failed test location. If three additional tests fail on either side of the initial test site, the seam shall be rejected and either cap stripped or reconstructed.

Further incremental testing shall be performed until acceptable test results are achieved. These additional tests may continue onto previous or subsequent seam work performed by the seaming technician, welding machine, or both.

c. If more than one field seaming unit is employed, tracing of a failed weld shall only be done along seams welded by the same equipment used to weld the seam in question.

4. Reconstructed seams less than 150' in length shall be non-destructively tested in accordance with Section 4.01.B. Reconstructed seams greater than 150 feet in length shall be destructively tested in accordance with Section 4.01.B.3.

5. The entire geomembrane surface shall be examined continuously by the QC Representative to confirm that it is free of any defects, holes, blisters, undispersed raw materials, or contamination by foreign matter. Upon completion of the installation of each liner, and prior to covering the liner, a final review will be made by the Engineer and the QC Representative.

6. The geomembrane surface shall be cleaned by the Contractor prior to final review. The liner shall be free of dust, mud, debris or other material that would prevent examination of the surface.

7. Any defects or suspect areas shall be clearly marked by the Engineer or QC Representative. Such defects or suspect areas shall be repaired and non-destructively tested in accordance with Section 4.01.B by the Contractor.

8. As the work progresses, the Contractor's representative, Installation Supervisor and QC representative shall make continuous efforts to prevent the accumulation of waste materials on the liner surface and staging areas. Provision shall be made for containment of waste as the installation proceeds.

E. Submittal of Quality Control Documentation

1. Contractor shall provide written documentation regarding quality control results from each item specified in this section in a format(s) approved by Engineer.
2. Written documentation will be provided to Engineer on a regular basis as the installation proceeds, at a minimum once per week.
3. A separate report with all documentation will be submitted upon completion of the installation. A separate report with all documentation will be submitted upon completion of the leak location survey and leak repairs.

F. Drainage Geocomposite and Select Sand Placement

1. Prior to covering any portion of the liner system, the Contractor shall submit all QC documentation to the Engineer for review, comment and submittal as required to regulatory agencies.

2. The QC representative shall identify any wrinkles which may have been built into the geomembrane. Any wrinkle which may result in fold over of liner material upon placement of sand shall be cut, repaired and tested by the Contractor.

3. The QC Representative shall identify any slope toe, declivity, or other surface transitions which might result in bridging of the geomembrane during placement of the sand blanket. Any such area shall be cut, repaired and tested by the Installer.

4. The QC Representative shall coordinate with the installer, engineer and leak location contractor to create 0.25 in diameter test holes in the primary geomembrane to be used in calibration of leak location equipment.

5. Equipment used for placing and compacting the sand blanket shall not be driven directly on the geomembrane or composite. Such equipment shall be closely monitored during placement to ensure that no damage occurs to the geomembrane or composite.

6. A minimum thickness of 12 in of select sand cover shall be maintained between the geomembrane and drainage geocomposite and earth moving equipment. Only low ground pressure (LGP) tracked vehicles, having a maximum ground pressure of 4.7 psi shall be used at the minimum thickness.

7. For calculating equivalent ground pressure for non-LGP equipment operating on top of greater thicknesses, equivalent ground pressure shall be calculated at 12 in above the liner surface and shall meet LGP.

8. In all cases, the placement of sand blanket shall be done with caution and in a manner which is least likely to cause wrinkles in, or damage to, the geomembrane and composite. In order to eliminate wrinkles, significant methods must be employed including but not limited to use of hand labor and equipment to cast and place sand.

9. Select sand, screened till and topsoil materials shall be placed upslope or laterally on slopes greater than 4:1.

PART 5 COMPLETION OF WORK

5.01 REQUIREMENTS

A. All required deployment, seaming, repairs, testing, records and site clean-up shall be completed by the Contractor.

B. Contractor shall submit a comprehensive quality control report, including all QC documentation specified in this section to the Engineer.

C. The Engineer shall be satisfied that the information provided by the Contractor indicates that the geomembrane has been installed in accordance with the above Specifications.

D. Contractor shall dispose of all trash, waste material and equipment used in connection with the work and shall leave the premises in an acceptable condition.

END OF SECTION

SECTION 02930
LOAMING AND SEEDING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Process (screen) existing loam materials provided by the Owner, test, amend, and place loam, seed, lime, fertilizer, and mulch on all areas disturbed during construction, where shown on the Plans, and as directed by the Engineer.

1.02 RELATED REQUIREMENTS

A. Section 02223 - Filling
B. Section 02270 - Erosion Control

1.03 SUBMITTALS

A. The Contractor shall furnish all materials, other than loam, to be used in performing the work under this Contract. Prior to use, the Contractor shall be required to furnish the following information to the Engineer.

1. Copies of delivery tickets showing the net weight of materials delivered to the job site.

2. Certification from the suppliers of ground limestone showing:

   a. Magnesium oxide content
   b. Total calcium oxide neutralizing equivalent, and
   c. Gradation of the ground limestone

3. Certification that the fertilizer meets the requirements of NHDOT Specifications, Division 600, Section 643 “Fertilizer for Grasses.”

4. The bag tag for each variety of mix and bag of seed showing test results and the date of test.

1.04 CERTIFICATE OF PROVISIONAL ACCEPTANCE

A. The Owners Representative will inspect all work upon the written request of the Contractor received at least ten days before the anticipated date of inspection.

B. Seeded areas shall be reviewed for acceptance only after all areas have a close stand of grass with no bare spots greater than two inches in diameter, at least 90%

of the grass established shall be permanent grass species and the lawns have been maintained for a minimum of ninety (90) days prior to inspection.

C. Furnish full and complete written instructions for maintenance of all lawns to the Owner at the time of provisional acceptance.

D. Owner's Representatives inspection shall determine if the seeded areas are acceptable and whether maintenance shall continue in any part.

E. After all necessary corrective work and clean-up has been completed, and maintenance instructions have been received by the Owner, the Owner's Representative will certify in writing the acceptance of the seeded areas. The Contractor's responsibility for maintenance of seeded areas shall cease on receipt of the Certificate of Provisional Acceptance.

1.05 EXAMINATION OF CONDITIONS

A. All areas to be seeded shall be inspected by the Contractor before starting work and any defects, such as incorrect grading, drainage problems, etc., shall be reported to the Owner's Representative prior to beginning this work. The commencement of work by the Contractor shall indicate his acceptance of the areas to be seeded, and he shall assume full responsibility for the work of this Section.

PART 2 PRODUCTS

2.01 LOAM

A. Loam materials shall be processed to meet the requirements of NHDOT Specifications Division 600, Section 641 "Loam."

B. The loam shall be screened to remove all particles greater than two inches (2) inch in any diameter, and be reasonably free from subsoil, clay lumps, stones, brush, objectionable stumps, roots, litter, toxic substances, and other material or substances which may be harmful to plant growth or be a hindrance to grading, planting and maintenance operations.

C. The minimum and maximum pH value shall be from 5.5 to 7.6. Loam shall contain a minimum of 3 percent and a maximum of 10 percent of organic matter as determined by loss by ignition. Not more than 65 percent shall pass a No. 200 (0.075 mm) sieve as determined by the wash test in accordance with ASTM D 1140. In no instance shall more than 20 percent of that material passing the No. 4 (4.75 mm) sieve consist of clay size particles.

D. A sample of the processed loam materials shall be provide to the Engineer for laboratory testing, to determine recommended fertilizer application rates and whether any additives are required. Contractor shall treat the loam to meet the specifications.

E. Loam shall be applied to areas disturbed during construction, where shown on the Plans, and as directed by the Engineer.

2.02 LIME

A. Lime shall conform to NHDOT Specifications Division 600, Section 642 "Limestone."

2.03 FERTILIZER

A. Fertilizer shall conform to NHDOT Specifications Division 600, Section 643 "Fertilizer for Grasses."

B. Fertilizer to be used must be the equivalent of a standard 19-19-19 mixture and shall be approved by the Engineer. Fertilizer shall be a standard commercial grade fertilizer conforming to all State and Federal regulations and to the standards of the Association of Official Agricultural Chemists. The analysis shall represent respective percentages of nitrogen, phosphoric acid, and potash.

2.04 SEED

A. All seed shall be certified as to mixture, germination, and purity, and shall conform to Slope Seed Type 44 as defined in NHDOT Specifications Division 600, Section 644 "Grass Seed."

B. The Contractor shall use approved slope erosion resistant seed mix for erosion control of sloped areas and use grass mix for level areas.

2.04 BONDED FIBER MATRIX

A. Bonded fiber matrix shall be installed on all vegetated slopes steeper than 4:1. Acceptable manufacturers include:
   1. Mat Inc. (Soil Guard);
   2. Central Fiber Corporation (Spray Matt);
   3. Terra Novo (Earthguard Fiber Matrix); or
   4. Approved equal.

B. Application rates of the stabilizer and fiber mulch shall be in accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.01 SEEDING PERIODS

A. Unless otherwise authorized, the Contractor shall do all seeding during the following periods:

1. April 1 and July 1
2. August 15 and October 15
3. If seeding is done beyond October 15, the Contractor shall apply mulch at a rate of 2 to 2½ tons per acre, but no more than 3 tons/acre.

Seeding shall not be done during windy weather or when the ground is frozen, excessively wet, or otherwise untillable.

3.02 SEED BED PREPARATION

A. Seed will be applied to a well-conditioned smooth firm seedbed, prepared to a depth of three (3) inches. Clods or other obstructions generally larger than two (2) inches in diameter of thickness that will prevent uniform seeding shall be removed or reduced in size.

B. Hard or caked seed bed shall be reconditioned before the seed is applied.

C. Prior to seeding, Contractor shall track the loam slope areas with a dozer in a direction parallel to the slope, to provide water bars and reduce erosion potential and promote see catch.

D. Care must be taken by the Contractor to see that excessive ruts or ridges are not created on the graded areas.

3.03 LIMING, FERTILIZING, AND SEEDING

A. Lime, fertilizer and seed may be applied by any of the methods described in NHDOT Specifications, Division 600, Section 644 “Grass Seed.” The rates of application shall conform NHDOT Specifications, Division 600, Section 642, 643, and 644 “Limestone,” “Fertilizer for Grasses,” and “Grass Seed.”

B. Lime and fertilizer shall be applied based upon nutrient availability of the soil and worked into the soil at the time of seed bed preparation.

3.04 FIBER MULCHING

A. MULCH:

Immediately after the area has been seeded or during application of seed, it shall be uniformly covered by fiber mulch at the rate recommended by the manufacturer of the fiber matrix.

3.05 MAINTENANCE AND PROTECTION

A. Maintenance shall begin immediately after any area is seeded and shall continue for ninety (90) days or until final written acceptance by the Owner's Representative, whichever is longer.

B. Maintenance shall include reseeding, mowing, watering, weeding, liming and fertilizing.

C. Watering of Seeded Areas:

1. First Week: The Contractor shall provide all labor and arrange for all watering necessary to establish an acceptable lawn. In the absence of an adequate rainfall, watering shall be performed daily or as often as necessary during the first week and in sufficient quantities to maintain moist soil to a depth of at least two inches.
2. Second and Subsequent Weeks: The Contractor shall water the lawn as required to maintain adequate moisture, in the upper two inches of soil, necessary for the promotion of deep root growth.
3. Watering shall be done in a manner which will provide uniform coverage, prevent erosion due to application of excessive quantities over small areas, and prevent damage to the finished surface by the watering equipment. The Contractor shall furnish sufficient watering equipment to apply one complete coverage to the seeded areas in an eight (8) hour period.

D. Reseeding: After the grass in seeded areas has appeared, all areas and parts of areas which, in the opinion of the Owner's Representative, fail to show a uniform stand of grass, for any reason whatsoever, shall be reseeded and such areas and parts of areas shall be seeded repeatedly until all areas are covered with a satisfactory growth of grass. Reseeding together with necessary grading, fertilizing, and trimming shall be done at the expense of the Contractor.

E. Fertilizing: A second application of fertilizer, as specified herein, shall be applied after one (1) season of growth of a minimum of two (2) months duration, but only during the months of April, May, August or September. Fertilizer shall be applied at the rate of thirty (30) pounds per one thousand (1,000) square feet.

F. Liming: If more than one initial application of limestone is required by the soils analysis to bring the pH of the stockpiled loam to a specified range, the Contractor shall be responsible for all additional required lime applications.

3.05 GUARANTEE PERIOD

A. The Contractor shall guarantee all seeded areas for a period of one (1) year following the date of Provisional Acceptance. During the guarantee period, the Contractor shall make periodic inspections of seeded areas and to determine if any remedial actions are necessary to prevent erosion or damage to seeded areas.

B. At the end of the guarantee period, the Engineer and Owner shall observe the vegetation, at the written request of the Contractor, at least ten (10) days before anticipated date. Seeded area not demonstrating satisfactory vegetation, as determined by the Engineer and Owner, shall be repaired, reseeded, and maintained to meet all requirements specified herein.

C. After the completion of all necessary corrective work, the Engineer shall issue a certificate of final acceptance, which shall terminate the Contractors responsibility for the seeded areas.

END OF SECTION

SECTION 13001
SITE SAFETY AND CONTINGENCY WORK PLAN OUTLINE

PART 1 GENERAL

1.01 DESCRIPTION

A. The Franklin Secure Residue Landfill site is located off Punch Brook Road in the City of Franklin. The existing landfill occupies approximately 20 acres of the site. Elsewhere on the site are located the operations office, maintenance building, and leachate pre-treatment, storage and pump station systems.

The lined landfill was first permitted by NHDES in 1985 to accept residue from the combustion of municipal solid waste from the Penacook Waste to Energy Facility.

B. The Contractor shall employ practices that ensure health and safety of others.

C. The purpose of the Site Safety and Contingency Work Plan (SSACWP) outline is to assist the Contractor in assessing specific site hazards which may be encountered, to suggest safety procedures which will reduce personnel exposure to hazardous conditions, and to outline emergency response procedures. The Contractor shall prepare the final SSACWP for Contractor's work. The SSACWP shall be submitted to the Engineer for review and submittal to NHDES within two weeks following Notice of Award and prior to beginning site work. All comments from Engineer and NHDES must be addressed prior to commencing activities that disturb waste. The SSACWP will provide for the identification of hazardous site conditions and shall provide for discontinuance of the work in the area identified and notice to the Engineer of the location, time, type of waste and action taken.

D. This Contract anticipates that the Work will be performed in Level D personal protective equipment (PPE), supported by health-and-safety monitoring and appropriate response actions.

E. The Contractor shall be fully responsible for liabilities, claims, or damages, which are the result of the Contractor's negligence, willful misconduct or failure to comply with any part of this Contract.

F. The Contractor shall be solely responsible for the safety of employees and subcontractors. The Contractor shall comply with all applicable provisions of National and Local safety laws and building codes to prevent accidents or injury to persons on, about or adjacent to the premises where the work is being performed. The Contractor shall erect and properly maintain at all times, as required by the conditions and progress of the Work, all necessary safeguards and barricades for the protection of employees on the Work and the safety of others

employed near the Work and the public, and shall post danger signs and warning lights clearly indicating potential hazards created by features of the construction.

G. The Contractor shall provide the developed SSACWP and shall coordinate safety requirements for all representatives visiting the site, including the Engineer (including resident engineer), the Owner, the NHDES, and all other visitors to the site.

H. The Contractor shall immediately report in writing, giving full details to the Engineer, Contractor shall immediately report the accident by telephone or messenger whether the accident occurs on or adjacent to the site, causes death, serious personal injury or substantial property damage. If a claim is made or suit is filed by anyone against the Contractor or any subcontractor on account of any accident, the Contractor shall promptly report the facts in writing to the Engineer giving full details of the claim.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. The Contractor is required to maintain appropriate health and safety equipment on-site for the use of personnel at times during excavation of waste materials, or when the potential exists for exposure to noxious or hazardous conditions.

B. The Contractor shall maintain at the site, at a minimum, a combustible gas indicator, hydrogen gas meter, and oxygen meter for the duration of the work.

C. In addition, the Contractor shall maintain fire extinguishers, first aid kits, eye wash and other related safety equipment on-site for the duration of the Work.

D. All safety equipment shall be inspected periodically by the Contractor and maintained in good working order. The Contractor shall clearly tag and/or remove from the site, any equipment that does not pass the Contractor's inspection, and replace such equipment immediately.

PART 3 EXECUTION

3.01 SITE SAFETY AND CONTINGENCY WORK PLAN - GENERAL

A. The Contractor shall prepare a SSACWP in accordance with 29 CFR 1910.120. The plan will include at a minimum, the following for each phase of the Work: identification of specific site hazards, risk analysis, personal protection program, and an air monitoring plan. In addition, the plan shall include a comprehensive work plan and also outline emergency contacts and response actions. The

Contractor's SSACWP shall include the elements described in the SSACWP Required Elements Outline, Part 3.05 of this section.

B. The Contractor's SSACWP shall be prepared by a certified industrial hygienist or a person certified as a safety professional experienced with similar types of projects. The Plan shall include a signed statement from the preparer attesting the adequacy of the Plan.

C. The Contractor shall submit the prepared SSACWP to the Engineer within 2 weeks after Contract award and before initiating any site activities. Any comments provided by the Engineers and NHDES must be addressed prior to commencing work that will disturb waste. The Engineer's review does not relieve the Contractor of responsibilities for SSACWP completeness, accuracy, and implementation.

D. All Work shall be consistent with the applicable provisions of Federal, State, and Local laws, including 29 CFR 1926. The Contractor shall comply with all applicable OSHA requirements.

E. The Contractor shall provide copies of the Contractor's SSACWP to all emergency contacts, including the Engineer, Owner, Local Fire Department, Police Department, NHDES-Waste Management Division and Hospital identified in the Plan. The Contractor shall also provide notification of scheduled SSACWP meetings and provide briefings to the emergency contacts and agencies listed in this section.

3.02 SAFETY PERSONNEL - GENERAL

A. The Contractor's SSACWP shall identify a primary Site Manager who will be available on-site at all times while construction work is in progress. The Site Manager shall be responsible for site activities related to the performance of Work. The Site Manager shall also serve as the Contractor's representative and point of contact for all on-site communications. All communication with the Site Manager shall be considered to be communication with the Contractor. An Alternate Manager shall also be designated to carry out the responsibilities of the primary Site Manager when the primary Site Manager is not available.

B. The Contractor shall designate a site Safety Officer for the duration of the project. The Safety Officer shall be experienced with work similar in nature to this project along with hazardous materials identification and monitoring. The Contractor may designate an alternate Safety Officer having qualifications meeting this section, to carry out the responsibilities of the primary Safety Officer when the primary Safety Officer is unavailable.

C. The Safety Officer shall be trained according to the requirements of CFR 29 1910.130 and shall maintain certification throughout the duration of the project.

D. The Safety Officer shall be present on-site during all on-site activities that may potentially involve hazardous material, including waste excavation, or other intrusive activity.

E. The Safety Officer shall be responsible for the SSACWP implementation.

3.03 ADDITIONAL CONSIDERATIONS FOR SSACWP DEVELOPMENT

Reports on the landfill operation and waste materials received at the facility will be made available to the Contractor. The Contractor is provided the following additional considerations for SSACWP development.

A. Physical Hazards: The Contractor should recognize construction physical hazards. Physical hazards include the following: heavy equipment operation during excavation of ash residue, steep and potentially unstable slopes, bulky metal waste materials, glass, un-combusted waste materials, or other objects which may become dislodged and move downslope during excavations, obscured vision due to dust or other obstructions, sharp objects and unstable footing on waste or capping system maerials.

B. Air: Chemical stabilization of the ash residue has been observed to generate hydrogen gas. The SSACWP shall include provisions in the event of detection of explosive levels of hydrogen gas.

C. Leachate: Landfill leachate may also be encountered during the waste excavation work and liner system construction.

E. Stormwater: Stormwater runoff may contain residual compounds resulting from contact with residue waste in the landfill.

3.04 SITE SAFETY AND CONTINGENCY WORK PLAN REQUIRED ELEMENTS OUTLINE

The requirements for the Contractor's SSACWP shall be as described in the following outline. The order of the Contractor's SSACWP sections may be modified by the Contractor. The Contractor may also include additional sections or provisions as needed or required based on the Contractor's approach to completing the Work. The absence of particular provisions in the outline does not relieve the Contractor of developing appropriate sections or procedures for site work in accordance with applicable OSHA standards. The Contractor shall ensure that all subcontractors engaged to perform work for Contractor either adopt the Contractor's SSACWP provisions or develop a SSACWP consistent with the following outline.

A. Introduction: This section shall describe the Contractor's SSACWP purpose. This section shall describe the health and safety responsibilities of the Contractor and

subcontractors in performing the Work. This section shall describe the general OSHA training requirements for personnel involved in site field work.

B. Site Description/History: This section shall briefly describe relevant physical site features including the following: location, size, layout, topography, surface water and ground water. The site history shall briefly describe relevant previous site activities which may assist site workers in understanding the nature of wastes anticipated during construction activities.

C. Project Description and Work Plan: This section shall briefly describe the general tasks to be conducted by Contractor. The project description and work plan section shall include categories of site work such as excavation, grading, liner placement and methane vent pipe installation.

D. Personnel, Responsibilities and Training Requirements: This section shall include the Contractor personnel names, company affiliation, responsibility and whether the individual will be on-site during specific tasks. This section shall name a Site Manager, Alternate Site Manager, Safety Officer, and an Alternate Safety Officer. Contractor's construction foreman, heavy equipment operators and laborers may be listed as "VARIOUS". All site personnel shall read and sign the Contractor's SSACWP. This section should also list Engineer representatives, municipal emergency response representatives and appropriate regulatory agency officials. The training and medical monitoring requirements specified in 29 CFR 1910.120 for each individual or class of individuals shall be specified in this section. The level of training and medical monitoring per individual shall be appropriate for the tasks assigned.

E. Hazardous Material Summary: This section shall include the general categories of the waste physical and chemical characteristics which may be encountered during site work.

F. Hazards of Concern: This section shall include the applicable general hazards of concern for consideration during site work. Example hazards of concern include the following: heat stress, cold stress, explosive or flammable substances, oxygen deficiency, radiological, biological, noise, toxicity, corrosivity and physical hazards.

G. Overall Hazard Evaluation Per Task: This section shall include a qualitative assignment of risks as high, medium, low or unknown to health and safety resulting from site work per task. This section shall include justification of the PPE level used for each site task based on the qualitative risk designation. Justification for selection of PPE may include: the hazards of anticipated wastes, the nature of the task, and selection of air monitoring procedures and/or frequency to evaluate that the proper level of PPE is maintained.

H. Protective Clothing: This section shall establish the anticipated task-specific levels of PPE (such as A, B, C or D) based on the task-specific hazard evaluation. This section shall include a task-specific description of the levels of PPE including the anticipated respiratory and protective clothing requirements for each task.

I. Environmental Monitoring Equipment and Procedures: This section shall establish the task-specific environmental monitoring equipment and monitoring procedures to be employed during site work. This section shall include the instrument type and the monitoring parameter (for example methane) for each monitoring device employed during site work and a description of calibration procedures to be followed for the instrument. This section shall establish task and instrument specific monitoring frequencies to be employed during site work. This section shall establish the task-specific conditions under which levels of PPE shall be upgraded in response to environmental monitoring.

J. Mitigation of Physical Hazards: This section shall include a description of mitigating procedures for task-specific physical hazards that will be employed during site work. This section may include a description of mitigating procedures for fall prevention, fire and explosion hazards, electrical hazards and heavy equipment operation hazards.

K. Personnel Decontamination Procedures: This section shall establish personnel decontamination procedures for each level of PPE (such as A, B, C or D) anticipated during site work, including personnel and equipment washing and rinsing procedures. This section shall include a description of the on-site storage method to be employed during site work for used disposable and reusable protective clothing pending final off-site or on-site disposal.

L. Equipment Decontamination Procedures: This section shall establish procedures to decontaminate equipment that contacts hazardous material, if applicable.

M. Site Control: This section shall establish procedures to reduce contact of site personnel and equipment with contaminated or potentially contaminated materials, including procedures for reducing site access to non-project personnel or non-essential vehicular traffic.

N. Heat/Cold Stress Monitoring: This section shall establish procedures to monitor site personnel and site weather conditions to control heat and cold stress. Monitoring may include ambient air temperature, cloud cover and site personnel heart rates and oral temperatures.

O. Emergency Procedures: This section shall establish mitigation procedures to be followed for potential emergencies during the Work. Potential emergencies may include personnel chemical exposure through potential exposure pathways, personnel injury, fire or explosion and spills of hazardous or potentially hazardous

materials. Mitigation procedures may include assessing personnel exposure pathways and vital signs, rendering appropriate first aid measures, contacting fire and/or ambulance units and spill assessment and containment measures. This section shall also establish emergency evacuation procedures if Work area evacuation is necessary during site work. Emergency evacuation procedures may include evacuation signals, evacuation routes and staging areas for the assembling of evacuated personnel.

P. Emergency Equipment: This section shall designate emergency or safety equipment required on-site during the Work. Emergency equipment may include extra protective clothing, first aid kits, fire extinguishers, portable telephones, air horns, and air purifying respirators with suitable cartridges.

Q. Emergency Contacts: This section shall include a listing all personnel or agencies that require notification during an emergency. The listing should include the contact name and phone number and where the contact can be located. The listing should include the Project Manager or supervisor, the Safety Officer, the Owner, the Engineer, the local fire and police departments, NHDES Waste Management Division, and appropriate State of New Hampshire and federal agencies. The listing should also include medical emergency contact information including the nearest hospital with emergency services with the hospital address and telephone number, the telephone number of the nearest ambulance service and directions with a map showing the most direct route to the hospital. The Emergency Contact list shall also be posted at the job site trailer.

3.05 RESPONSE PROCEDURES

A. It is anticipated that materials encountered in the landfill will consist of household garbage, some construction/demolition waste, ash materials, and unclassified wastes. However, if potentially hazardous materials are encountered during the progress of the Work, the Contractor shall immediately implement the following:

1) All work in the immediate area will be suspended, and site personnel will be evacuated to a safe zone.
2) All materials suspected of being hazardous shall immediately be reported to the Engineer and Owner.
3) The Contractor's Safety Officer and the Engineer will assess if the material is hazardous by observation, screening, or if necessary, by sampling and analysis by the Contractor.
4) The Contractor shall maintain a log of all incidents related to the discovery of potentially hazardous materials which shall be available to the Owner and Engineer at all times.

B. If the material is assessed to be a hazard, the Contractor will notify the Engineer and Owner. The notification must include the following:

1) The name and telephone number of the person reporting.
2) The landfill location where the material was observed.
3) Identification and approximate quantity of materials discovered.
4) The extent of on-site hazards and personnel injuries, if any.
5) An assessment of hazards to health and safety of on-site personnel, and nearby people, if applicable.
6) Recommendations to control or remove the site hazard.

END OF SECTION

APPENDIX D
CONSTRUCTION COST ESTIMATE

Cost Estimate Form for Closure of a Lined Landfill

Facility Name: Franklin Secure Residue Landfill
Phase: Phases I - V
Owner: Concord Regional Solid Waste/Resource Recovery Cooperative
Address of Facility: Punch Brook Road; Franklin, NH
Date: November 2014
DES Permit #: NH/DPHS-SW-85-003

State of New Hampshire
Waste Management Division
Department of Environmental Services
29 Hazen Drive, PO Box 95
Concord, NH 03302-0095
(603) 271-3503 FAX 603-271-2867
TDD Access: Relay NH 1-800-735-2964

1 Stage I Closure Construction Cost

Stage I Closure Area 12.4 Acres
Total Landfill Area 19.9 Acres

2013 Phase I Closure Expenses	$1,179,332
2014 Phase I Closure Expenses (as of September 2014)	$1,419,849
Base Construction Contract (Kingsbury Companies, LLC)	$1,823,000
Change Orders	$406,026
Revised Contract Total	**$2,229,026**
Contingency	$20,000
Engineering/Testing	$443,000
Total Estimated Phase I Closure Cost	**$2,692,026**
2014 Phase I Estimated Amount Remaining	**$92,844**
$/Acre:	**$217,000**

2 Estimated Stage II Closure Construction Cost (2015)

Stage II Closure Area 7.5 Acres

Complete this form in accordance with the NH Solid Waste Rules Part Env-Sw 1403

	Task	Unit	Unit Cost	Quantity	Total Cost
I	Design of Final Closure Plans				
	Engineering Cost	LS	$110,000	1	$110,000
	Plans	LS			
II	Mobilization, Demobilization & Insurance				
	Total cost	LS	$110,000	1	$110,000
III	Erosion Control	LS			
	Silt Fence	LS	$5,000		
	Erosion Matting/Blanket	LS			
	Hay Bale Sediment Barrier	LS			
	Hay Mulch Cover	LS			
	Check Dams	LS	$2,500		
	Other	LS	$47,500		
	Total cost	LS	$55,000	1	$55,000
IV	Waste Relocation				
	Test Pits (to define limits of refuse and/or ground water to refuse contact)	DAY			
	Clearing & Grubbing	SY			
	Waste Regrading (Refuse Excavation/Relocation & Compaction)	CY			
	Other				
V	Capping				
A	Cap (Material and Installation)				
	Geomembrane	SF	$0.62	335,000	$207,700
	Soil	CY			
	Testing	LS			
	Anchor Trench				
	Drainage Net Composite	SF	$0.71	335,000	$237,900
B	Gas Vents Devices				
	Gas Vents/Wells	EA	$2,500	8	$20,000
	Other				
C	Layers				
	Drainage Layer - Free Draining Sand - 12" thick	CY	$18.00	12,100	$217,800
	Moisture Retention Layer - 6" thick	LS	$16.00	6,050	$96,800
	Sand - Protective Gas Venting Layer - 12" thick	CY	$18.00	12,100	$217,800
	Topsoil/Loam or Manufactured Soil - 6" thick	CY	$25.00	6,050	$151,300
	Other	LS			
VI	Stabilization, Run-off Control				
	Seed & Mulch (Include Lime, Fertilizer, Seed & Hay Mulch)	AC	$4,700	7.5	$35,300
	Surface Water Diversion Swales	LS	$80,000	1	$80,000
	Stone Rip-Rap	CY			

	Catch Basins, Manholes & Drop Inlets	LS			
	Toe Drain	LS	$85,000	1	$85,000
	Detention Pond and Associated Outlet Devices				
	Other				
VII	Monitoring Devices				
	Settlement Monuments/Plates	EA			
	Groundwater Monitoring Wells	EA			
	Gas Monitoring Probes				
	Other				
VIII	Roadway				
	Access Roadway	LF			
	Drainage Ditches				
	Culvert Inlet & Outlet Headwalls				
	Guide Rail	LF			
	Dust Control - Calcium Chloride				
	New/Replaced Pavement	SY			
	Other				
IX	Miscellaneous				
	Signs	LS			
	Perimeter Fence	LF			
	Entry Gate - Double Unit	EA			
	Miscellaneous Work and Cleanup				
	Ledge Removal	CY			
	Other				
X	Surveying				
	Baseline, Bench Marks, and Survey Control	LS			
	Other				
XI	Construction Phase Testing				
	Compaction Testing				
	QAQC		$12,000	1	$12,000
	Other				
XII	Engineering				
	Resident Engineer, Project Manager, Project Engineer	LS	$150,000	1	$150,000
	Record Drawings/ As-Built	LS	$10,000	1	$10,000
	Qualified Professional Oversight	LS	$20,000	1	$20,000
XIII	Other (list)				
	Construction Cost				**$1,515,000**
XIV	Contingency (minimum 10%)	LS	10%	1,817,000	$181,700
	Total Cost				**$1,999,000**

Estimated Stage I Closure Construction	**$2,693,000**
Estimated Stage II Closure Construction	**$1,999,000**
Estimated Total Closure Construction Cost	**$4,692,000**
Lined Area:	19.9
Closure Area:	19.9
$/Acre:	**$235,779**

This form provides a basis for cost estimating closure costs for a lined landfill. This form is not inclusive of all costs that may be associated with the landfill closure. The cost estimate must include all items needed to comply with all DES permits. Please use the spaces provided above noted as "Other" or attach an additional sheet if necessary.

APPENDIX E
APPLICATION FOR WAIVER

Concord Regional Solid Waste/Resource Recovery Cooperative
Franklin Secure Residue Landfill – Stage II Closure
Permit Number: DPHS-SW-85-003

Application for Waiver

Stage II Closure Construction

March 2015

Submitted to:

NH Department of Environmental Services
Waste Management Division
P.O. Box 95, 29 Hazen Drive
Concord, New Hampshire 03302-0095

Prepared for:

Concord Regional Solid Waste/Resource Recovery Cooperative
P.O. Box 157
Franklin, NH 03235

Prepared by:

CMA Engineers, Inc.
Civil and Environmental Engineers
35 Bow Street
Portsmouth, New Hampshire 03801

STATE OF NEW HAMPSHIRE
PAUL D. SCHMIDT
No. 9525
LICENSED
PROFESSIONAL ENGINEER

Franklin Secure Residue Landfill
DPHS-SW-85-003

Application for Waiver

Stage II Closure Construction

Franklin, New Hampshire

March 2015

Table of Contents

Application for Waiver of Env-Sw 805.10(e)(1) and (j) – Landfill Capping System Design Standards

NHDES Waiver Application Form

Section

I	Applicant Identification (Section I(6))
IV	Notice of Filing Requirements
V	Reason for Requesting Waiver
VI	Proposed Alternative Procedure, Method, or Activity
VIII	Demonstration of Criteria

NHDES WAIVER APPLICATION FORM

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Waste Management Division

For Office Use Only:
WMD Log #:_____
Date Rec'd.:_____
No. of Copies:_____

APPLICATION FOR WAIVER

pursuant to
the provisions of Part Env-Sw 202 of the New Hampshire Solid Waste Rules

APPLICATION FILING AND PROCESSING INSTRUCTIONS

(1) Complete this form by providing all of the information requested. If you need more space than provided on the form to answer a particular question and you are using a paper copy of this form, attach additional pages as necessary; mark each page clearly to show both the applicant name and the question being answered; and indicate on the form that the additional pages are attached

(2) Submit **THREE** copies of the completed waiver application, **EACH bearing ORIGINAL signatures**. Applications may be submitted to the department electronically. If the applicant chooses to submit an application electronically, a single paper copy shall also be submitted to the department to the following address:
:

New Hampshire Department of Environmental Services (DES)
Waste Management Division (WMD)
Permitting & Design Review Section (P&DRS)
29 Hazen Drive, PO Box 95
Concord, NH 03302-0095

(3) All references on this form that begin with "Env-Sw" are citations from the New Hampshire Solid Waste Rules. You may obtain a copy of the Rules from the DES Public Information and Permitting Office at (603) 271-2975. The Rules are also available on the Internet at http:\\www.des.nh.gov.

(4) DES will process your application in conformance with Env-Sw 202, Env-Sw 304 and Env-Sw 305.

(5) For further assistance with completing this form, contact the DES Permitting & Design Review Section (P&DRS) at (603) 271-2925 or at the above noted mailing address.

(6) You may also contact DES at TDD Access: Relay NH 1 (800) 735-2964.

SECTION I. APPLICANT IDENTIFICATION

(1)	Name: Franklin Secure Residue Landfill			
(2)	Mailing address: P.O. Box 157 Franklin, NH 03235			
(3)	Telephone number: (603) 934-5037			
(4)	If different than above, identify the individual associated with and designated by the applicant to be the contact individual for matters concerning this application:			
	(a)	Name: James Presher	(b)	Title: Director
	(c)	Mailing address:		
	(d)	Telephone number:	(e)	E-mail: crswrrc@aol.com
(5)	If the applicant is an individual, provide date of birth and go to Section II:			
(6)	If the applicant is a corporation, partnership or other association, provide the following information as specified:			
	(a)	The facility is owned by a: ☐ corporation ☐ partnership ☒ other association		
	(b)	State of incorporation/formation: New Hampshire		
	(c)	Principal business address: P.O. Box 157 Franklin, NH 03235		
	(d)	Provide on separate paper and attach/mark as "Attachment I(6)(c)," the names and addresses of all directors, officers and shareholders (*), if for a corporation; all partners (whether general or limited), if for a partnership; or all principals, members or participants, if for another type of association. (*) For a privately held corporation, identify all shareholders. For a publicly traded corporation, identify all shareholders owning 10% or more of the corporation's equity or debt.		

SECTION II. FACILITY OR ACTIVITY TO WHICH THIS REQUEST RELATES

Identify the particular facility or activity to which this application for waiver relates.

(1)	Related activity [check that which applies]:			
	☐	Application for a Standard Permit	☐	Application for a Permit-by-Notification
	☐	Application for an Emergency Permit	☐	Application for Research & Development Permit
	☐	Application to certify a waste-derived product for distribution and use	☐	Application for Operator Certification
	☒	Application to modify a permit (specify the permit number): DES-SW-DPHS-SW-85-003		
	☐	Other (specify):		
(2)	If the requested waiver relates to a particular application, provide the date the application was/will be submitted to DES: Type II Permit Modification for Stage II Closure Construction, submitted concurrently in March 2015			
(3)	If the requested waiver relates to a particular facility, provide the facility name and location in the space below. (Note: For a waiver relating to a particular facility, you must also notice the host municipality, host solid waste district and, in some instances, the abutters, as specified by Section IV of this form).			
	(a)	Facility name: Franklin Secure Residue Landfill		
	(b)	Street address: Punch Brook Road		
	(c)	Town/City: Franklin, NH 03235		

SECTION III. SPECIFIC RULE(S) FOR WHICH A WAIVER IS SOUGHT

Below, identify the specific solid waste rule(s) that you wish to have waived. Give the complete "Env-Sw" citation(s).

Env-Sw 805.10(e)(1) and (j) - Landfill Capping System Standards

SECTION IV. NOTICE OF FILING REQUIREMENTS

(1) If this application for waiver relates to a particular facility, you must send by certified mail, or deliver in hand, a complete copy of this application and a "notice of filing" to the host municipality, host solid waste management district and other affected entities, as specified by Env-Sw 303. To identify the host solid waste management district, contact the host town/city office or the P&DRS at (603) 271-2925.

(2) In addition, if this application for waiver is to reduce the required setback distance to any residence or property line, a notice of filing must be provided to the affected property owner(s) as specified in Env-Sw 303.

(3) A copy of the required notice(s) of filing and proof of receipt [i.e., signature(s) of the recipient(s) acknowledging receipt] must be attached to and submitted with this application for waiver, unless you are combining the notice of filing with the notice requirements for a related permit application as indicated by item (4) below.

(4) If this application for waiver is being submitted as part of an application for a facility permit or permit modification, the required notice(s) of filing may be combined with the notice(s) of filing prepared for the permit application/permit modification application itself. If so, check here: ☒

(5) For assistance with preparing the required notice of filing, please refer to either Env-Sw 303 or "A Guide for Preparing Notices of Filing." If the guide is not included with this application form, you may obtain a copy from the P&DRS at (603) 271-2925.

SECTION V. REASON FOR REQUESTING WAIVER

Explain why a waiver is being requested, including an explanation of the hardship that would be caused by having to comply with the rule. Use extra paper as necessary.

See attached

SECTION VI. PROPOSED ALTERNATE PROCEDURE, METHOD OR ACTIVITY

Provide a full explanation of any alternate procedure, method, or other activity that you propose to substitute for the procedure, method or activity you wish to have waived. Include written documentation and/or data to support the proposed alternative. Use extra paper as necessary.

See attached

SECTION VII. DURATION OF WAIVER

Specify the proposed duration for the requested waiver. If you are seeking a "permanent" waiver, including one that would expire when the facility to which it relates may close, so state and provide the desired starting date.

Proposed effective/starting date: April 2015		
Proposed expiration date:	***OR***	☒ I am seeking a "permanent" waiver

SECTION VIII. DEMONSTRATION OF CRITERIA

Provide a full explanation of why you believe that having the waiver granted will meet the below listed criteria. [Note: Economic, technological, practical application and safety issues shall be considered in evaluating a demonstration of the criteria; however, the merits of the application shall not be weighed solely on the basis of cost].

Criteria for Waiver, pursuant to Env-Sw 202.04:

(a) Exemption from complying with the rule shall:
1. Not result in an adverse effect to the environment or natural resources of the state, public health or to public safety.
2. Not result in an impact on abutting properties that is more significant than that which would result from complying with the rule.
3. Be in keeping with the intent and purpose of the rule being waived.

(b) One or more of the following conditions shall be satisfied:
1. Strict compliance with the rule will result in an adverse effect on the environment, public health or safety; AND/OR
2. Strict compliance with the rule will result in a circumvention of the goals and objectives of the state's solid waste management program, as specified in RSA 149-M:1 through 3 and the state solid waste management plan; AND/OR
3. Strict compliance with the standard will provide no benefit to the public and will cause an operational or economic hardship to the applicant.

Use the space below to provide your demonstration. Use extra paper as necessary.

See attached

SECTION IX. CERTIFICATION OF COMPLIANCE/COMPLIANCE REPORT

If you are able to certify that each of the following statements is true, do so by your signature. If you are unable to certify that each of the following statements is true, you must prepare a separate Compliance Report as specified by Env-Sw 303.15.

COMPLIANCE STATEMENT

The applicant shall certify that each of the statements listed in (1)-(8) below are true for each of the following individuals and entities:

- ☒ **the applicant, and**
- ☒ **the facility owner, and**
- ☒ **the facility operator, and**
- ☐ **all individuals and entities holding 10% or more of the applicant's debt or equity, and**
- ☒ **all of the applicant's officers, directors, and partners, and**
- ☐ **all individuals and entities having managerial, supervisory or substantial decision making authority and responsibility for the management of facility operations or the activity(s) for which approval is being sought**

(1)	No individual or entity listed above has been convicted of or plead guilty or no contest to a felony in any state or federal court during the 5 years before the date of the application.	
(2)	No individual or entity listed above has been convicted of or plead guilty or no contest to a misdemeanor for a violation of environmental statutes or rules in any state or federal court during the 5 years before the date of the application.	
(3)	No individual or entity listed above has owned or operated any hazardous or solid waste facility which has been the subject of an administrative or judicial enforcement action for a violation of environmental statutes or rules during the 5 years before the date of the application.	
(4)	No individual or entity listed above has been the subject of any administrative or judicial enforcement action for a violation of environmental statutes and rules during the 5 years before the date of the application.	
(5)	All hazardous and solid waste facilities owned or operated in New Hampshire by any individual or entity listed above are in compliance with either.	
	(a)	All applicable environmental statutes, rules, and DES permit requirements.
	(b)	A DES approved schedule for achieving compliance therewith.
(6)	All individuals and entities listed above are in compliance with all civil and criminal penalty provisions of any outstanding consent agreement, settlement, or court order to which DES is a party.	
(7)	All individuals and entities listed above have paid, or are in compliance with the payment schedule for any administrative fine	

	assessed by DES.
(8)	All individuals and entities listed above are in compliance with all terms and conditions under every administrative order, court order or settlement agreement relating to programs implemented by DES.

Signature of the applicant certifying the above statements are true:

Applicant Name **(Print Clearly or Type)** James Presher, Director of Concord Regional Solid Waste/Resource Recovery Cooperative

Applicant Signature _____

Date 3-11-15

OR

Circle the untrue statement(s) and attach a Compliance Report, pursuant to Env-Sw 303.15

SECTION X. APPLICANT SIGNATURE REQUIREMENTS

The applicant must sign the following statement prior to submitting this application. All copies of the application filed with DES must bear the applicant's original signature. If the applicant is not an individual, an individual duly authorized by the applicant shall sign the application.

To the best of my knowledge and belief, the information and material submitted herewith is correct and complete. I understand that any approval granted by DES based on false and/or incomplete information shall be subject to revocation or suspension, and that administrative, civil or criminal penalties may also apply.

Applicant Name **(Print Clearly or Type)** James Presher, Director of Concord Regional Solid Waste/Resource Recovery Cooperative

Applicant Signature _____

Date 3-11-15

SECTION XI. PROPERTY OWNER SIGNATURE

For applications relating a specific facility or activity, sited or to be sited on property not owned by the applicant, the property owner must also sign this form as follows. All copies of the application filed with DES must bear the property owner's ORIGINAL signature. If the property owner is not an individual, an individual duly authorized by the property owner shall sign the application.

(1)	I hereby affirm that the applicant has, or shall be granted, the legal right to occupy and use the property on which the subject facility is or will be located for the purposes specified in this application.
(2)	I hereby affirm that I shall grant access to the property for closure and post-closure monitoring of the subject facility and site as required by RSA 149-M and the New Hampshire Solid Waste Rules (Env-Sw 100-300 and Env-Sw 400-2000), as amended.

Property Owner Name **(Print Clearly or Type)** _____

Property Owner Signature _____

Date _____

SECTION I
APPLICANT IDENTIFICATION

Attachment I(6)(c)

Entity Name: Concord Regional Solid Waste/
Resource Recovery Cooperative

Address: P.O. Box 157 Franklin, NH 03235

Name	Title	Title Role	Role Start
James Presher	Director	Director	1990

SECTION IV
NOTICE OF FILING REQUIREMENTS

In accordance with Env-Sw 303, notice of filing of the Application for Waiver has been transmitted to the City of Franklin City Manager and landfill abutters. A sample copy of the notification letter, an abutter list, and a property site plan are enclosed for reference. The certified mail receipts will be transmitted to the Department under separate cover upon receipt.

March 16, 2015

City of Franklin
Elizabeth Dragon, City Manager
316 Central Street
Franklin, NH 03235

Map-Lot/Sublot #57-401

VIA CERTIFIED MAIL – RETURN RECEIPT REQUESTED

RE: Franklin Secure Residue Landfill (NHDES Permit No.: DPHS-SW-85-003)
Concord Regional Solid Waste/Resource Recovery Cooperative
New Hampshire Department of Environmental Services
Waste Management Division Permitting
Type II Permit Modification and Waiver Application

Dear City of Franklin,

The Concord Regional Solid Waste/Resource Recovery Cooperative (the Cooperative) is applying to the New Hampshire Department of Environmental Services (NHDES) for a Type II Modification to Solid Waste Facility Permit to the for the Franklin Secure Residue Landfill, located on Punch Brook Road. The permit modification is for Stage II Landfill Closure Construction which is planned to be completed this year. This is the final stage of the on-going closure project which began in 2013. The facility stopped receiving ash residue on January 1st of this year.

The Type II Permit Modification also includes an Application for Waiver of Env-Sw 805.10(e)(1) and (j) – Landfill Capping System Design Standards, as described in detail below. In accordance with Env-Sw 303 of the NHDES Solid Waste Rules, the Cooperative is providing you with notice of the planned filing of the Type II Permit Modification and the Waiver Application. This notice is provided to satisfy the requirements of NHDES for notifying the host municipality and project abutters.

The Type II Permit Modification and Waiver Application are being filed concurrently with the NHDES and will not require a public hearing. The proposed waiver application addresses two rules related to capping system design. The first waiver is to eliminate a 12” layer of unspecified

soil immediately overlying the waste, as required by Env-Sw 805.10(e)(1). The second waiver is to modify the requirements for minimum steepness of final slopes, as required by Env-Sw 805.10(j). These rules address design issues associated with municipal solid waste landfills, and do not apply to incinerator residue (ash) landfills such as the Franklin Secure Residue Landfill.

The Type II Permit Modification Application and the Waiver Application can be reviewed at NHDES located at 29 Hazen Drive, Concord, NH. The Permit Applicant and Property Owner is the Concord Regional Solid Waste/Resource Recovery Cooperative, P.O. Box 157, Franklin, NH 03235.

If you have any questions regarding the permit application review process, or wish to comment on the subject application, please contact Mr. Wayne Wheeler at NHDES-Waste Management Division, 29 Hazen Drive, P.O. Box 95, Concord, NH, 03302-0095 (603) 271-2925. For additional information regarding the permit modification or waiver applications you may contact Paul Schmidt at CMA Engineers, Inc., 55 South Commercial Street, Manchester, NH 03801 (603) 627-0708, or contact me directly at (603) 934-5037.

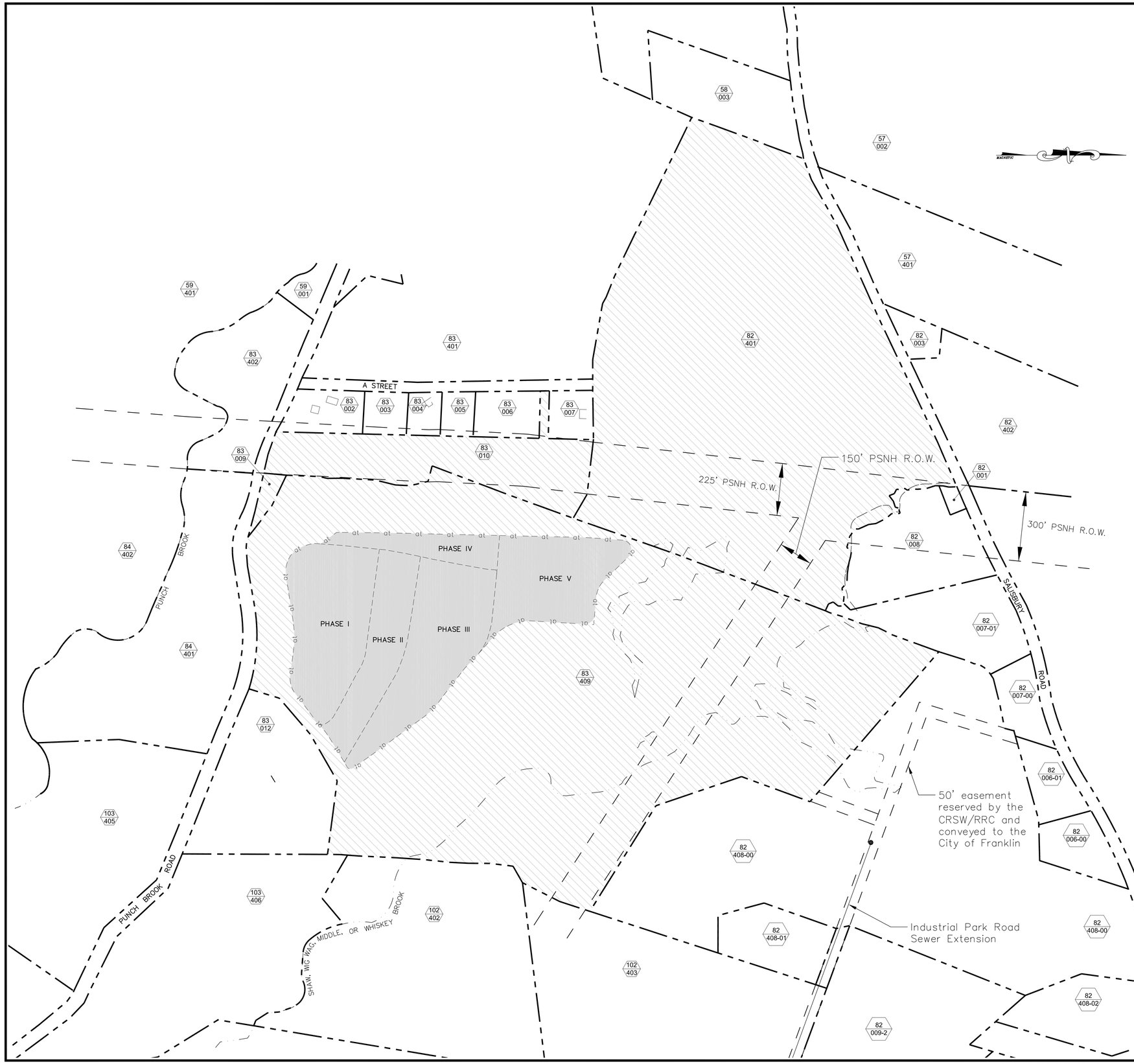
Very truly yours,

James R. Presher, Director
Concord Regional Solid Waste/Resource Recovery Cooperative

cc: Paul D. Schmidt, P.E., CMA Engineers

FRANKLIN SECURE RESIDUE LANDFILL
ABUTTER LIST – February 13, 2015

Map-Lot/ Sublot	Name and Address
57-002	Tarbin, Iona J. & Richard F.; 321 Salisbury Road, Franklin, NH 03235
57-401	City of Franklin; 316 Central Street; Franklin, NH 03235
58-003	Rudolph Estate, Philip E. & Maureen Rudolph; 308 Salisbury Road, Franklin, NH 03235
82-001	Public Service of NH; PO Box 330; Manchester, NH 03105
82-003	Young, John C. & Mary A.; 122 Salisbury Road, Franklin, NH 03235
82-007-00	Schiavone, Guy A. & Kim R.; 196 Salisbury Road, Franklin, NH 03235
82-007-01	Rayno Family Trust; 206 Salisbury Road, Franklin, NH 03235
82-008	West, Richard T. and Mary E., 226 Salisbury Road, Franklin, NH 03235
82-402	Campbell Family Trust; Campbell, Cynthia A. – Trustee; 247 Salisbury Road, Franklin, NH 03235
82-408-00	Weglarz, Stanley S. 602 South Main Street; Franklin, NH 03235
83-002	Tucker-Gonthier, Robin J.; 900 W Adams Street #110, Jacksonville, FL 32204-1102
83-003	Kozak, Michael & Diane M.; 15 A Street, Franklin, NH 03235
83-004	Laroche, Leon C. & Mable M.; 21 A Street, Franklin, NH 03235
83-005	Giraldo, Amilcar & Velez-Villa, Alejandrina; 5 Lander Street, Lynn, MA 01902
83-006 83-007	Ball, Diane L.; 49 A Street; Franklin, NH 03235
83-012	City of Franklin; 316 Central Street, Franklin, NH 03235
83-401 83-402	Emerson Family Trust; Emerson, Raymond L. III & Lillian R. – Trustees; 185 Punch Brook Road, Franklin, NH 03235
84-401	Jackman, Philip E; Papas, John; Gerald, Robertello; 1108B Carriage Lane, Cameron, MO 64429
102-402	Franklin Commons Realty Group, LLC; 70 Industrial Park Drive – Unit 7, Franklin, NH 03235
102-403	F.I.P Expansion, Inc.; F.B.I.D.C. PO Box 174, Franklin, NH 03235
103-406	RD Edmunds Land Holdings, LLC; 221 Franklin Street, Franklin, NH 03235



Notes:

1. Approximate Property Lines taken from City of Franklin Assessor's Maps No. 59, 82, 83, 84, 85, 102 & 103.
2. City of Franklin Assessors Cards used for Additional Information.
3. Parcel 83/008 Perimeter Survey performed by Lapene, Knowlton & Darbyshire Associates.
4. Parcel 82/409 Perimeter Survey performed by Paul Darbyshire, LLS.

Legend:

- Existing Property Line
- Existing Right of Way
- Existing Stream/Brook
- Existing CRSW/RRC Property
- Existing Landfill Footprint
- 82/007 — Tax Map Sheet No. 082, Lot No. 007

Landfill Site Abutters:

Map 57 Lot 002
Tarbin, Iona J. & Richard F.
321 Salisbury Road
Franklin, NH 03235

Map 57 Lot 401
City of Franklin
316 Central Street
Franklin, NH 03235

Map 58 Lot 003
Rudolph, Philip E. & Maureen
308 Salisbury Road
Franklin, NH 03235

Map 82 Lot 001
Public Service of NH
PO Box 330
Manchester, NH 03105

Map 82 Lot 003
Young, John C. & Mary A.
122 Salisbury Road
Franklin, NH 03235

Map 82 Lot 007 Sublot 00
Schiavone, Guy A. & Kim R.
196 Salisbury Road
Franklin, NH 03235

Map 82 Lot 007 Sublot 01
Rayno Family Trust
206 Salisbury Road
Franklin, NH 03235

Map 82 Lot 008
West, Richard T. and Mary E.
226 Salisbury Road
Franklin, NH 03235

Map 82 Lot 402
Campbell Family Trust
Campbell, Cynthia A.–Trustee
247 Salisbury Road
Franklin, NH 03235

Map 82 Lot 408 Sublot 00
Weglarz, Stanley S.
602 South Main Street
Franklin, NH 03235

Map 83 Lot 002
Tucker–Gonthier, Robin J.
900 W Adams Street #110
Jacksonville, FL 32204–1102

Map 83 Lot 003
Kozak, Michael & Diane M.
15 A Street
Franklin, NH 03235

Map 83 Lot 004
Laroche, Leon C. & Mable M.
21 A Street
Franklin, NH 03235

Map 83 Lot 005
Giraldo, Amilcar & Velez–Villa, Alejandrina
5 Lander Street
Lynn, MA 01902

Map 83 Lots 006 & 007
Ball, Diane L.
49 A Street
Franklin, NH 03235

Map 83 Lot 012
City of Franklin
316 Central Street
Franklin, NH 03235

Map 83 Lots 401 & 402
Emerson Family Trust
Emerson, Raymond L. III & Lillian R.–Trustees
185 Punch Brook Road
Franklin, NH 03235

Map 84 Lot 401
Jackman, Philip E.;
Papas, John;
Gerald, Robertello;
1108B Carriage Lane
Cameron, MO 64429

Map 102 Lot 402
Polyclad Laminates, Inc.
3100 W. Ray Road
Suite 301
Chandler, AZ 85226–2473

Map 102 Lot 403
F.I.P Expansion, Inc.
F.B.I.D.C.
PO Box 174
Franklin, NH 03235

Map 103 Lot 406
RD Edmunds Land Holdings, LLC
221 Franklin Street
Franklin, NH 03235

no.	revision	date	by

CMA ENGINEERS
CIVIL/ENVIRONMENTAL ENGINEERS
35 Bow Street
Portsmouth, NH
603/431-6196
55 So. Commercial Street
Manchester, NH
603/627-0708
Lafayette Center
Stone Street Building,
Suite 3B
Kennebunk, ME
207/985-8717
info@cmaengineers.com
www.cmaengineers.com

designed by: PDS/APV
drawn by: APV
approved by: PDS
date: March 2015
project no: 874
file name: 874-Property Plan 150316.dwg
scale: 1" = 200' (in feet)

CRSW/RRC
Franklin Secure Residue Landfill
Franklin, New Hampshire
Property Site Plan

drawing no. 1
sheet: 1 of 1

SECTION V
REASON FOR REQUESTING WAIVER &
SECTION VI
PROPOSED ALTERNATIVE PROCECURE, METHOD, OR ACTIVITY

Env-Sw 805.10(e)(1)

A waiver is being requested from this rule which sets forth required components of a landfill capping system, specifically as it relates to including layer 1 of a 5-layer capping system. Env-Sw 805.10(e)(1)a. states "Layer 1, immediately overlying the waste, shall serve to provide a stable, properly graded base for layer 2." We are proposing a capping system that does not include layer 1. The purpose of this rule relates to landfill covers over municipal solid waste. A municipal solid waste subgrade would by its nature be uneven, yielding, and potentially contain sharp or protruding objects that could damage an overlying cap geomembrane. Layer 1 is intended to provide an unyielding, even surface and a cushion between the waste and the overlying buffer/gas sand layer.

For this project, however, the waste consists of waste-to-energy incinerator residue consisting mostly of ash and metal. The ash surface has hardened through pozzolanic chemical reactions over time, and provides a highly stable base for layer 2. The ash surface has already been graded, and covered with a temporary geomembrane (to be removed). Any surface metal has already been removed from the ash by raking and hand-picking prior to the temporary geomembrane liner installation. Metal has not subsequently penetrated or damaged temporary geomembrane that has been in place for up to 20 years or more. In other areas of the landfill where future filling is planned to occur, the temporary geomembrane has been placed directly on this prepared ash surface without any damage to the geomembrane from metal in the ash. Furthermore, the ash has solidified and hardened, so the potential for metal migration to the surface is negligible.

Env-Sw 805.10(e)(1)b. states "Layer 1, immediately overlying the waste, shall be designed to resist raveling, or the sifting of fines downward into the underlying wastes." Layer 1 therefore is intended to function as a filter to prevent loss of buffer/gas sand (layer 2) from migration of the sand into the waste mass. The need for a filter applies to municipal solid waste, which is quite porous, but does not apply to incinerator residue where the potential for migration of gas sand into the ash does not exist.

Env-Sw 805.10(j)

A waiver is being requested from this rule which establishes a minimum cap system slope. Env-Sw 805.10(j) states "…landfill capping systems shall be designed at a slope of 5% or greater, as necessary to accommodate the anticipated effects of settlement and consolidation and assure positive drainage and stability of the capping system during the post-closure period." As stated, the intent of the minimum 5% cap slope rule is to initially provide a sufficiently steep slopes to maintain positive drainage after settlement, consolidation and degradation of the waste occurs over time after closure. Settlements in the range of 20 to 30 percent can be anticipated on the surface of municipal solid waste landfills after closure. The Secure Residue Landfill contains waste-to-energy residue consisting of mostly ash and metal that is essentially not expected to settle, consolidate or degrade. Minimum slopes of 2% are therefore sufficient to ensure long term positive drainage of the cap.

SECTION VIII
DEMONSTRATION OF CRITERIA

Criteria for Waiver, pursuant to Env-SW 202.04: All three of the following criteria shall be met:

a. Exemption from the Rule shall:

1. Not result in an adverse effect to the environment or natural resources of the state, public health or to public safety;

Waiver of Env-Sw 805.10(e)(1) and (j) would have no adverse effects to the environment, natural resources of the state, public health or public safety as the landfill cover system will perform as intended by the rules.

2. Not result in an impact on abutting properties that is more significant than that which would result from complying with the rule;

There will no associated impact on abutting properties that is more significant than that which would result from complying with the rule because proper closure of the Stage II landfill area of the Franklin Secure Landfill will result in no impact to abutting properties.

3. Be in keeping with the intent and purpose of the rule being waived;

The intent and purpose of the rules being waived is to address design issues associated with the capping of municipal solid waste. The Franklin Secure Landfill does not contain municipal solid waste, rather it contains waste-to-energy residue consisting of mostly ash and metal that does not have the design issues being addressed by these two rules.

b. One or more of the following criteria shall be satisfied:

1. Strict Compliance with the rule will result in an adverse effect on the environment, public health or safety;

2. Strict compliance with the rule will result in a circumvention of the goals and objectives of the state's solid waste management program, as specified in RSA 149-M:1 through 3 and the state solid waste management plan;

3. Strict compliance with the standard will provide no benefit to the public and will cause an operational or economic hardship to the applicant.

There is no benefit to the public in strictly complying with the rules, as the proposed cover system will perform in full compliance with the intent and purpose of the regulations. There are significant economic hardships associated with complying with the rules as well, by having to add an unnecessary 12 inch layer of soil to the cover system and by having to excavate, fill and re-shape the ash fill to create the required steeper slopes.

APPENDIX F
CONSTRUCTION DRAWINGS

CONCORD REGIONAL SOLID WASTE/ RESOURCE RECOVERY COOPERATIVE
Franklin Secure Residue Landfill
Franklin, New Hampshire

Type II Permit Modification Application
Stage II Closure Construction Drawings

Issued for NHDES Review - March 2015

Sheet Index

1 Overall Site Plan
2 Existing Conditions and Demolition Plan
3 Proposed Site Plan
4 Erosion Control Plan
5 Landfill Cross Sections
6 Closure Details
7 Closure Details
8 Closure Details

Locus Plan

Prepared For:

Concord Regional Solid Waste/Resource Recovery Cooperative
P.O. Box 157
Franklin, NH 03235

Prepared By:

CMA ENGINEERS
CIVIL /ENVIRONMENTAL ENGINEERS

35 Bow Street
Portsmouth, New Hampshire
03801-3819
Phone: 603/431-6196
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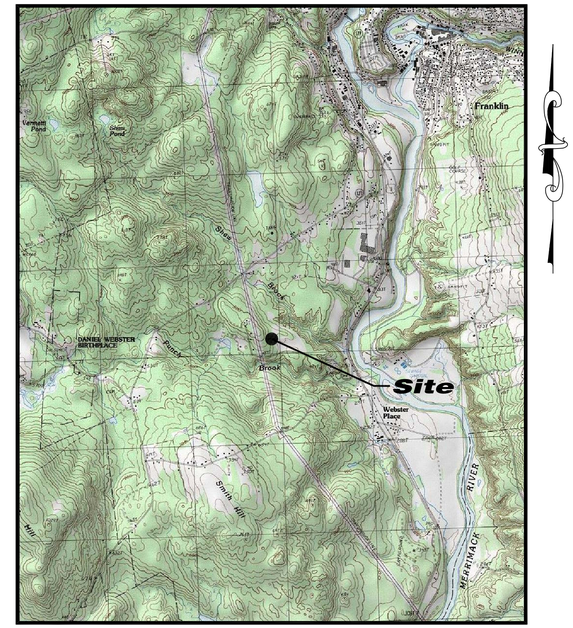
Langer Place
55 South Commercial Street
Manchester, New Hampshire 03101
Phone: 603/627-0708
Fax: 603/627/0746

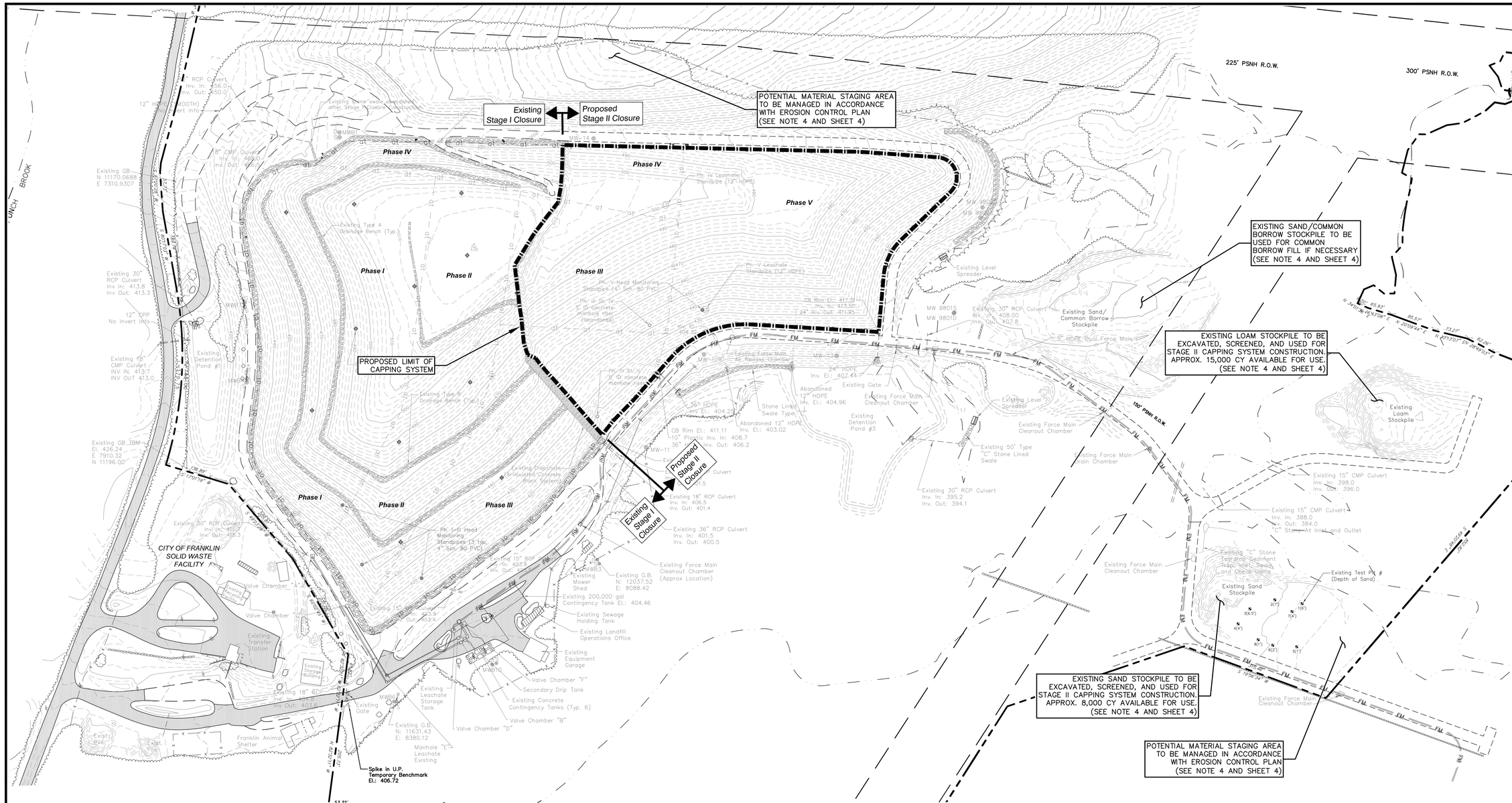
10 Free Street
Portland, Maine 04101
Phone: 207/541-4223
Fax: 207/541-4225

Website: www.cmaengineers.com
E-mail: info@cmaengineers.com

STATE OF NEW HAMPSHIRE
PAUL D. SCHMIDT
No. 9525
LICENSED
PROFESSIONAL ENGINEER



Project Location
Not to Scale



Legend:

- Existing 2' Contour
- 410 — Existing 10' Contour
- Existing Tree Line
- Existing Stone Wall
- GSE 12 / VZ 12 — Existing Utility Pole
- mw-405sr — Existing Monitoring Well
- gmw-15 — Existing Gas Monitoring Well
- Existing Culvert
- Approximate Property Line
- Delineated Edge of Wetlands
- Existing Pavement
- Existing Edge of Gravel Road
- x — Existing Fence
- FM — Existing Force Main
- Existing Stone
- at — Existing Anchor Trench
- Existing Gas Vent
- Existing Leachate Cleanout
- Existing Head Monitoring Standpipe
- LS — Existing Leachate Standpipe
- Proposed Limit of Capping System

Notes:

1. Existing topography shown inside the anchor trench in the Stage II closure area is based on field survey performed by T.F. Bernier, Inc. on January 15, 2015 and represents top of ash.
2. Existing topography shown inside the anchor trench in the Stage I closure area is based on GPS field survey performed by Kingsbury Companies, LLC in October 2014 and represents top of cap/vegetated surface.
3. Existing topography shown outside the anchor trench is a compilation of field survey performed by Paul M. Darbyshire, Associates on June 27, 2007 and by T.F. Bernier, Inc. on June 21, 2010. The perimeter gravel roadway is based on field survey performed by T.F. Bernier, Inc. on October 23, 2012.
4. The Contractor shall install silt fence around the perimeter of all active stockpiles and on the downslope of all active excavation areas in accordance with the Erosion Control Notes and Details depicted on the Erosion Control Plan (Sheet 4). At the conclusion of the project, the Contractor shall shape, grade, and hydroseed all current and prior stockpile and staging areas.

Construction Sequence Notes:

1. Install silt fence and check dams prior to construction start as shown on the Erosion Control Plan (Sheet 4).
2. Remove temporary geomembrane cover and ballast systems (wood strapping, steel posts, tires, sand bags) and dispose off-site. Temporary geomembrane cover to be removed in sections immediately prior to installing buffer/gas sand.
3. Install common borrow fill for drainage bench berms.
4. Install 12" buffer/gas sand layer.
5. Install geomembrane cap liner and weld to existing primary liner in anchor trench. Install toe drain swale liner and weld to cap liner. Install drainage geocomposite on cap, drainage benches, and to drain swale.
6. Install 12" select drainage sand layer over the drainage geocomposite using low ground pressure equipment.
7. Install select gravel and stone materials for drainage benches and toe drain swale.
8. Install 12" loam layer using low ground pressure equipment.
9. Hydroseed, fertilize, and stabilize.
10. Site cleanup. Remove erosion control measures once site is stable.

no.	revision	date	by

CMA ENGINEERS
CIVIL/ENVIRONMENTAL ENGINEERS
55 So. Commercial Street
Manchester, NH
603/627-0708
info@cmaengineers.com
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79 Bow Street
Portsmouth, NH
603/431-6196

STATE OF NEW HAMPSHIRE - PAUL D. SCHMIDT No. 9525 - PROFESSIONAL ENGINEER

designed by: PDS/APV
drawn by: APV
approved by: PDS
date: March 2015
project no: 874
file name: 874-ECP 1503.dwg
scale: 1" = 100' (in feet)

CRSW/RRC
Franklin Secure Residue Landfill
Franklin, New Hampshire
Stage II Closure Construction Drawings
Overall Site Plan

drawing no. 1

sheet: 1 of 8

F:\CADD\PROJECTS\874-Franklin\dwg\Stage II\Construction\874-ECP 1503.dwg Date Plotted: Mar 18, 2015 - 10:43am Plotted By: AVARDAKIS

EXISTING MONITORINTG WELL TO BE PROTECTED IN ROADWAY

EXISTING CLEANOUTS TO BE PROTECTED AND EXTENDED AS NECESSARY (TYP.)

EXISTING TEMPORARY GEOMEMBRANE AND COMMON BORROW TO BE EXCAVATED AND SHAPED AS NECESSARY TO EXPOSE EXISTING ANCHOR TRENCH LINERS. ANCHOR TRENCH TO BE HAND EXCAVATED TO PREVENT LINER DAMAGE AND TO PREPARE FOR NEW CAP LINER WELD TO EXISTING PRIMARY LINER.

EXISTING TEMPORARY GEOMEMBRANE COVER AND BALLAST SYSTEM (WOOD STRAPPING, STEEL POSTS, TIRES, SAND BAGS) TO BE REMOVED AND DISPOSED OFF-SITE

EXISTING GEOMEMBRANE-LINED SWALE, STONE, AND BERM TO BE REMOVED. EXISTING GEOCOMPOSITE AND GEOMEMBRANE LINER TO BE EXPOSED AND CUT AS NECESSARY TO PREPARE FOR NEW LINER CONNECTION.

EXISTING PHASE IV LEACHATE STANDPIPE TO BE ABANDONED

EXISTING PHASE V HEAD MONITORING STANDPIPE TO BE ABANDONED

EXISTING PHASE V LEACHATE STANDPIPE TO BE EXTENDED

EXISTING SWALE MATERIALS TO BE REMOVED AS NECESSARY TO EXPOSE EXISTING GEOCOMPOSITE AND GEOMEMBRANE LINER TO EXTEND DRAINAGE BENCH

LOCATION OF EXISTING ANCHOR TRENCH LINERS AT PHASE III/V INTERFACE TO BE CONFIRMED

EXISTING GEOCOMPOSITE AND GEOMEMBRANE LINER LOCATED BENEATH PLYWOOD AT EDGE OF DROPCHUTE. STONE, GRAVEL, AND PLYWOOD TO BE REMOVED TO PREPARE FOR NEW LINER CONNECTION.

EXISTING PHASE III ACCESS MANHOLE TO BE ABANDONED. EXISTING COVER WITH HATCH TO BE REPLACED WITH SOLID PRECAST TOP.

EXISTING PLUNGE POOL MATERIALS (TYPE A RIP RAP, CLASS "D" STONE) TO BE EXCAVATED AS NECESSARY TO PREPARE FOR NEW TOE DRAIN SWALE LINER CONNECTION. ANCHOR TRENCH TO BE HAND EXCAVATED TO PREVENT LINER DAMAGE.

Phase I
Phase II
Phase III
Phase IV
Phase V

CITY OF FRANKLIN SOLID WASTE FACILITY

Notes:

1. Existing topography shown inside the anchor trench in the Stage II closure area is based on field survey performed by T.F. Bernier, Inc. on January 15, 2015 and represents top of ash.
2. Existing topography shown inside the anchor trench in the Stage I closure area is based on GPS field survey performed by Kingsbury Companies, LLC in October 2014 and represents top of cap/vegetated surface.
3. Existing topography shown outside the anchor trench is a compilation of field survey performed by Paul M. Darbyshire, Associates on June 27, 2007 and by T.F. Bernier, Inc. on June 21, 2010.
4. Existing grass-lined swale, drainage structures, and valve chambers along eastern roadway shall be protected and retained. Any damage to existing systems shall be repaired or replaced at the discretion of the Engineer.

Legend:

- Existing 2' Contour
- Existing 10' Contour
- Existing Tree Line
- Existing Stone Wall
- Existing Utility Pole
- Existing Monitoring Well
- Existing Gas Monitoring Well
- Existing Culvert
- Approximate Property Line
- Delineated Edge of Wetlands
- Existing Pavement
- Existing Edge of Gravel Road
- Existing Fence
- Existing Force Main
- Existing Stone
- Existing Anchor Trench
- Existing Gas Vent
- Existing Leachate Cleanout
- Existing Head Monitoring Standpipe
- Existing Leachate Standpipe
- Proposed Limit of Capping System
- Existing Well/Cleanout To Be Protected and Extended As Necessary
- Existing Standpipe To Be Extended
- Existing Standpipe To Be Cut and Capped

no.	revision	date	by

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STATE OF NEW HAMPSHIRE – PAUL D. SCHMIDT No. 9525 – PROFESSIONAL ENGINEER

designed by: PDS/APV
drawn by: APV
approved by: PDS
date: March 2015
project no: 874
file name: 874-ECP 1503.dwg
scale: 1" = 60' (in feet)

CRSW/RRC
Franklin Secure Residue Landfill
Franklin, New Hampshire
Stage II Closure Construction Drawings
Existing Conditions and Demolition Plan

drawing no. 2

sheet: 2 of 8

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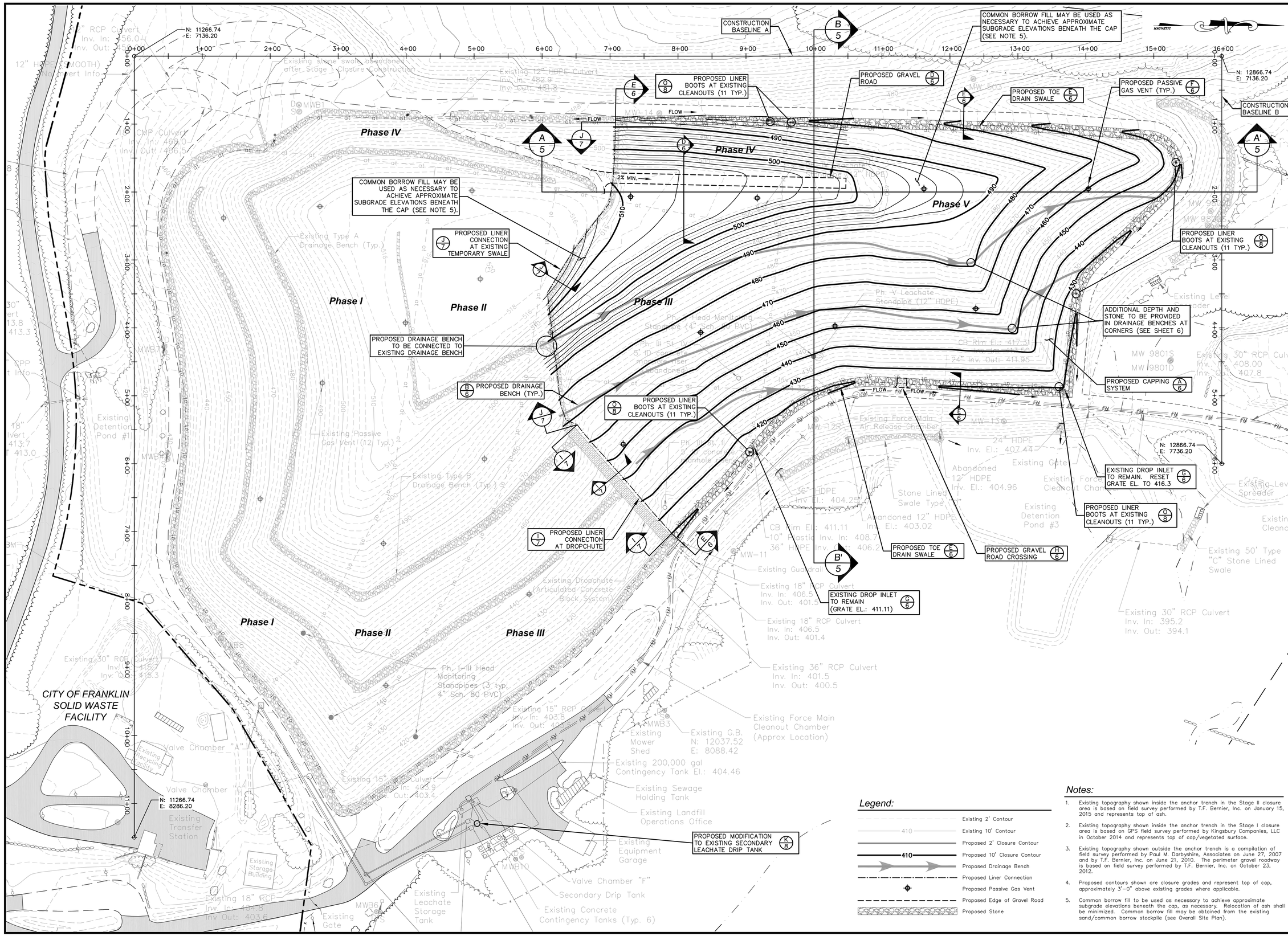

Legend:

- Existing 2' Contour
- 410 Existing 10' Contour
- Proposed 2' Closure Contour
- 410 Proposed 10' Closure Contour
- Proposed Drainage Bench
- Proposed Liner Connection
- Proposed Passive Gas Vent
- Proposed Edge of Gravel Road
- Proposed Stone

Notes:

1. Existing topography shown inside the anchor trench in the Stage II closure area is based on field survey performed by T.F. Bernier, Inc. on January 15, 2015 and represents top of ash.
2. Existing topography shown inside the anchor trench in the Stage I closure area is based on GPS field survey performed by Kingsbury Companies, LLC in October 2014 and represents top of cap/vegetated surface.
3. Existing topography shown outside the anchor trench is a compilation of field survey performed by Paul M. Darbyshire, Associates on June 27, 2007 and by T.F. Bernier, Inc. on June 21, 2010. The perimeter gravel roadway is based on field survey performed by T.F. Bernier, Inc. on October 23, 2012.
4. Proposed contours shown are closure grades and represent top of cap, approximately 3'-0" above existing grades where applicable.
5. Common borrow fill to be used as necessary to achieve approximate subgrade elevations beneath the cap, as necessary. Relocation of ash shall be minimized. Common borrow fill may be obtained from the existing sand/common borrow stockpile (see Overall Site Plan).

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STATE OF NEW HAMPSHIRE PAUL D. SCHMIDT No. 9625 PROFESSIONAL ENGINEER

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file name: 874-PSP 1503.dwg
scale: 1" = 60' (in feet) 0 30 60

CRSW/RRC
Franklin Secure Residue Landfill
Franklin, New Hampshire
Stage II Closure Construction Drawings
Proposed Site Plan

drawing no. 3

sheet: 3 of 8

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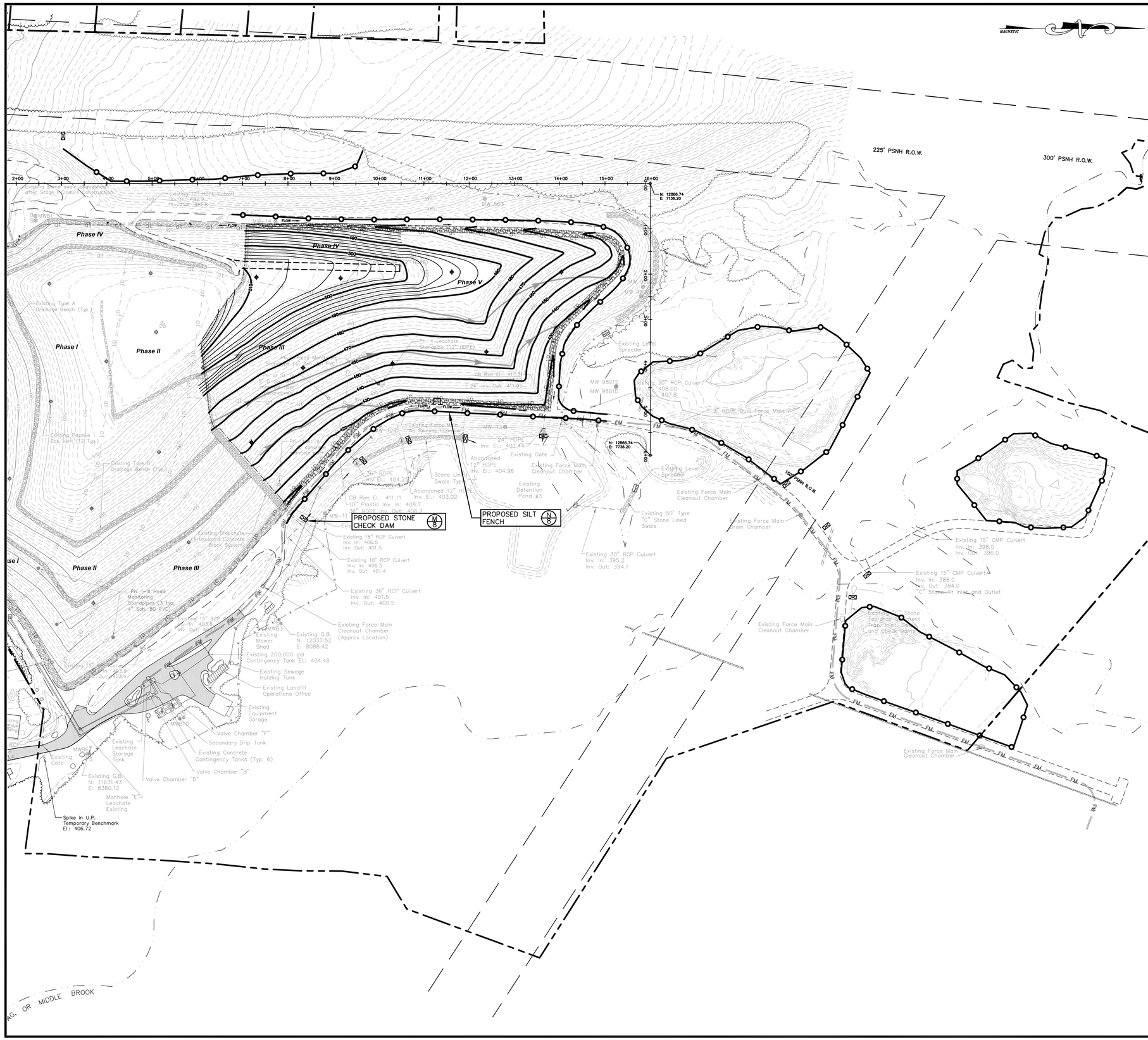

Notes:

1. Existing topography shown inside the anchor trench in the Stage II closure area is based on field survey performed by T.F. Bernier, Inc. on January 15, 2015 and represents top of ash.
2. Existing topography shown inside the anchor trench in the Stage I closure area is based on GPS field survey performed by Kingsbury Companies, LLC in October 2014 and represents top of cap/vegetated surface.
3. Existing topography shown outside the anchor trench is a compilation of field survey performed by Paul M. Darbyshire, Associates on June 27, 2007 and by T.F. Bernier, Inc. on June 21, 2010. The perimeter gravel roadway is based on field survey performed by T.F. Bernier, Inc. on October 23, 2012.
4. Proposed contours shown are closure grades and represent top of cap, approximately 3'–0" above existing grades where applicable.

Erosion Control Notes:

1. Prior to construction and thereafter erosion control measures are to be implemented as noted. The smallest practical area of land should be exposed at any one time during construction. When land is exposed during construction, the exposure should be kept to the shortest practical period of time. Land should not be left exposed during the winter months.
2. All disturbed areas and side slopes which are finish graded with no further construction to take place shall be seeded and mulched within 72 hours. All seed, lime and fertilizer programs shall conform to all applicable sections of the specifications.
3. Any disturbed areas which are to be left temporarily, or longer than two weeks and which will be regraded later during construction, shall be machine hay mulched and seeded at the rate of 2 tons per acre. The smallest practical area shall be disturbed during construction, but in no case shall exceed 5–acres at any one time before disturbed areas are stabilized.
4. Avoid use of undisturbed areas whenever possible during construction. Construction traffic shall travel the road beds of existing and future roads.
5. Silt fence shall be installed & maintained where shown and additional silt fence added as required by the Engineer prior to any on–site grading or disturbance of existing surface material. It should be maintained during and after development to remove sediment from runoff water and from land undergoing development. Where possible natural drainage ways should be utilized and left open to remove clean excess surface water. The silt fence is to be maintained and cleaned until all slopes have a healthy stand of grass.
6. Erosion control devices shall be inspected weekly and after every 0.5–in of rainfall.
7. All disturbed areas shall have a minimum of 4 inches of loam placed outside limits of the cap (excluding existing loam, sand, and common borrow stockpiles) and 12 inches within cap areas before being seeded and mulched unless otherwise shown. Bonded Fiber Matrix Stabilizer shall be placed on all slopes steeper than 4:1.
8. After all disturbed areas have been stabilized, the temporary erosion control measures are to be removed and accumulated sediment disposed of in an on site location designated by the Owner.
9. Baled hay and mulch shall be mowings of acceptable herbaceous growth, free from noxious weeds or woody stems, and shall be dry.
10. Silt fences shall be minimum of 36 inches high with the bottom of the fabric keyed into the ground (see detail). Posts shall be of wood or steel.
11. The erosion control devices shown on the Drawings and in the Specifications represent the minimum required for erosion control. The Contractor shall add to these devices any and all measures as required by the Engineer to effectively prevent migration of sediment from the work area.
12. All slopes and disturbed areas to be seeded shall comply with Slope Seed Type 44 as defined in the NHDOT Specifications, Div. 600, Section 644 "Grass Seed."
13. Lime shall conform to NHDOT Specifications, Div. 600, Sec. 642 "Limestone". Limestone shall be applied by either the dry or hydraulic method as described in NHDOT Div 600, Sec. 644. The amount of limestone applied should be based on evaluation of soil tests conducted by the contractor. The minimum rate of 2 tons per acre or 100 lbs per sq. ft. shall be applied if required.
14. Fertilizer to be used must be the equivalent of a 19–19–19 mixture and shall be reviewed by the Engineer. Fertilizer shall conform to NHDOT specifications Div. 600, Sec. 643 "Fertilizer for Grasses." Kinds and amounts of fertilizer should be based on evaluation of soil tests conducted by the Contractor. The minimum amounts applied shall be as follows:

    Nitrogen (N) 150 lbs per acre or 1.1 lbs per 1000 s.f.
    Phosphate (P O) 100 lbs per acre or 2.2 lbs per 1000 s.f.
    Potash (K O) 100 lbs per acre or 2.2 lbs per 1000 s.f.

    (Note: This is the equivalent of 500 lbs per acre of 10–20–20 fertilizer or 1,000 lbs per acre of 5–10–10)
15. All proposed swales must be stabilized prior to directing runoff to them.
16. All roadways to be stabilized within 72 hours of achieving finished grade.
17. All areas shall be stabilized within 45 days of initial disturbance. An area shall be considered stable if one of the following has occurred:
    –Base course gravels have been installed in areas to be paved;
    –A minimum of 85% vegetated growth has been established;
    –A minimum of 3–in of non–erosive material such as stone or rip rap has been installed; or
    –Erosion control blankets have been properly installed.
18. Contractor shall control fugitive dust emissions from the work area by use of wetting, covering, or shielding to the extent practical. The use of calcium chloride is not permissible at this facility.

Winter Construction Notes

1. All proposed vegetated areas which do not exhibit a minimum of 85% vegetative growth by October 15th shall be stabilized by seeding and installing fiber matrix on slopes greater than 4:1, and seeding and placing 3 to 4 tons of mulch per acre, secured with anchored netting on slopes less than 4:1, elsewhere. The installation of erosion control blankets or mulch and netting shall not occur over accumulated snow or on frozen ground and shall be completed in advance of thaw or spring melt events.
2. All grass lined swales which do not exhibit a minimum of 85% growth by October 15, or which are disturbed after October 15th, shall be stabilized temporarily with stone or erosion control blankets appropriate for the design flow conditions.
3. After November 15th, incomplete road or parking surfaces, where work has stopped for the winter season, shall be protected with a minimum of 3 inches of crushed gravel per NHDOT item 304.3

Legend:

- Existing 2' Contour
- 410 Existing 10' Contour
- Proposed 2' Closure Contour
- 410 Proposed 10' Closure Contour
- Proposed Drainage Bench
- Proposed Liner Connection
- Proposed Passive Gas Vent
- Proposed Edge of Gravel Road
- Proposed Stone
- Proposed Silt Fence
- Proposed Stone Check Dam

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STATE OF NEW HAMPSHIRE – PAUL D. SCHMIDT No. 9525 – PROFESSIONAL ENGINEER

designed by: PDS/APV
drawn by: APV
approved by: PDS
date: March 2015
project no: 874
file name: 874-PSP 1503.dwg
scale: 1" = 100' (in feet)

CRSW/RRC
Franklin Secure Residue Landfill
Franklin, New Hampshire
Stage II Closure Construction Drawings
Erosion Control Plan

drawing no. 4

sheet: 4 of 8

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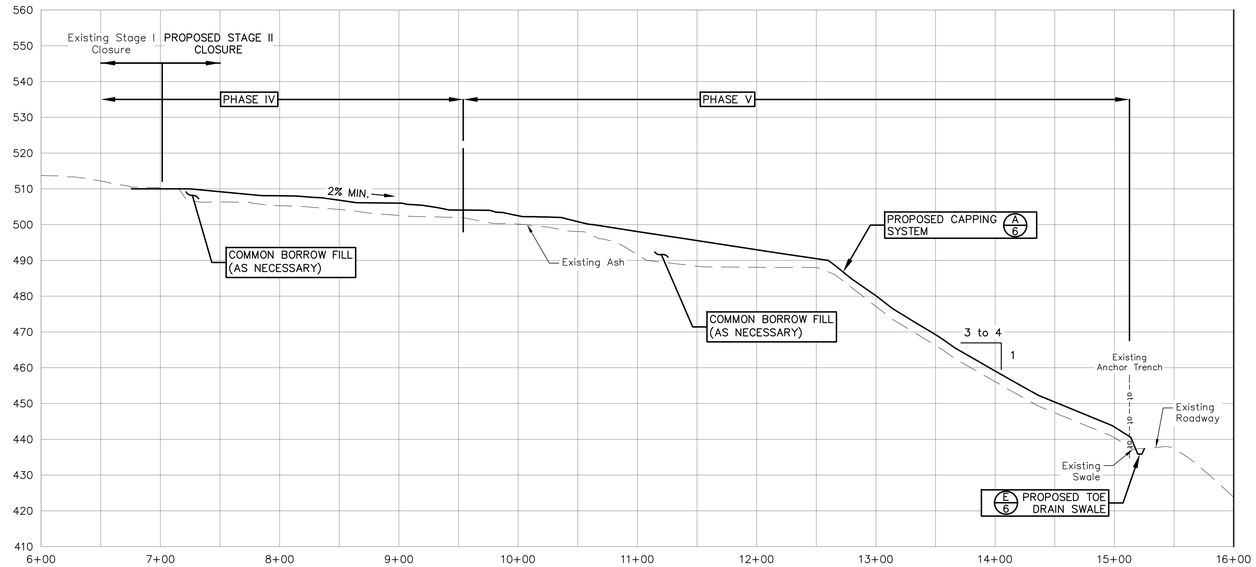
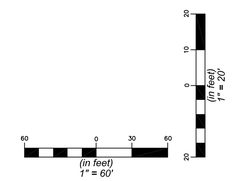
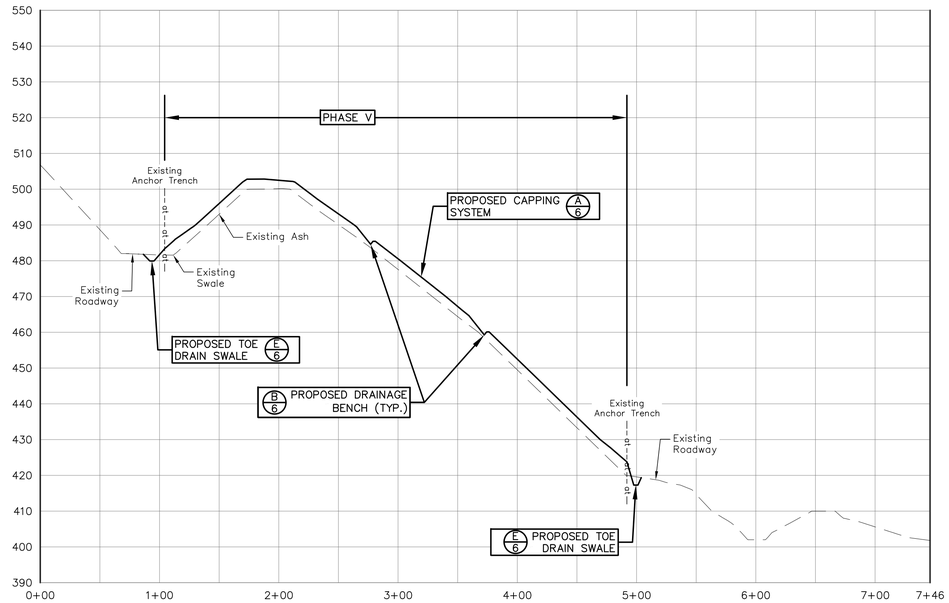


Landfill Cross Section A-A'

(See Sheet 4)

Scale: 1" = 60' (Horiz.)
1" = 20' (Vert.)

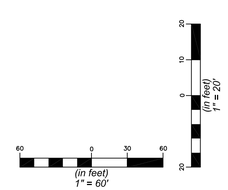




Landfill Cross Section B-B'

(See Sheets 4)

Scale: 1" = 60' (Horiz.)
1" = 20' (Vert.)



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STATE OF NEW HAMPSHIRE - PAUL D. SCHMIDT No. 9525 - LICENSED PROFESSIONAL ENGINEER

designed by: PDS/APV
drawn by: APV
approved by: PDS
date: March 2015
project no: 874
file name: 874-XSections 1503.dwg
scale: As Shown

CRSW/RRC
Franklin Secure Residue Landfill
Franklin, New Hampshire

Stage II Closure Construction Drawings
Landfill Cross Sections

drawing no. 5

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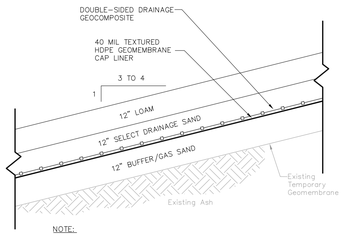


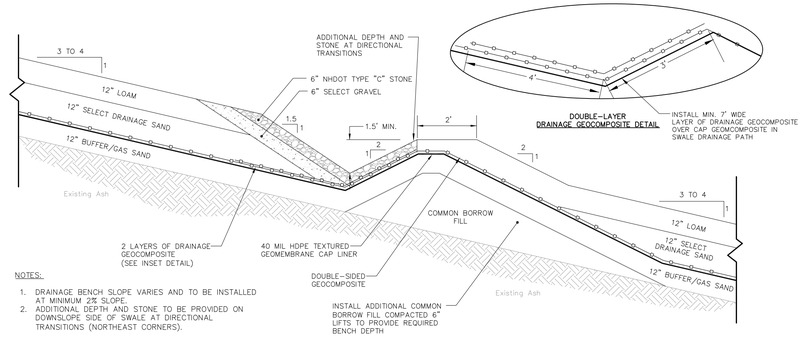
NOTE:

CONTRACTOR TO REMOVE AND DISPOSE OF TEMPORARY GEOMEMBRANE AND BALLAST SYSTEM.

Capping System Section

Not to Scale

A / 3



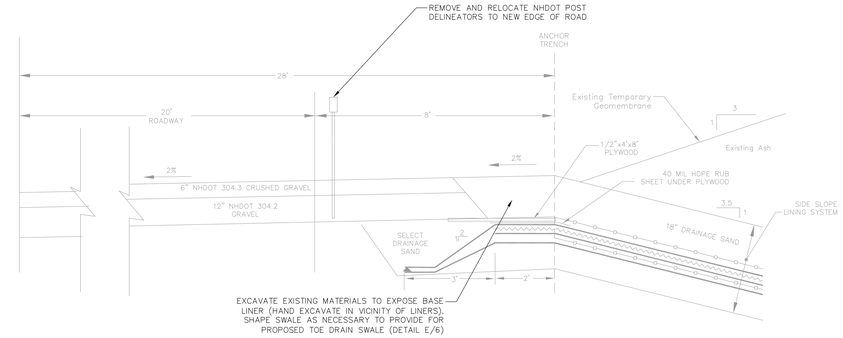
NOTES:

1. DRAINAGE BENCH SLOPE VARIES AND TO BE INSTALLED AT MINIMUM 2% SLOPE.
2. ADDITIONAL DEPTH AND STONE TO BE PROVIDED ON DOWNSLOPE SIDE OF SWALE AT DIRECTIONAL TRANSITIONS (NORTHEAST CORNERS).

Drainage Bench

Not to Scale

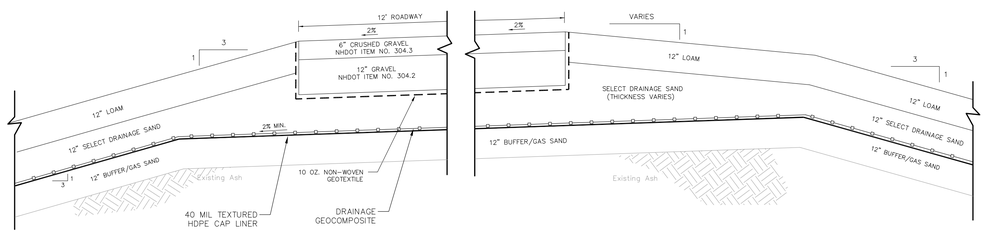
B / 3



Existing Anchor Trench and Gravel Road

Not to Scale

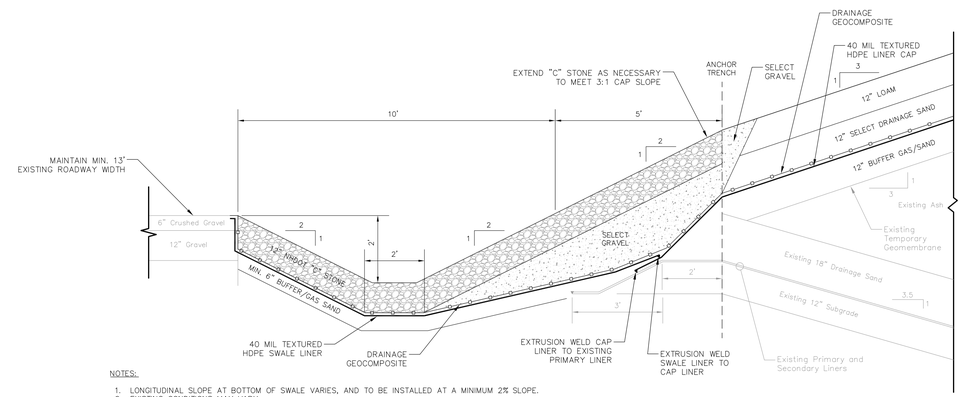
C / 2



Gravel Road

Not to Scale

D / 3



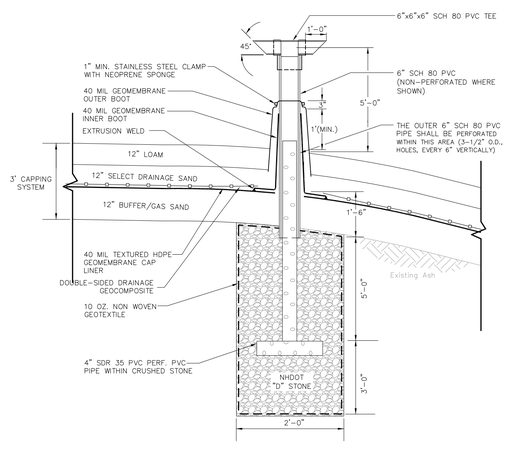
NOTES:

1. LONGITUDINAL SLOPE AT BOTTOM OF SWALE VARIES, AND TO BE INSTALLED AT A MINIMUM 2% SLOPE.
2. EXISTING CONDITIONS MAY VARY.
3. CONTRACTOR SHALL HAND EXCAVATE IN VICINITY OF EXISTING LINERS AND ANCHOR TRENCH.
4. MIN. 13' ROADWAY WIDTH TO BE MAINTAINED.
5. SELECT GRAVEL AND "C" STONE ON SLOPE TO BE INSTALLED NO STEEPER THAN 2:1.
6. PROPOSED SWALE CONTOURS ON SITE PLANS REPRESENT TOP OF STONE OUTSIDE OF ANCHOR TRENCH.

Toe Drain Swale

Not to Scale

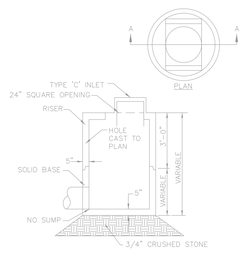
E / 3



Passive Gas Vent

Not to Scale

F / 3



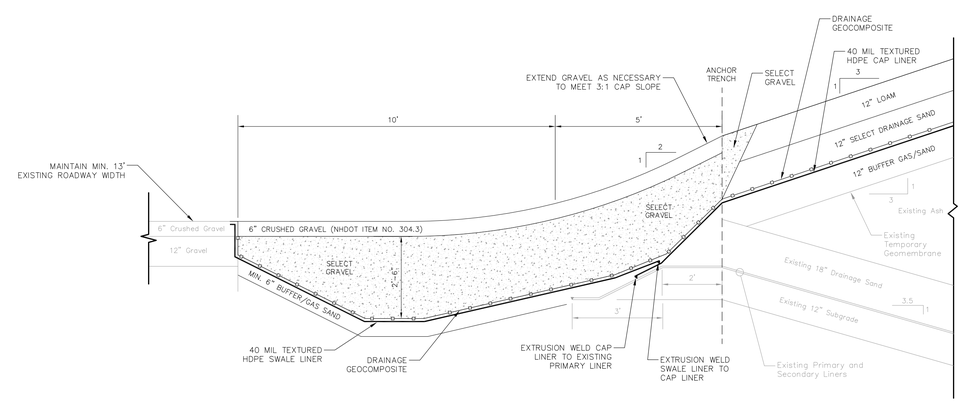
NOTES:

1. TOE DRAIN SWALE TO BE CONSTRUCTED OVER EXISTING DROP INLET. NEW SWALE LINER TO DIRECT STORMWATER INTO EXISTING INLET.

Existing Drop Inlet

Not to Scale

G / 3



NOTES:

1. GRAVEL ROAD CROSSING TO BE CONSTRUCTED AT HIGH POINT OF TOE DRAIN SWALE FOR LENGTH OF 13'.

Gravel Road Crossing

Not to Scale

H / 3

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STATE OF NEW HAMPSHIRE - PAUL D. SCHMIDT No. 9625 - PROFESSIONAL ENGINEER

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drawn by: APV
approved by: PDS
date: March 2015
project no: 874
file name: 874-Details 1503.dwg
scale: Not to Scale

CRSW/RRC
Franklin Secure Residue Landfill
Franklin, New Hampshire

Stage II Closure Construction Drawings
Closure Details

drawing no. 6

sheet: 6 of 8

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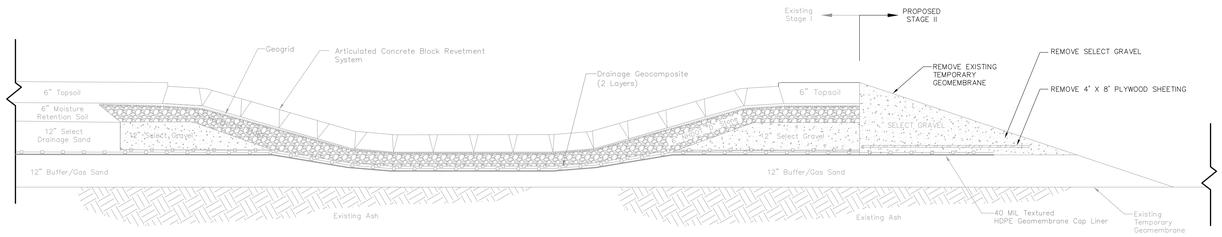
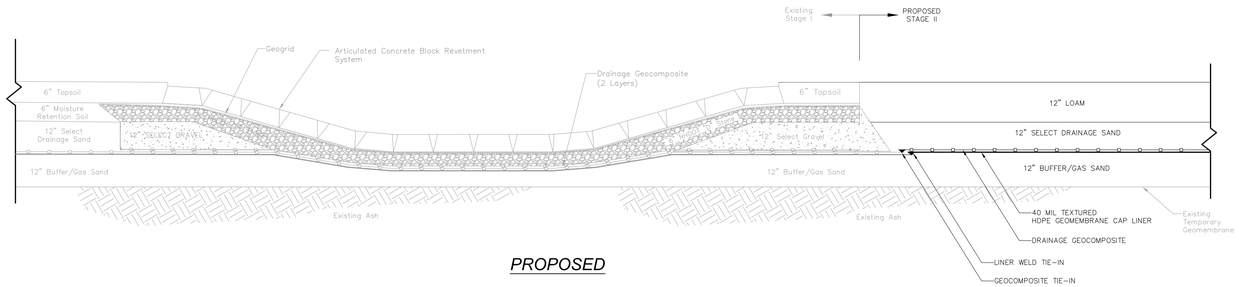


Existing

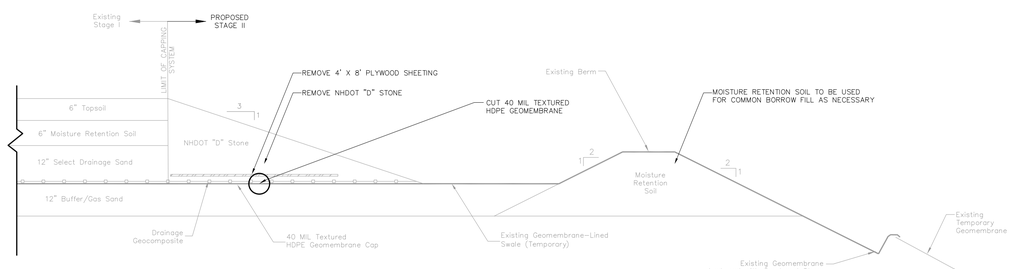


PROPOSED

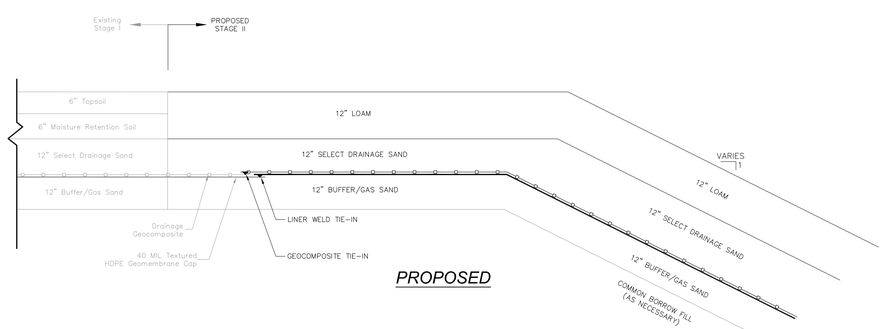
Liner Connection at Dropchute

Not to Scale

J
2,3



Existing



PROPOSED

Liner Connection at Existing Temporary Swale

Not to Scale

J
2,3

no.	revision	date	by

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STATE OF NEW HAMPSHIRE – PAUL D. SCHMIDT No. 9625 – PROFESSIONAL ENGINEER

designed by: PDS/APV
drawn by: APV
approved by: PDS
date: March 2015
project no: 874
file name: 874-Details 1503.dwg
scale: Not to Scale

CRSW/RRC
Franklin Secure Residue Landfill
Franklin, New Hampshire
Stage II Closure Construction Drawings
Closure Details

drawing no. 7

sheet: 7 of 8

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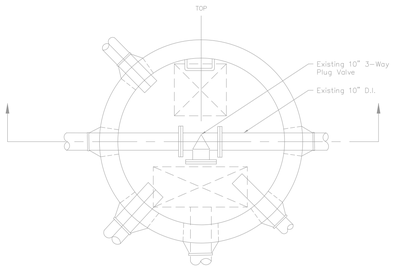
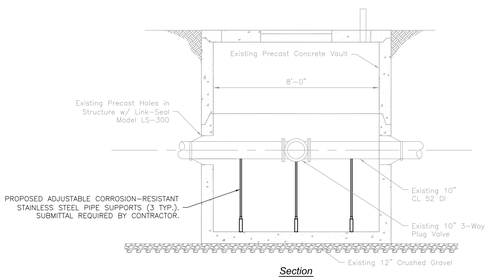


Plan

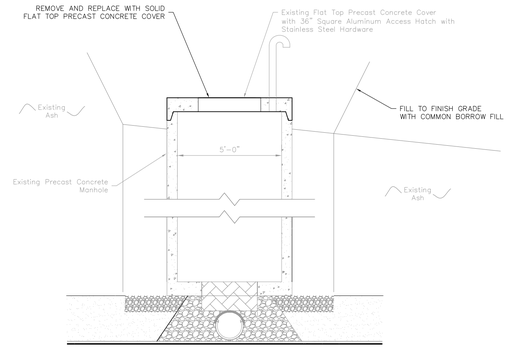


Section

Modification to Secondary Leachate Drip Tank

Not to Scale

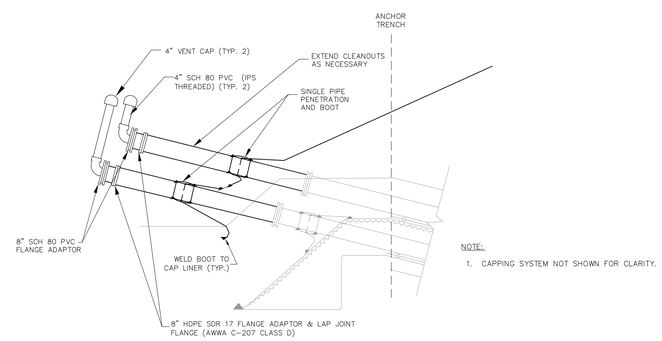
K / 3



Phase III Access Manhole Abandonment

Not to Scale

L / 2



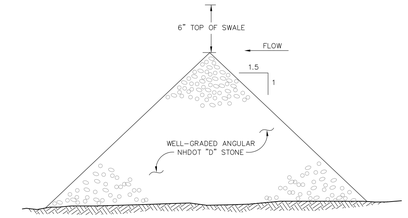
NOTE:

1. CAPPING SYSTEM NOT SHOWN FOR CLARITY.

Liner Boots at Existing Cleanouts

Not to Scale

O / 3



NOTES:

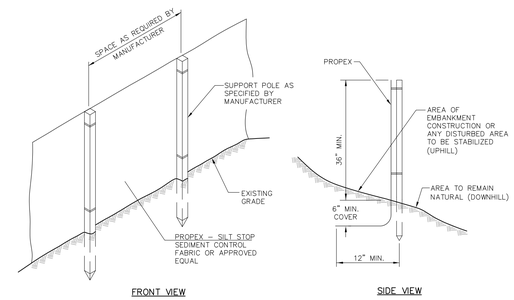
1. PLACE CRUSHED STONE TO WITHIN 6" OF TOP OF DRAINAGE WAY OR MAX. TOTAL HEIGHT OF 2 FEET FOR DEEP EXISTING SWALES.

2. FOR ACTIVE DRAINAGE OUTFLOW CHECK DAMS SHALL BE PLACED IN SERIES ALONG FLOW LINE TO RETAIN SEDIMENTS.

Stone Check Dam

Not to Scale

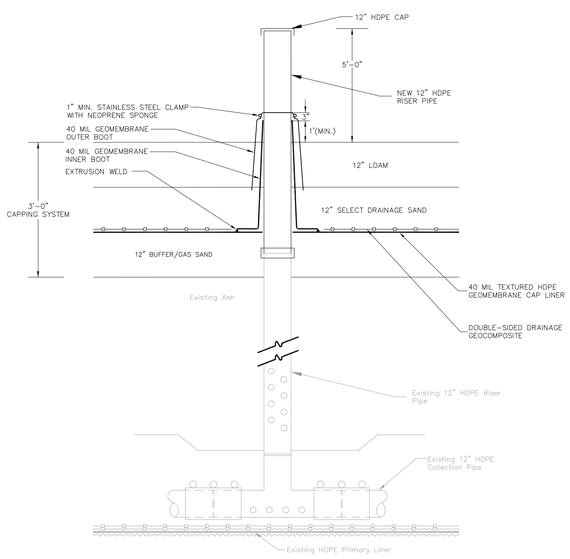
M / 4



Silt Fence

Not to Scale

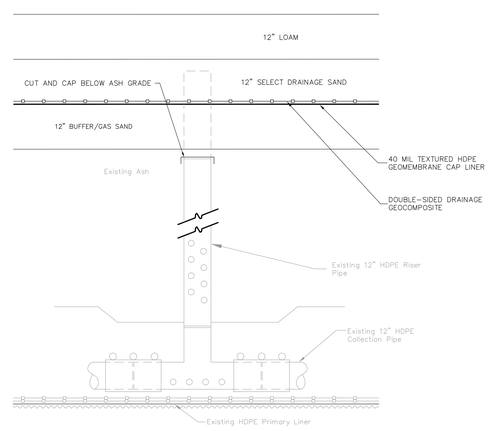
N / 4



Existing Phase V Leachate Standpipe Extension

Not to Scale

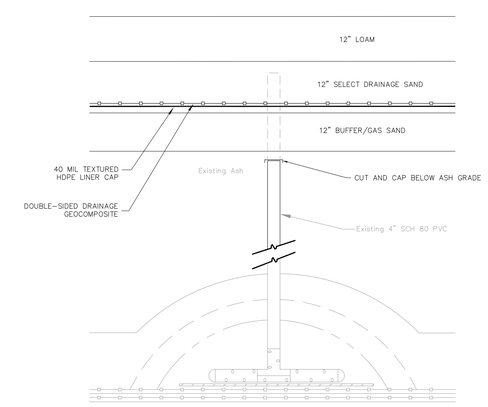
P / 2



Existing Phase IV Leachate Standpipe Abandonment

Not to Scale

Q / 2



Existing Phase V Head Monitoring Standpipe Abandonment

Not to Scale

R / 2

no.	revision	date	by

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drawn by: APV
approved by: PDS
date: March 2015
project no: 874
file name: 874-Details 1503.dwg
scale: Not to Scale

CRSW/RRC
Franklin Secure Residue Landfill
Franklin, New Hampshire

Stage II Closure Construction Drawings
Closure Details

drawing no. 8

sheet: 8 of 8

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