March 11, 2015

Mr. Ed Mussler, III, PE, Supervisor
Permitting Branch, Solid Waste Section
Division of Waste Management, NCDENR
1646 Mail Service Center
Raleigh NC 27699

Dear Mr. Mussler,

On behalf of Green Meadow, LLC and Charah, Inc., HDR provides the enclosed Addendum 2 regarding the permit application entitled:

> *Permit Application, Colon Mine Site, Structural Fill, Charah, Inc., Sanford, North Carolina*. Prepared for Charah, Inc. Prepared by HDR Inc. November 2014. DIN 22354.

The purpose of this addendum is to relate proposed enhancement to certain design and engineering aspects of the proposed project, specifically regarding the liner system groundwater separation, stormwater and leachate management systems, and the water quality monitoring plan. In addition this addendum clarifies that a minimum five foot groundwater separation buffer is maintained in the design. The following provides a brief summary of the sections and revisions in this addendum.

Facility Plan, Engineering Plan, Operations Plan

The narrative of each of these plans has been edited based on the proposed design enhancements and associated calculations. Changes generally include reference to an increase in the minimum groundwater separation, accommodation of the 25-year 24-hour design storm for leachate management, reduction of the subcell sizes to reduce leachate generation potential of the larger design storm, and an increase in the leachate tank capacity.

Calculations

Revised calculations include HELP model runs using a more stringent lift thickness and design storm in order to model the head on the liner system and determine the required leachate pipe spacing. Additional revised calculations include; leachate generation calculations, pipe capacity and sizing calculations and stormwater calculations to ensure the basins adequately manage the design storm.

Design Hydrogeological Plan

The Plan is revised to reflect the inclusion of 8 background monitoring events, statistical evaluation, and reference to analysis for Appendix III constituents.

440 S Church Street, Suite 1000, Charlotte, NC 28202-2075
704.338.6700

Technical Specifications
Revisions to the geocomposite, GCL, and geotextiles technical specifications are included that align more specifically to management of coal combustion residuals.

Drawings
Drawing revisions include the reduction of subcell sized, inclusion of additional leachate collection piping, adjustment to associated drawing details, and modification to erosion control drawings and details to accommodate the larger design storm.

Revisions in narrative documents are shown with deletions struckthrough (~~struckthrough~~) and additions underlined (underlined) along with a change line indicator in the left margin. In most cases, only revised pages of narrative documents have been provided. As requested, upon completion of the permit application process the revisions will be combined into a final permit application document for the record.

Please contact me should you have any questions. We hope you find these design enhancements acceptable and we look forward to discussing them with you.

Sincerely,
HDR Engineering, Inc. of the Carolinas

Michael D. Plummer, PE
Project Manager

Enclosures: Appendix to Lee County Application
- Facility Plan
- Engineering Plan
- Operations Plan
- Calculation D Leachate
  - HELP Model Summary Memo
  - Design of Leachate Collection System Narrative
  - Attachment 1 Summary of Model Input Data and Results
  - Attachment 2 HELP Model Output Files (Scenarios 1-7)
  - Pipe Sizing
  - Pipe Orifice Sizing
  - Pipe Perforations
  - Pipe Capacity Determination
  - Leachate Tank Sizing
- Calculation E Stormwater
  - Subcell Divider Berms
  - Sediment Basins #3, 4, 6, 8, 9

Design Hydrogeological Report
- Figure 6 (revised)

Technical Specifications
- 01060 – Special Conditions
- 02777 – Drainage Composite
- 02778 – Geotextiles
- 02800 – Geosynthetic Clay Liner (GCL)

Drawings
- Site Work
- 00C-02
- 00C-03
- 00C-05
- 00C-06
- 00C-08
- Erosion and Sedimentation Control
- 01C-11
- 01C-12

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APPENDIX TO
LEE COUNTY APPLICATION

This document is attached as an appendix to the application (Application) being submitted by Charah, Inc. for the permitting, construction and operation of a facility in Lee County (Facility) to receive coal combustion products (CCP) from one or more electric generating facilities operated by Duke Energy Progress, Inc. and Duke Energy Carolinas, LLC. For clarity, the applicant will only receive ash from Duke's North Carolina facilities. The purpose of this Appendix is to describe the goals and philosophy reflected in the Application, which is intended to comply with all applicable environmental standards, including both (1) Session Law 2014-122, which enacted the Coal Ash Management Act of 2014 as a part of its terms (collectively, CAMA); and (2) the rules regarding Hazardous and Solid Waste Management system: Disposal of Coal Combustion Residuals from Electric Utilities, promulgated by the United States Environmental Protection Agency (EPA) submitted for publication on December 19, 2014 (CCR Rules).

The Application is being submitted to the Division of Waste Management (DWM) of the North Carolina Department of Environment and Natural Resources to secure an individual permit (Permit) under G.S. § 130A-309.215 that would authorize the use of CCP as structural fill at the Facility to reclaim an open pit mine in accordance with G.S. § 130A-309.201(14). As such, the Application contains the information required under G.S. § 130A-309.215(b), which reflects the following:

- the design, construction and operational requirements in G.S. § 130A-309.216(a);
- the liner, leachate collection system, cap and groundwater monitoring system requirements in G.S. § 130A-309.216(b);
- the siting requirements under G.S. § 130A-309.216(c); and

- the financial assurance requirements of G.S. § 130A-309.217.

The Application also reflects, to the extent necessary or appropriate, efforts that will be required to comply with the remaining terms of Subpart 3 of CAMA and other applicable provisions of Chapter 130 of the North Carolina General Statutes and Title 15A of the North Carolina Administrative Code (NC Requirements).

While the Facility as proposed in the Application would meet the four (4) criteria applicable to unencapsulated beneficial use of the CCP, and the proposed use of the CCP as mine filling as a practical matter constitutes a beneficial use of the material, the Applicant will take the conservative approach of seeking compliance with the requirements of the applicable CCR Rules. While the Application requests a state permit from DWM under the NC Requirements, the Applicant is also voluntarily designing, siting, constructing, and operating the Facility in accordance with the CCR Rules including:

- location restrictions, including placement above the uppermost aquifer (40 CFR § 257.60), wetlands (40 CFR § 257.61), fault areas (40 CFR § 257.62), seismic impact zones (40 CFR § 257.63), and unstable areas (40 CFR § 257.64);
- design criteria (40 CFR § 257.70);
- operating criteria, including air criteria (40 CFR § 257.80), run-on and run-off controls (40 CFR § 257.81), inspection requirements (40 CFR § 257.84), groundwater monitoring and potential groundwater corrective actions (40 CFR §§ 257.90-257.98 and Appendices III and IV), and closure and post-closure care (40 CFR §§ 257.101-275.104); and
- recordkeeping (40 CFR § 257.105), notification (40 CFR § 257.106), and internet posting requirements (40 CFR § 257.107).

It is presumed that any Permit that DWM issues for the Facility based on the Application will be consistent with this approach and design philosophy.

Facility Plan

Colon Mine Site Structural Fill

Charah, Inc.

Sanford, NC

November 2014
Revised January 2015
Revised March 2015

Table 1 Structural Fill Horizontal Separation Requirements Summary

Feature	Restriction: A structural fill cannot be within
Property boundary	50 feet
Private dwelling or well	300 feet
Perennial stream or other surface water body[a]	50 feet
Floodplain	A 100-year floodplain[b]
Wetland	50 feet[c]

[a] The structural fill cannot be within 50 feet of the top of the bank of a perennial stream or other surface water body.
[b] In accordance with NCGS §130A-309.216 (c) (5), the structural fill cannot be placed "within a 100-year floodplain except as authorized under [NC]G.S. 143-215.54A(b). A site located in a floodplain shall not restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain or result in washout of solid waste so as to pose a hazard to human life, wildlife, or land or water resources."
[c] In accordance with NCGS §130A-309.216 (c) (6), the structural fill cannot be placed "within 50 horizontal feet of a wetland, unless, after consideration of the chemical and physical impact on the wetland, the United States Army Corps of Engineers issues a permit or waiver for the fill."

The property boundary, private dwellings, groundwater wells, and floodplain buffers have been maintained as shown on Sheet G-02, Facility Plan and Buffers . Streams and wetlands were delineated and located onsite by Clearwater Environmental on August 8, 2014. The structural fill design impacts approximately 2,040 linear feet of streams and 0.62 acres of wetlands. Impacts to these will be permitted by the US Army Corp of Engineers and the NCDENR Division of Water Quality before construction occurs in these areas.

2.1.3.2 VERTICAL SEPARATION REQUIREMENT

NCGS §130A-309.216 (c) also mandates a vertical separation requirement for CCPs used as structural fill. The structural fill can not be placed within four feet of the seasonal high groundwater table per NCGS §130A-309.216 (c) (4). For this application tThe bottom of ~~ash~~ the GCL liner has been designed to be a minimum ~~four~~ five feet above the estimated seasonal high groundwater table. The proposed design satisfies the vertical separation requirements as shown on drawings provided with the Design Hydrogeological Report included in this Permit Application.

2.1.4 Types of CCP

The types of CCP specified for placement in the structural fill area are anticipated to be consistent with the CCP definition found in NCGS §130A-309.201 (4). This includes fly ash, bottom ash, boiler slag, or flue gas desulfurization materials.

2.1.5 Estimated Placement Rates

The anticipated filling rates of 6,000 to 8,000 tons per day which equates to 130,000 to 140,000 tons per month or 1,560,000 to 1,680,000 tons per year. This material will be brought to the site by truck, rail, or a combination thereof. Placement methods are detailed in the Operations Plan included in this Permit Application. Based on these filling rates, an assumed CCP density of 1.25 tons per cy, and an overall CCP capacity of approximately 7.25 million cy, this structural fill should take approximately 5.4 TO 5.8 years to complete.

2.1.6 Service Area

CCPs may come from power generation facilities located in North Carolina and South Carolina. Initial operations will receive ash from Duke Energy's Riverbend and Sutton facilities.

2.1.7 Procedures for CCP Acceptance

The structural fill will only accept CCPs that it is permitted to receive. The appropriate toxicity characteristic leaching procedure (TCLP) analyses are included in the Related Documents section of this application. The process will be repeated if the source changes. Any load that contains materials or CCPs that the structural fill is not allowed to accept will not be placed in the structural fill.

2.1.8 Equipment Requirements

Equipment requirements may vary in accordance with the method or scope of structural fill operations at any given time. Additional or different types of equipment may be provided as necessary to enhance operational efficiency; however, in order to ensure adequate operation of the proposed facility, arrangements shall be made to ensure that equipment is available for the following activities.

- Excavation of onsite soil
- Preparing the cells for CCP reception
- Spreading and compacting the CCP
- Moisture conditioning the CCP or structural fill
- Excavating and transporting cover soil
- Spreading and compacting cover soil
- Site maintenance, dust control, and clean-up work

The equipment onsite is currently used to manage mining operations. When the proposed structural fill is ready to accept CCPs, the equipment will use the procedures and techniques for spreading, compacting, and covering CCPs outlined in the Operations Plan included in this Permit Application. In the event the amount of CCP placement increases significantly, the need for additional equipment will be evaluated. Additional equipment may be rented to accommodate short term needs or purchased to accommodate increased CCP placement rates.

2.2 Containment and Environmental Control Systems

The base liner and final cap system will be constructed in accordance with NCGS §130A-309.216.

2.2.1 Base Liner System

The purpose of the base liner system is to contain CCPs within the structural fill and prevent groundwater contamination by the CCPs. The base liner area for the structural fill is approximately 118 acres and is shown on Sheet No. 00C-03, Top of Liner. The post-settlement bottom elevation of the ~~ash~~ GCL liner will meet the minimum requirement of ~~four~~five feet above the seasonal high groundwater table. North Carolina law allows two different types of baseliner systems. The following describes the components of the regulatory base liner system options from top down and as shown on the drawings.

2.2.1.1 COMPOSITE BASE LINER SYSTEM OPTION 1

- 60 mil HDPE geosynthetic liner
- 24 inches of compacted soil liner with a permeability of 1 x 10^{-7} cm/sec

2.2.1.2 COMPOSITE BASE LINER SYSTEM OPTION 2

- 60 mil HDPE geosynthetic liner
- geosynthetic clay liner
- 18 inches of compacted soil liner with a permeability of 1 x 10^{-5} cm/sec

Option 2 was used as the basis of design for this permit application.

2.2.2 Final Cap System

The purpose of the final cap system is to contain CCP within the structural fill, prevent exposure of CCP, prevent infiltration into the structural fill, minimize erosion, and prevent stormwater from contacting CCP. The total area for the final cap system for the structural fill is approximately 118 acres (see Sheet 00C-04, Reclamation Plan). There are two proposed final cap system designs: a soil and geomembrane cap system option and a soil, geocomposite drainage layer and geomembrane cap system option. Each cap system has a top design and a side slope design. The components of the two proposed final cap systems are shown in Tables 2 and 3 below. The soil permeabilities are shown on the drawings.

Table 2 Final Cap System Design: Soil and Geomembrane Option

2% Top Design	4:1 Sideslope Design
• 6 inches topsoil	• 6 inches topsoil
• 12 inches low permeable soil layer	• 12 inches low permeable soil layer
• 24 inches unclassified soil layer	• 12 inches unclassified soil layer
• 30 inches drainage soil layer	• 18 inches drainage soil layer
• 40 mil polyethylene geomembrane	• 40 mil polyethylene geomembrane

Table 3 Final Cap System: Soil, Geocomposite Drainage Layer and Geomembrane Option

2% Top Design	4:1 Sideslope Design
• 6 inches topsoil	• 6 inches topsoil
• 66 inches soil layer	• 42 inches soil layer
• 250 mil geocomposite drainage layer	• 250 mil geocomposite drainage layer
• 40 mil polyethylene geomembrane	• 40 mil polyethylene geomembrane

2.2.3 Drainage, Erosion and Sediment Control

The erosion and sediment control structures are designed and maintained to manage the run-off generated by the 25-year storm event, convey it to the sediment basins, and conform to the requirements of the Sedimentation Pollution Control Law. Sediment basins were designed to ~~pass~~ contain the ~~10~~25-year 24-hour design storm without employing use of the emergency spillways. Additional routing was performed to confirm that the emergency spillways can successfully pass the ~~25-year and~~ 100-year storm events.

As part of the final cap system, diversion berms, side slope swales, and slope drains will be constructed to intercept run-off and prevent erosion. The side slope swales and diversion berms will be longitudinally sloped will carry run-off to slope drains that discharge into a perimeter channel. Channels will direct stormwater flow to sediment basins within the property.

Based on the topography shown on Sheet 00C-01, Existing Conditions, approximately 1.83 million cy of cut and 250,000 cy of fill are anticipated to construct the structural fill basegrades, perimeter berms, and perimeter roads. This represents an excess of approximately 1.58 million cy of soil that can be used for liner system or final cover construction if the soil meets the applicable specifications. Soils unsuitable for these uses can be stockpiled for operations or sold under the existing mining permit. Since Table 4 indicates that approximately 1.4 million cy will be required for the base system and closure, a net soil surplus of approximately 180,000 cy is anticipated, assuming all the soils onsite are suitable for use in the construction. Should there be a deficit in soils, the soil necessary to compensate for this deficit will be obtained from onsite borrow areas unidentified at this time or offsite sources. Two areas on Sheet 00C-02, Base Grade Plan, identified locations for potential future stockpiling of onsite soils. Erosion and sedimentation controls will be designed and permitted and any other necessary permits will be obtained prior to construction.

2.4 Leachate Management

The leachate management system includes features for collection, storage and disposal of leachate.

2.4.1 Leachate Collection System

NCGS §130A-309.216 (b) (2) mandates that, "[a] leachate collection system, which is constructed directly above the base liner and shall be designed to effectively collect and remove leachate from the project." The base liner system will be constructed to maintain positive drainage post settlement to encourage leachate to drain to the sump.

The general leachate management system includes the collection, storage, treatment, and disposal of the leachate generated. The collection of leachate will be facilitated within the structural fill by the geocomposite drainage layer located directly on top of the base liner system and the use of perforated HDPE pipe laterals and header designed to hydraulically convey leachate to sump areas, which will contain submersible pumps. From there, leachate will be pumped through a solid wall HDPE forcemain to a leachate storage tank that will be located at the site. Clean-out riser pipes will be provided as shown on the drawings to allow for cleaning as necessary.

Leachate storage is provided in a ~~250,000~~1,000,000 gallon storage tank with ~~a~~ secondary containment. Leachate storage may be managed in the structural fill as needed for periods not exceeding 72 hours.

The Operator will dispose of the leachate properly at a wastewater treatment plant and will obtain a discharge permit and/or a pump and haul permit for the leachate.

2.4.2 Leachate Generation Rates

Leachate is generated from a couple of sources: the liquids present in the ash at the time of placement and stormwater that infiltrates the CCP. Disposal of large quantities of liquid is currently prohibited in structural fills and unless it has rained during collection, most CCP is relatively dry; therefore, the majority of all leachate is derived from precipitation. Operations can greatly influence the diversion of precipitation from the placed CCP and hence impact the amount entering the system to be collected as leachate at some future date.

Construction of structural fill will result in a total lined area of approximately 118 acres. For the largest ~~a sub~~cell ~~15.3~~31.9 acres in size and using an estimated leachate generation rate of ~~43,761~~78,144 cubic feet per acre per year as determined through HELP Model runs (see Calculations section of this Permit Application), a typical daily generation rate of ~~13,721~~51,085 gallons per day is anticipated. A ~~250~~1,000,000 gallon leachate storage tank represents approximately ~~18~~ 23.5 days of storage capacity for the entire structural fill in operation. ~~Storage capacity is also available within the subcell.~~

Based on information provided by Charah, the leachate/contact water discharged from the Asheville airport site to the Buncombe County Metropolitan Sewer District (MSD) has averaged 1,418,000 gallons per month for Area 3 (30.8 acres) or 46,039 gallons per acre per month. This average includes varying surface conditions across the Area 3 containment area from open areas where all rainwater becomes contact water to areas that are above grade and covered with soil thereby diverting clean rain water to the sediment basins.

The HELP Model results included in the Calculations section of the Permit Application estimates an average annual flow rate of ~~43,760~~59,786 cubic feet (~~327,325~~447,200 gallons) per acre assuming a 20 foot thick layer of ash across the acre. However, the worst case condition for leachate handling would be contact water from a storm event immediately upon activating an area. A ~~2~~25-year 24-hour storm event was selected as the design storm ~~since the largest subcell (15.3 acres) will take approximately five months to floor in the area with 20 feet of ash at the lower placement rate of 1,560,000 tons per year. The 2-year storm event~~which for the area is ~~3.6~~6.28 inches. This equates to approximately ~~1,495,555~~1,023,000 gallons ~~within the largest~~over a 6 acre subcell area~~ or 97,749 gallons per~~. The leachate pipes as shown in the Pipe Sizing calculation of the Leachate Calculation section have been designed to reduce the head on the liner system to below 30 cm ~~convey~~ for this storm event within ~~5.5 days~~ 72 hours. The subcell divider berms have been designed to store the entire storm event as shown in the Stormwater Calculation section. The leachate/contact water from each subcell will be piped to the sump in solid pipes, out to the leachate tank, and then pumped to the treatment plant.

2.4.3 Leachate Management Systems

2.4.3.1 LEACHATE PIPELINE OPERATING CAPACITY

The 8-inch diameter design for the leachate collection laterals and headers is sufficient to drain leachate and allow for pipe cleaning and video recording. The maximum drainage length is 950 feet~~, as modeled on a two percent slope~~. The required maximum drainage length will vary as the slope of the base liner varies. Leachate pipe spacing should be verified prior to leachate pipe placement. HDPE pipe will be used due to its chemical resistance to corrosion from leachate. The thickness and other physical properties of the pipe were selected to provide adequate structural strength to support the maximum static and dynamic loads and stresses imposed by the overlying materials and any equipment used in construction and operation of the structural fill.

The material surrounding the leachate collection pipes will consist of a coarse aggregate installed to provide a direct conduit between the pipe and CCP. The aggregate will be chemically compatible with the leachate generated and will be placed to provide adequate support to the pipes.

Calculations for various materials and conditions are included in the Calculations portion this Permit Application.

2.4.3.2 CAPACITY OF STORAGE AND TREATMENT FACILITIES

The primary leachate disposal will via private sewer line to a wastewater treatment plant. A discharge permit is currently being sought and will be provided prior to operation of the system

2.4.3.3 FINAL DISPOSAL PLANS AND DISCHARGE LIMITS

Leachate will be hauled by tanker trucks for disposal at a wastewater treatment plant. A discharge permit has not yet been obtained from a wastewater treatment plant. A copy of the discharge permit for the leachate will be included in the Operations Plan. The industrial discharge permit will be provided prior to the placement of ash within the structural fill. A pump and haul permit may also be obtained.

2.5 Landowner Statement

NCGS §130A-309.215 (b) (1) e. requires that this permit application include a signed and dated statement by the owner of the land on which the structural fill is to be placed, acknowledging and consenting to the use of CCP as structural fill on the property and agreeing to record the fill in accordance with the requirements of G.S. 130A-[309].219. The Landowner Statement can be found in Appendix A of this Facility Plan.

2.6 Generator Contact Information

In accordance with NCGS §130A-309.215 (b) (1) f., the name, address, and contact information for the generator of the CCP is provided in Appendix B. Initial generators listed are Duke Energy's Riverbend and Sutton facilities. This information will be updated if new generators or new sources of CCP will be used as structural fill at the site.

2.7 Coal Combustion Product Generation Location

In accordance with NCGS §130A-309.215 (b) (1) g. the physical location of the project at which the CCP were generated is provided in Appendix B. This information will be updated if new generators or new sources of CCP will be used as structural fill at the site.

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Engineering Plan

Colon Mine Site Structural Fill

Charah, Inc.

Sanford, NC

November 2014
Revised December 2014
Revised March 2015

Boring logs from the Design Hydrogeological Report were used to determine the soil types, depths and SPT values for each well and piezometer location within the structural fill footprint. Proposed base grades, final grades, and water table elevations were determined at each well and piezometer location. The existing vertical stress was calculated in each soil layer based on laboratory test data obtained for the foundation soils and published information for similar materials. The structural fill loading due to CCP and final cover was also determined using laboratory test data provided for compacted CCP obtained from the Riverbend Steam Station in Mount Holly, North Carolina. The total settlement was calculated using standard equations for elastic settlement and primary and secondary consolidation settlement as appropriate for the types of soils encountered at each location. The controlling surface (bedrock or water) was determined and the post settlement separation of the base grade from the controlling surface was verified. Also determined was the post settlement slope of the base grade. The pre- and post-settlement average slopes at several locations were analyzed for local settlement based on the anticipated loading and the boring log information. The calculations indicated positive drainage toward the leachate sumps would be maintained after settlement.

3 Base Liner System Design

In accordance with NCGS §130A-309.216 a base liner consisting of one of two liner systems are allowed for CCP structural fills.

3.1 Base Liner System 1

- A composite liner that consists of two components: a geomembrane liner installed above and in direct and uniform contact with a compacted clay liner with a minimum thickness of 24 inches (0.61 m) and a permeability of no more than 1.0 x 10^{-7} centimeters per second.

3.2 Base Liner System 2

- A composite liner that consists of three components: a geomembrane liner installed above and in uniform contact with a geosynthetic clay liner overlying a compacted clay liner with a minimum thickness of 18 inches (0.46 m) and a permeability of no more than 1.0 x 10^{-5} centimeters per second.

For the purposes of this Permit Application, Base Liner System 2 has been shown in the calculations; however, either liner system is allowed.

4 Leachate Management System Details

The general leachate management system includes the collection, storage, treatment, and disposal of the leachate generated. The collection of leachate will be facilitated within the structural fill by use of a series of interconnected perforated and solid HDPE pipe laterals and headers designed to hydraulically convey leachate to a sump area along with a geocomposite that covers the geomembrane barrier layer. The leachate collection pipes are surrounded by stone and geotextile. The solid and perforated pipes contain valves to allow the pipes to ~~convey either~~ segregate stormwater ~~or~~ and leachate depending on whether the subcell has received

CCP. In addition to the valves each subcell divider berm will have a rain flap welded to the bottom geomembrane. When the Operator is ready to activate a subcell for CCP placement the valves will be opened and the rain flap removed to allow leachate to flow downstream to a sump area that will contain two submersible pumps. There are three sump locations with pumps installed in HDPE riser pipes that will pump the leachate into a forcemain which discharges to a leachate storage tank to be located south of Cell 1. The leachate will then be pumped from the tank to the receiving treatment plant or into trucks for hauling to and disposal at the local treatment plant. Depending on availability, the leachate may be discharged directly to the sanitary sewer system.

Clean-out riser pipes will be provided for each lateral and header as shown on the drawings to allow for periodic cleaning and maintenance. The leachate collection system has been designed to manage a ~~2~~25-year, 24 hour storm event during an open subcell condition and has been modeled through the HELP model for prediction of long term leachate generated at varying stages of fill.

5 Stormwater Segregation Features

In order to minimize leachate generation during initial filling, stormwater will be segregated by using subcell divider berms, pipes, and a rain flap over the divider berms. The subcell divider berms have been sized to manage a ~~2~~25-year 24-hour storm. The stormwater that is collected in the subcells will be pumped out to the perimeter channel. Stormwater that is in contact with the CCP structural fill will be collected and handled as leachate. As filling progresses, the areas where CCP has reached final grade will be covered with intermediate cover soil to minimize leachate generation.

Site development is intended to comply with the North Carolina Sedimentation Pollution Control Act of 1973, as amended.

The plans provide for a pre- and post-development erosion control plan that splits the onsite drainage areas into nine separate basins during the initial grading operations. As the fill project comes out of the ground and begins to take shape with permanent drainage, four of these initial basins will be removed and drainage redirected to one of the five remaining basins to serve as the final erosion control primary measures. The drainage areas for these basins range in size from 3 to 86 acres. The ponds are designed to discharge the ~~10~~25-year storm (Type II, 24 hour) through the principal spillways (Risers and Barrels) and are capable of passing the 100-year storm in a controlled manner through an emergency spillway~~ with one foot of freeboard~~.

Initial development will include the installation of all perimeter erosion control measures (construction entrance, silt fence, tree protection), and temporary diversion swales as necessary to direct sediment laden run-off to the primary treatment basins. Along all sensitive boundaries (streams and wetlands not to be disturbed), double silt fence will be installed. The ponds that are to exist in both pre and post conditions are to be installed for the most conservative condition and outlet protection is designed for the maximum flow that a particular basin and its drainage area may produce.

materials. A detailed description of the parameter selection process is provided in the slope stability Calculations section of this permit application.

A search routine within PCSTABL5M was used to determine the critical sliding block surface based on the modified Janbu method and critical circular arc surface using the modified Bishop method. Analyses were performed under both total stress and effective stress conditions. The estimated high groundwater potentiometric surface was also used in the analyses. Two types of circular arc analyses were performed by adjusting the limits of the search routine. These included global circular arc failure surfaces extending through the foundation soils and into or beyond the perimeter berm as well as failure surfaces originating and terminating within the CCP fill. A summary of the minimum factors of safety associated with each analysis under both static and seismic conditions is provided in the slope stability calculations included in this permit application. The critical analysis was determined to be the sliding block analysis along the bottom liner system under effective stress conditions with static and seismic factors of safety of 4.33 and 3.03, respectively. All factors of safety are satisfactory and meet EPA guidelines.

Final cover veneer stability analyses were performed for both final cover options to determine the minimum interface friction angle required for the final cover system. The analysis for Option 1, which included an 18-inch thick soil drainage layer placed directly over the final cover geomembrane, assumed that this layer would be fully saturated due to lateral seepage. The analysis for Option 2, which included a geocomposite placed directly over the final cover geomembrane in lieu of the soil drainage layer used for Option 1, assumed the geocomposite would be designed to contain the lateral seepage and therefore the overlying soil would not become saturated. The analyses that were performed for the proposed final slope of 25% (4H:1V) under both static and seismic conditions resulted in a minimum required interface friction angle of 25.0 degrees for Option 1 and 20.5 degrees for Option 2. These minimum required interface friction angles should be readily achieved using geosynthetic products readily available in the market. Project specific interface testing, however, should be performed to confirm that the minimum required interface friction angle can be achieved using the actual materials that will be used during construction.

8 Leachate/Stormwater Storage and Treatment Facilities

Determination of leachate storage capacity was based on average annual leachate collection rate from the HELP model. The maximum average annual leachate collection calculated was ~~43,761~~78,144 cf/acre. Based on the largest ~~sub~~cell at ~~15.3~~31.9 acres the leachate generation volume is ~~669,543~~2,492,794 cf/year (~~13,721~~51,085 gal/day). Considering the ~~250,000~~1,000,000 gal capacity available onsite, the storage capability is approximately ~~18~~ 23.5 days. Note that the above estimate is based on average leachate generation rate and the storage capacity needed could be significantly more if peak day leachate generation rates are used. Therefore, the owner may need increased leachate pumping and/or trucking capabilities during peak demands.

Determination of storage capacity is based on the ~~2~~25-year, 24-hr rain event which is ~~3.6~~6.28 inches. Each subcell has been analyzed for its storage capacity based on grading and the height of the subcell divider berms. ~~Most~~ All subcells are capable of holding the design storm event. ~~The largest subcell 2 (15.3 acres) will generate 1,495,554 gals of stormwater during the design event. Its holding capacity is 2,533,311 gals based on the containment berm height. Subcells 1B, 4B, and 5B can manage the stormwater generated in upper subcells meaning the owner can manage stormwater for both subcells within the lower subcell. Subcells 3B and 4D cannot manage the stormwater from the upstream subcell and therefore should be maintained independently.~~

~~Storage capacity onsite is governed by average leachate generation rates based on HELP model. Since the peak storage capacity is greater than leachate subcell capacities, the methods of filling and leachate pumping from a subcell may need to be altered to facilitate filling.~~

9 Site Access

Security for the site consists of fencing, gates, berms, and wooded buffers. Unauthorized vehicle access to the site is prevented around the property by woodlands, fencing, gates, and stormwater conveyance features.

The access road to the site is of all-weather construction and will be maintained in good condition. Potholes, ruts, and debris on the road(s) will receive immediate attention in order to avoid damage to vehicles.

10 Construction Practices

A test pad will be constructed of the soils proposed for use as the soil liner to determine the construction methods necessary to achieve the design criteria.

Placement will begin by "ramping in" with material from a corner of the cell. Low ground pressure dozers will be used to spread the material. A minimum thickness of 24 inches will be maintained between the liner and the tracks of the spreading equipment and 24 inches above the HDPE pipes. The CCP material will be end-dumped onto previously placed material and then spread out by the dozer. A spotter assisting the operator will observe placement of protective cover material to ensure that spreading is not causing excessive wrinkling or other damage to the synthetic liner, pipes, or geocomposite drainage media. The spotter will measure the forward edge of material placement to ensure that the proper thickness is being applied. The contractor will confirm adequate thickness by surveying before and after placement. The operator shall observe the top of the completed protective cover layer for a smooth, uniform surface free of depressions or high-spots. Refer to the Technical Specifications and Construction Quality Assurance (CQA) Plan included in this Permit Application

11 Design Hydrogeologic Report

The subsurface geology and hydrogeology beneath the proposed structural fill is detailed in the Design Hydrogeologic Report included in this Permit Application.

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Operations Plan

Colon Mine Site Structural Fill

Charah, Inc.

Sanford, NC

November 2014
Revised January 2015
Revised March 2015

- Daily Operation Record
- Employee Training Records and Materials
- or anything else as indicated in the Operations Plan

The above records are to be kept in the operating record for the active life of the Colon Mine Site and the 30-year post-closure period. Information contained in the operating record must be furnished upon request to the North Carolina Department of Environment and Natural Resources (NCDENR). Additional records kept onsite should include the following.

- Facility permit application
- Facility permits
- Record of the amount of structural fill placed on a monthly basis
- Regulatory agency inspection reports
- Construction documents
- Employee training records
- As-built drawings and specifications
- Health & Safety Plan
- Emergency Action Plan

1.11 Permit Drawings

Permit drawings are included in the structural fill permit application.

2 Operations Management

The primary objective of operations management at the Colon Mine Site is to place structural fill in the form of CCPs in compliance with permit conditions while operating in a safe manner. Prior to placement of CCP in a new cell, new subcell, or portion of a new subcell, the Owner will submit to NCDENR the Construction Quality Assurance documentation for the constructed base liner for review. Should any discrepancies be indicated, NCDENR will contact the Owner for follow up. Placement of CCP in new cell, new subcell, or portion of a new subcell prior to approval by NCDENR will be at the owner's risk.

The structural fill site has been designed to provide separation of contact water from non-contact water. Contact water is defined as water that contacts CCP material within the geomembrane lined limits of structural fill. Contact water will be managed as leachate while non-contact water will be managed as stormwater. Contact water and non-contact water separation are further described in subsequent sections of this plan.

Filling operations will generally proceed from ~~high to~~ low to high. The working face will be limited to as small an area as practical, at the owner's discretion. Contact water from the active face will be directed to the leachate collection system.

Intermediate cover will be placed as CCP fill reaches final grades to prevent contact water from entering the stormwater control features.

2.1 Structural Fill Placement and Sequencing

2.1.1 Structural Fill Capacity

The total anticipated airspace capacity for the Colon Mine Site is approximately 7.25million cubic yards and is based on a proposed 118-acre fill area.

2.1.2 Structural Fill Acceptance Requirements

In accordance with NCGS §130A-309.216 (a) (2) CCPs shall be collected and transported in a manner that will prevent nuisances and hazards to public health and safety. CCPs shall be moisture conditioned, as necessary, and transported in covered trucks or rail cars to prevent dusting. As such, the Colon Mine Site can accept CCPs defined as fly ash, bottom ash, boiler slag, or flue gas desulfurization materials in NCGS §130A-309.216 (4).

In accordance with NCGS §130A-309.215 (b) (1) d, a Toxicity Characteristic Leaching Procedure (TCLP) analysis has been performed on a representative sample from Duke Energy's Sutton Plant and Riverbend Steam Station CCP sources to be used in the structural fill project. Each was analyzed for, at a minimum, the following constituents: arsenic, barium, cadmium, lead, chromium, mercury, selenium, and silver. The TCLP results are included in the Related Documents section of this application. TCLP tests will be performed on each new ash source and at least annually for each source.

Asbestos containing material will not be placed in the structural fill site. In addition, the removal of CCP structural fill material from the site is prohibited without owner approval. Structural fill will be hauled and placed by dedicated and consistent operators.

2.1.3 Fill Sequencing

The Colon Mine Site will be developed in sequence from Cell 1 through Cell 5. CCP product will be placed in three to five foot operational lifts, ~~high to~~ low to high. A conceptual schematic of fill sequencing from ~~high to~~ low to high is included in the permit drawings; however, actual fill sequencing and lift heights may be modified at the Owner's discretion. More than one cell may be operational at a time. The cells ~~may~~ are also ~~be~~ subdivided into subcells.

The following procedure shall be followed to activate an area for leachate collection prior to placing CCP.

- Remove all stormwater (i.e., water that has not contacted ash) ponded within the area. Stormwater may be pumped directly into the perimeter channel.
- ~~Close the Stormwater valve. Ensure the valve is completely closed.~~
- Open the leachate valve. Ensure the valve is opened fully.
- Remove the rain flap by cutting above the weld to the sacrificial liner above the primary geomembrane (refer detail 8 on Drawing 00C-08). Visually inspect the area to confirm the integrity of the base liner. If the base liner appears damaged, repair it in accordance with the technical specifications.

- Modifying operations during dry and windy conditions

The operator may use, and is not limited to, combinations of these dust control methods or any method that is technically sound to control dust for specific site conditions. If the operator intends to use a dust control method not presented above, the proposed dust control method will be evaluated on a case by case basis to assess the effectiveness with specific site conditions. For the purposes of this Operations Plan, interim cover soil will be defined as soil material applied at a suitable thickness to provide dust control.

The effectiveness of the dust control methods implemented should be evaluated through visual observations of dust prone areas. Equipment operators shall continuously observe the active face and other areas within the facility for dust emissions.

If fugitive dust emissions are observed and observations indicate dust control measures are not achieving their intended purpose, then appropriate corrective actions will be taken. Dust control measures should be reapplied, repaired, or added, as necessary, to control dust emissions. The operator will construct, install, apply, and/or repair dust control measures prior to the end of the work day to control dust emissions during non-operating hours. The operator shall also implement dust control measures as preventative controls rather than in response to fugitive dust emissions.

A wheel wash system may be necessary to minimize dust and tracking of CCPs outside the facility.

2.2 Leachate and Contact Water Management

In accordance with NCGS §130A-309.216 (a) (5) the CCP structural fill project will be effectively maintained and operated as a nondischarge system to prevent discharge to surface water resulting from the project.

As previously described, the structural fill site has been designed to provide separation of contact water from non-contact water (stormwater). Contact water will be treated as leachate and conveyed to the LCS. Contact water which contacts exposed CCP material within the lined footprint will be conveyed through the LCS. Stormwater will be routed to onsite sediment basins prior to discharge from the site.

2.2.1 Leachate Collection System

The LCS includes a synthetic composite drainage layer and leachate collection pipes with clean-outs. Leachate generated in each cell drains by gravity via perforated header pipes to a series of sumps and then pumped to a central lift station where it is then pumped into a ~~250,000~~1,000,000 gallon storage tank with a secondary containment. Leachate will either be transported to a wastewater treatment plant or discharged directly into a sanitary sewer system.

All loading of leachate tankers will take place on the loading pad next to the storage tank. Prior to loading the operator will insure that the leachate diverter valve is open on the drain pad so any leachate that may be spilled during loading operations will drain back into the lift station.

Memo

Date:	Sunday, March 08, 2015
Project:	Charah Colon Mine
To:	Michael Plummer
From:	Eric Wright
Subject:	HELP Model - Slope and Pipe Spacing vs Peak Head on Liner

The HELP model was run for some initial lift conditions where no runoff was allowed. Most of the runs include a 25-year 24-hour storm event of 6.28 inches. The initial runs were done with the default data which had a 5.22 inch storm event. The runs adjusted drainage length for a group of slopes to maintain less than 30 cm (11.8 inches) of peak head on the liner system.

The table below summarizes the results. The HELP model runs are provided in Attachment 2 to the Design of the Leachate Collection System narrative. These seven scenarios replace all HELP model runs previously provided in Attachments 2 and 6 (Attachment 6 has been deleted).

Scenario	HELP Model	Max Storm (in)	Ash Thickness (ft)	Lift Thickness (ft)	Floor Slope	Drainage Length (ft)	Peak Head (in)
1	5-2ft lifts no runoff 0.5%	6.28	10	2	0.5%	300	9.7
2	5-2ft lifts no runoff 1%	6.28	10	2	1%	425	11.6
3	5-2ft lifts no runoff 2%	6.28	10	2	2%	600	11.6
4	5-2ft lifts no runoff 3%	6.28	10	2	3%	840	9.5
5	10-2ft lifts no runoff 2%	6.28	20	2	2%	950	0.36
6	2-20ft lifts no runoff 2%	6.28	20	20	2%	950	0.32
7	3-20ft lifts no runoff 2%	6.28	20	20	2%	950	0.26

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Design of Leachate Collection System

The HELP model Version 3.95D is used to design the leachate collection system for the Colon Mine Site in Sanford, NC. This section presents the design assumptions, decisions, background data, and calculations for the water balance model. The section outlines efforts to establish leachate generation rates and maximum hydraulic heads on the liner. The leachate generation rates established per acre should be used to design the leachate collection and removal system.

The structural fill liner will consist of the following components, from bottom to top.

- 18-inch compacted soil liner
- GCL
- 60-mil HDPE primary liner
- 300-mil biplanar drainage geocomposite

HELP Model Scenarios and Input Data

- Scenario 1 modeled a 10-foot depth of ash placed in five 2-foot lifts on the floor of the 0.5% liner based on a 5-year simulation period.
- Scenario 2 modeled a 10-foot depth of ash placed in five 2-foot lifts on the floor of the 1.0% liner based on a 5-year simulation period.
- Scenario 3 modeled a 10-foot depth of ash placed in five 2-foot lifts on the floor of the 2.0% liner based on a 5-year simulation period.
- Scenario 4 modeled a 10-foot depth of ash placed in five 2-foot lifts on the floor of the 3.0% liner based on a 5-year simulation period.
- Scenario 5 modeled ten 2-foot lifts based on the 2% floor of the liner on a
- 5-year simulation period.
- Scenario 6 modeled two 20-foot lifts based on the 2% floor of the liner on a
- 5-year simulation period.
- Scenario 7 modeled three 20-foot lifts based on 5-year simulation period.

Each scenario was modeled as a 1-acre area. A major goal for the modeling was to demonstrate that the drainage layer capacity is not exceeded. The second aim of the modeling was to estimate leachate production. The table in Attachment 1 provided summarizes the model input data, and summarizes the results of the scenarios. HELP model output files for scenarios 1-7 are provided in Attachment 2.

Temperature and solar radiation data were synthetically generated using coefficients from Raleigh, NC. Evapotranspiration data from Raleigh, NC was used in all scenarios. Sanford is located approximately 35 miles southeast of Raleigh, NC and should be accurately represented by weather data generated from Raleigh. Precipitation data was revised to capture the 25-year, 24-hour storm event with a rainfall of 6.28 inches in one day.

Material Properties and Structural Fill Geometry

The maximum flow path for leachate in the leachate drainage layer geocomposite will vary between 300 and 950 feet depending on the slope of the floor, at which point the leachate will enter an interceptor perforated pipe surrounded by gravel trench for conveyance to the sumps.

Material Properties

Initial moisture content for ash after placement at the cell is set at optimum moisture content based on proctor test data for open-fill runs. The initial moisture content for ash is set to the field capacity of coal burning electric plant fly ash for the closed-fill runs. Refer to Attachment 4 for physical properties of material.

- Default model parameters were used for the final cover layers and subgrade. Note the permeability for final cover layers was manually adjusted.
- Structural fill base liner was modeled as material texture 35, HDPE.
- Structural fill final cover liner was modeled as material texture 36, LLDPE
- Pinhole density for the membrane liners was set at 1 per acre.
- Installation defects were set at 1 per acre for the membrane liners, reflective of generally good installation procedures.
- Membrane liner placement quality was assumed to be “good”.
- Structural fill base leachate drainage layer was modeled as material texture 34, except the transmissivity was modified to reflect select material properties (Refer to Attachment 3). Transmissivity of the geocomposite should be determined based on site-specific ash and loading before selecting the material for installation.

A detailed calculation of the bottom liner geocomposite’s required hydraulic conductivity is contained in Attachment 3. The maximum overburden pressure, based on 100 pcf density and approximately 50 foot ash/soil mixture is 5000 psf.

Model Outputs and Conclusions

The table in Attachment 1 summarizes the model outputs for each of the scenarios considered. The model demonstrates that the proposed design will comply with applicable design standards. More specifically:

- The peak head on HDPE bottom liner in any HELP Model scenario is 11.6 inches.
- Maximum leachate generated during filling is 1,822 cf/acre/day at a 3% floor slope.
- Drainage length in the bottom ranges from 300 - 950 feet depending on the floor slopes.
- As ash is placed the required drainage length to maintain head on the liner system increases.

Attachment 1 (revised)

Summary of Model Input Data and Results

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Attachment 1
HELP Model Results
Charah Colon Mine

Input Data

Parameter	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
SCS runoff curve number	91.21	91.21	91.21	91.21	91.21	91.21	91.21
fraction of area allowing runoff (%)	0	0	0	0	0	0	0
area simulated (acres)	1	1	1	1	1	1	1
Ash k (cm/sec)	1.6x10^-4	1.6x10^-4	1.6x10^-4	1.6x10^-4	1.6x10^-4	1.6x10^-4	1.6x10^-4
Ash Thickness (ft)	**10**	**10**	**10**	**10**	**20**	**40**	**60**
subgrade thickness (inches)	18	18	18	18	18	18	18
geocomposite thickness (inches)	0.26	0.26	0.26	0.26	0.26	0.26	0.26
geocomposite hydr. conductivity (cm/sec)	9.7	9.7	9.7	9.7	9.7	9.7	9.7
bottom liner drainage layer slope (%)	**0.5**	**1**	**2**	**3**	**2**	**2**	**2**
bottom liner drainage length (feet)	**300**	**425**	**600**	**840**	**950**	**950**	**950**
HDPE liner thickness (mils)	60	60	60	60	60	60	60
liner pinhole density (holes/acre)	1	1	1	1	1	1	1
liner installation defects (holes/acre)	1	1	1	1	1	1	1
liner placement quality	good	good	good	good	good	good	good
recirculation? (amount recirculated)	N	N	N	N	N	N	N
cap drainage layer thickness (inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
cap drainage layer k (cm/sec)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
cap liner thickness (mils)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
cap liner pinhole density (holes/acre)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
cap liner installation defects (holes/acre)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
cap liner placement quality	N/A	N/A	N/A	N/A	N/A	N/A	N/A
number of years simulated	5	5	5	5	5	5	5

Output Data

average annual leachate collected in base liner system collection layer (ft^3)	55,042	55,044	55,046	55,046	59,786	69,300	78,144
average annual head on primary base liner (inches)	0.18	0.10	0.04	0.02	0.04	0.05	0.05
peak day leachate collected in base liner system collection layer (ft^3)	984	1203	1703	1822	756	674	548
peak day max head on primary base liner (inches)	11.53	11.58	11.64	9.50	0.36	0.32	0.26

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Attachment 2 (replaced)

HELP Model Output Files (Scenarios 1-~~5~~7)

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```
***************************************************************************
***************************************************************************
**                                                                       **
**                                                                       **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE            **
**                                                                       **
**              HELP Version 3.95 D          (10 August 2012)            **
**                              developed at                             **
**        Institute of Soil Science, University of Hamburg, Germany      **
**                                based on                               **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)            **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                **
**                    USAE WATERWAYS EXPERIMENT STATION                  **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY           **
**                                                                       **
**                                                                       **
***************************************************************************
***************************************************************************


 TIME:  10.27     DATE:   8.03.2015


 PRECIPITATION DATA FILE:      C:\Users\mplummer\Desktop\HELP runs\Weather Data\SF
Charah Sanford 25 yr storm y3m8d16.d4
 TEMPERATURE DATA FILE:        C:\Users\mplummer\Desktop\HELP runs\Weather
Data\Charah Sanford.d7
 SOLAR RADIATION DATA FILE:    C:\Users\mplummer\Desktop\HELP runs\Weather
Data\Charah Sanford.d13
 EVAPOTRANSPIRATION DATA F. 1: C:\Users\mplummer\Desktop\HELP runs\Weather
Data\Charah Sanford.d11
 SOIL AND DESIGN DATA FILE  1: C:\Users\mplummer\Desktop\HELP runs\Mike's
runs\MPColon 5-2ft lifts no runoff 05% 300.d10
 OUTPUT DATA FILE:             C:\Users\mplummer\Desktop\HELP runs\0.5% MPRevised.out


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

      TITLE:  Coal Ash-First Lift (Five Lifts, No Runoff, 0.5% slope)

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


                           WEATHER DATA SOURCES
---------------------------------------------------------------------------



         NOTE:  PRECIPITATION DATA FOR     RALEIGH             NORTH CAROLINA
                  WAS ENTERED BY THE USER.



         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    RALEIGH             NORTH CAROLINA

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
```

```
-------     -------     -------     -------     -------     -------
 39.60       41.60       49.30       59.50       67.20       73.90
 77.70       77.00       71.00       59.70       50.00       42.00


    NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    RALEIGH             NORTH CAROLINA
               AND STATION LATITUDE  =  35.87 DEGREES


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

                              LAYER DATA   1
------------------------------------------------------------------------------

                           VALID FOR   5 YEARS


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                              LAYER  1
                              --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   0
        THICKNESS                    =    24.00   INCHES
        POROSITY                     =     0.5410 VOL/VOL
        FIELD CAPACITY               =     0.1870 VOL/VOL
        WILTING POINT                =     0.0470 VOL/VOL
        INITIAL SOIL WATER CONTENT   =     0.3100 VOL/VOL
        EFFECTIVE SAT. HYD. CONDUCT.=     0.1600E-03 CM/SEC


                              LAYER  2
                              --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   0
        THICKNESS                    =    24.00   INCHES
        POROSITY                     =     0.5410 VOL/VOL
        FIELD CAPACITY               =     0.1870 VOL/VOL
        WILTING POINT                =     0.0470 VOL/VOL
        INITIAL SOIL WATER CONTENT   =     0.3100 VOL/VOL
        EFFECTIVE SAT. HYD. CONDUCT.=     0.1600E-03 CM/SEC


                              LAYER  3
                              --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   0
        THICKNESS                    =    24.00   INCHES
        POROSITY                     =     0.5410 VOL/VOL
```

```
FIELD CAPACITY              =      0.1870 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                         LAYER  4
                         --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.5410 VOL/VOL
FIELD CAPACITY              =      0.1870 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                         LAYER  5
                         --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.5410 VOL/VOL
FIELD CAPACITY              =      0.1870 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                         LAYER  6
                         --------

             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.26   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       9.700     CM/SEC
SLOPE                       =      0.50   PERCENT
DRAINAGE LENGTH             =    300.0    FEET


                         LAYER  7
                         --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
```

FML PLACEMENT QUALITY = 3 - GOOD

LAYER 8

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25 INCHES
POROSITY	=	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.3000E-08 CM/SEC

LAYER 9

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	18.00 INCHES
POROSITY	=	0.4270 VOL/VOL
FIELD CAPACITY	=	0.4180 VOL/VOL
WILTING POINT	=	0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4180 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1000E-06 CM/SEC

****

GENERAL DESIGN AND EVAPORATIVE ZONE DATA 1

VALID FOR 5 YEARS

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 9 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 1000. FEET.

SCS RUNOFF CURVE NUMBER	=	91.21	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	18.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	5.580	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.738	INCHES
FIELD CAPACITY OF EVAPORATIVE ZONE	=	3.366	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.846	INCHES
SOIL EVAPORATION ZONE DEPTH	=	18.000	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL INTERCEPTION WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	44.914	INCHES
TOTAL INITIAL WATER	=	44.914	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

****

EVAPOTRANSPIRATION DATA 1

VALID FOR 5 YEARS

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
RALEIGH NORTH CAROLINA

STATION LATITUDE	=	35.87 DEGREES
MAXIMUM LEAF AREA INDEX	=	4.50
START OF GROWING SEASON (JULIAN DATE)	=	86
END OF GROWING SEASON (JULIAN DATE)	=	310
EVAPORATIVE ZONE DEPTH	=	18.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.0 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	70.0 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	78.0 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	72.0 %

****

****

FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	7.0193	0.2925
2	6.3803	0.2658
3	4.8629	0.2026
4	5.4737	0.2281
5	5.6427	0.2351
6	0.0134	0.0522
7	0.0000	0.0000
8	0.1875	0.7500
9	7.5240	0.4180

TOTAL WATER IN LAYERS	37.104
SNOW WATER	0.000
INTERCEPTION WATER	0.000
TOTAL FINAL WATER	37.104

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.28	22796.400
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 6	0.27121	984.47894
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000003	0.01162
AVERAGE HEAD ON TOP OF LAYER 7	9.696	
MAXIMUM HEAD ON TOP OF LAYER 7	11.534	
LOCATION OF MAXIMUM HEAD IN LAYER 6 (DISTANCE FROM DRAIN)	145.5 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000003	0.01162
SNOW WATER	1.67	6061.1177
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.5112	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0470	

*** 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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****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.26	2.82	4.37	2.63	3.53	5.42
	4.57	6.47	2.81	3.77	2.52	2.90

```
  STD. DEVIATIONS        2.96     0.95     1.30     1.89     2.64     1.99
                         2.29     6.38     1.69     2.69     1.66     1.28

RUNOFF
------
  TOTALS                 0.000    0.000    0.000    0.000    0.000    0.000
                         0.000    0.000    0.000    0.000    0.000    0.000

  STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                         0.000    0.000    0.000    0.000    0.000    0.000

POTENTIAL EVAPOTRANSPIRATION
----------------------------
  TOTALS                 1.892    2.205    3.293    4.787    6.327    6.770
                         7.049    5.890    4.466    3.365    2.345    1.543

  STD. DEVIATIONS        0.140    0.177    0.179    0.403    0.445    0.263
                         0.410    0.413    0.352    0.062    0.182    0.125

ACTUAL EVAPOTRANSPIRATION
-------------------------
  TOTALS                 1.193    1.541    2.190    3.180    4.706    4.073
                         4.978    3.914    2.729    1.267    0.914    0.791

  STD. DEVIATIONS        0.095    0.154    0.276    0.684    1.211    1.405
                         1.282    1.455    1.165    0.187    0.268    0.186

LATERAL DRAINAGE COLLECTED FROM LAYER  6
----------------------------------------
  TOTALS                 1.0811   1.5403   1.7096   1.2263   1.4707   1.2420
                         1.1218   1.0789   1.7655   1.4896   0.8001   0.6373

  STD. DEVIATIONS        1.1101   1.3009   1.5602   1.1621   0.6397   0.3121
                         0.1513   0.3646   2.0392   1.8273   0.6202   0.4161

LATERAL DRAINAGE RECIRCULATED FROM LAYER  6 INTO L.  1
------------------------------------------------------
  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

PERCOLATION/LEAKAGE THROUGH LAYER  8
------------------------------------
  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

PERCOLATION/LEAKAGE THROUGH LAYER  9
------------------------------------
  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  7
  -------------------------------------
    AVERAGES              0.0381   0.1849   0.0602   0.0446   0.0518   0.0452
                          0.0395   0.0380   1.1528   0.4241   0.0291   0.0224

    STD. DEVIATIONS       0.0391   0.3145   0.0549   0.0423   0.0225   0.0113
                          0.0053   0.0128   2.5079   0.8954   0.0226   0.0146

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


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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------

                                      INCHES            CU. FEET      PERCENT
                                -------------------  -------------  ---------
 PRECIPITATION                   45.08    (  10.212)     163625.9     100.00

 RUNOFF                           0.000   (  0.0000)         0.00      0.000

 POTENTIAL EVAPOTRANSPIRATION    49.932   (  0.3704)     181254.19

 ACTUAL EVAPOTRANSPIRATION       31.475   (  1.0157)     114254.23    69.827

 LATERAL DRAINAGE COLLECTED      15.16304 (  8.99294)     55041.844   33.63884
   FROM LAYER  6

 DRAINAGE RECIRCULATED            0.00000 (  0.00000)         0.000    0.00000
   FROM LAYER  6 INTO L.  1

 PERCOLATION/LEAKAGE THROUGH      0.00002 (  0.00004)         0.071     0.00004
   LAYER  8

 AVERAGE HEAD ON TOP              0.178   (    0.321)
   OF LAYER  7

 PERCOLATION/LEAKAGE THROUGH      0.00002 (  0.00004)         0.071     0.00004
   LAYER  9

 CHANGE IN WATER STORAGE         -1.562   (  4.5481)      -5670.26    -3.465

*******************************************************************************
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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D          (10 August 2012)               **
**                              developed at                                **
**        Institute of Soil Science, University of Hamburg, Germany         **
**                                based on                                  **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


 TIME:   9.48     DATE:   8.03.2015


 PRECIPITATION DATA FILE:      C:\Users\mplummer\Desktop\HELP runs\Weather Data\SF
Charah Sanford 25 yr storm y3m8d16.d4
 TEMPERATURE DATA FILE:        C:\Users\mplummer\Desktop\HELP runs\Weather
Data\Charah Sanford.d7
 SOLAR RADIATION DATA FILE:    C:\Users\mplummer\Desktop\HELP runs\Weather
Data\Charah Sanford.d13
 EVAPOTRANSPIRATION DATA F. 1: C:\Users\mplummer\Desktop\HELP runs\Weather
Data\Charah Sanford.d11
 SOIL AND DESIGN DATA FILE  1: C:\Users\mplummer\Desktop\HELP runs\Eric's
Runs\MPColon 5-2ft lifts no runoff 1%425.d10
 OUTPUT DATA FILE:             C:\Users\mplummer\Desktop\HELP runs\1.0% MPRevised.out


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

      TITLE:  Coal Ash-First Lift (Ten 2-foot Lifts, No Runoff, 1% slope)

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


                           WEATHER DATA SOURCES
------------------------------------------------------------------------------



        NOTE:  PRECIPITATION DATA FOR     RALEIGH             NORTH CAROLINA
                 WAS ENTERED BY THE USER.



        NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    RALEIGH             NORTH CAROLINA

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
```

```
  -------     -------     -------     -------     -------     -------
   39.60       41.60       49.30       59.50       67.20       73.90
   77.70       77.00       71.00       59.70       50.00       42.00


     NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    RALEIGH             NORTH CAROLINA
                AND STATION LATITUDE  =  35.87 DEGREES


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

                                LAYER DATA   1
-------------------------------------------------------------------------------

                             VALID FOR   5 YEARS


NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
         WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   0
      THICKNESS                    =     24.00   INCHES
      POROSITY                     =      0.5410 VOL/VOL
      FIELD CAPACITY               =      0.1870 VOL/VOL
      WILTING POINT                =      0.0470 VOL/VOL
      INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
      EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                                   LAYER  2
                                   --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   0
      THICKNESS                    =     24.00   INCHES
      POROSITY                     =      0.5410 VOL/VOL
      FIELD CAPACITY               =      0.1870 VOL/VOL
      WILTING POINT                =      0.0470 VOL/VOL
      INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
      EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                                   LAYER  3
                                   --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   0
      THICKNESS                    =     24.00   INCHES
      POROSITY                     =      0.5410 VOL/VOL
```

```
FIELD CAPACITY              =      0.1870 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.5410 VOL/VOL
FIELD CAPACITY              =      0.1870 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.5410 VOL/VOL
FIELD CAPACITY              =      0.1870 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER  6
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.26   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       9.700     CM/SEC
SLOPE                       =      1.00   PERCENT
DRAINAGE LENGTH             =    425.0    FEET


                        LAYER  7
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
```

```
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  8
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                  =      0.25   INCHES
POROSITY                   =      0.7500 VOL/VOL
FIELD CAPACITY             =      0.7470 VOL/VOL
WILTING POINT              =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.7500 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=     0.3000E-08 CM/SEC


                        LAYER  9
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  16
THICKNESS                  =     18.00   INCHES
POROSITY                   =      0.4270 VOL/VOL
FIELD CAPACITY             =      0.4180 VOL/VOL
WILTING POINT              =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.4180 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=     0.1000E-06 CM/SEC


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

        GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                    VALID FOR   5 YEARS


   NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 9 WITH BARE
          GROUND CONDITIONS, A SURFACE SLOPE OF  2.% AND
          A SLOPE LENGTH OF 1000. FEET.

   SCS RUNOFF CURVE NUMBER              =     91.21
   FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH               =     18.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE    =      5.580  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE   =      9.738  INCHES
   FIELD CAPACITY OF EVAPORATIVE ZONE   =      3.366  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.846  INCHES
   SOIL EVAPORATION ZONE DEPTH          =     18.000  INCHES
   INITIAL SNOW WATER                   =      0.000  INCHES
   INITIAL INTERCEPTION WATER           =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS     =     44.914  INCHES
   TOTAL INITIAL WATER                  =     44.914  INCHES
   TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

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                        EVAPOTRANSPIRATION DATA   1
------------------------------------------------------------------------------

                            VALID FOR   5 YEARS


         NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                 RALEIGH             NORTH CAROLINA
             STATION LATITUDE                       =  35.87 DEGREES
             MAXIMUM LEAF AREA INDEX                =   4.50
             START OF GROWING SEASON (JULIAN DATE)  =     86
             END OF GROWING SEASON (JULIAN DATE)    =    310
             EVAPORATIVE ZONE DEPTH                 =  18.0  INCHES
             AVERAGE ANNUAL WIND SPEED              =   7.70 MPH
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  66.0  %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  70.0  %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  78.0  %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  72.0  %

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                   FINAL WATER STORAGE AT END OF YEAR    5
------------------------------------------------------------------------------

                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1           7.0193         0.2925

                      2           6.3803         0.2658

                      3           4.8629         0.2026

                      4           5.4737         0.2281

                      5           5.6427         0.2351

                      6           0.0102         0.0400

                      7           0.0000         0.0000

                      8           0.1875         0.7500

                      9           7.5240         0.4180

   TOTAL WATER IN LAYERS         37.101

   SNOW WATER                     0.000

   INTERCEPTION WATER             0.000

   TOTAL FINAL WATER             37.101
```

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.28	22796.400
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 6	0.33137	1202.88806
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000003	0.00928
AVERAGE HEAD ON TOP OF LAYER 7	8.229	
MAXIMUM HEAD ON TOP OF LAYER 7	11.579	
LOCATION OF MAXIMUM HEAD IN LAYER 6 (DISTANCE FROM DRAIN)	125.9 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000003	0.00928
SNOW WATER	1.67	6061.1177
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.5112	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0470	

*** 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.

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.26	2.82	4.37	2.63	3.53	5.42
	4.57	6.47	2.81	3.77	2.52	2.90

```
  STD. DEVIATIONS         2.96     0.95     1.30     1.89     2.64     1.99
                          2.29     6.38     1.69     2.69     1.66     1.28

RUNOFF
------
  TOTALS                  0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

  STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

POTENTIAL EVAPOTRANSPIRATION
----------------------------
  TOTALS                  1.892    2.205    3.293    4.787    6.327    6.770
                          7.049    5.890    4.466    3.365    2.345    1.543

  STD. DEVIATIONS         0.140    0.177    0.179    0.403    0.445    0.263
                          0.410    0.413    0.352    0.062    0.182    0.125

ACTUAL EVAPOTRANSPIRATION
-------------------------
  TOTALS                  1.193    1.541    2.190    3.180    4.706    4.073
                          4.978    3.914    2.729    1.267    0.914    0.791

  STD. DEVIATIONS         0.095    0.154    0.276    0.684    1.211    1.405
                          1.282    1.455    1.165    0.187    0.268    0.186

LATERAL DRAINAGE COLLECTED FROM LAYER  6
----------------------------------------
  TOTALS                  1.0875   1.5479   1.6994   1.2303   1.4695   1.2391
                          1.1239   1.0751   1.9755   1.2807   0.7978   0.6370

  STD. DEVIATIONS         1.1199   1.3097   1.5510   1.1613   0.6345   0.3115
                          0.1497   0.3632   2.5108   1.3641   0.6164   0.4172

LATERAL DRAINAGE RECIRCULATED FROM LAYER  6 INTO L.  1
------------------------------------------------------
  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

PERCOLATION/LEAKAGE THROUGH LAYER  8
------------------------------------
  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

PERCOLATION/LEAKAGE THROUGH LAYER  9
------------------------------------
  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 7

AVERAGES	0.0271	0.0425	0.0424	0.0317	0.0366	0.0319
	0.0280	0.0268	0.8151	0.0319	0.0206	0.0159
STD. DEVIATIONS	0.0279	0.0362	0.0387	0.0299	0.0158	0.0080
	0.0037	0.0091	1.7732	0.0340	0.0159	0.0104

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	45.08 (10.212)	163625.9	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
POTENTIAL EVAPOTRANSPIRATION	49.932 (0.3704)	181254.19	
ACTUAL EVAPOTRANSPIRATION	31.475 (1.0157)	114254.23	69.827
LATERAL DRAINAGE COLLECTED FROM LAYER 6	15.16367 (8.99710)	55044.137	33.64024
DRAINAGE RECIRCULATED FROM LAYER 6 INTO L. 1	0.00000 (0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.00001 (0.00002)	0.039	0.00002
AVERAGE HEAD ON TOP OF LAYER 7	0.096 (0.161)		
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00001 (0.00002)	0.039	0.00002
CHANGE IN WATER STORAGE	-1.563 (4.5465)	-5672.52	-3.467

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****

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**                                                                          **
**                                                                          **
**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE              **
**                                                                          **
**               HELP Version 3.95 D          (10 August 2012)              **
**                                developed at                              **
**         Institute of Soil Science, University of Hamburg, Germany        **
**                                  based on                                **
**               US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)              **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                  **
**                     USAE WATERWAYS EXPERIMENT STATION                    **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
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```

TIME: 9.58   DATE: 8.03.2015

PRECIPITATION DATA FILE: C:\Users\mplummer\Desktop\HELP runs\Weather Data\SF Charah Sanford 25 yr storm y3m8d16.d4
TEMPERATURE DATA FILE: C:\Users\mplummer\Desktop\HELP runs\Weather Data\Charah Sanford.d7
SOLAR RADIATION DATA FILE: C:\Users\mplummer\Desktop\HELP runs\Weather Data\Charah Sanford.d13
EVAPOTRANSPIRATION DATA F. 1: C:\Users\mplummer\Desktop\HELP runs\Weather Data\Charah Sanford.d11
SOIL AND DESIGN DATA FILE 1: C:\Users\mplummer\Desktop\HELP runs\MP Colon 5-2ft lifts no runoff 2%.d10
OUTPUT DATA FILE: C:\Users\mplummer\Desktop\HELP runs\2.0% MPRevised.out

****

TITLE: Coal Ash-First Lift (Five 2-foot Lifts, No Runoff)

****

WEATHER DATA SOURCES

NOTE: PRECIPITATION DATA FOR   RALEIGH   NORTH CAROLINA
WAS ENTERED BY THE USER.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR   RALEIGH   NORTH CAROLINA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL   FEB/AUG   MAR/SEP   APR/OCT   MAY/NOV   JUN/DEC

```
-------     -------     -------     -------     -------     -------
 39.60       41.60       49.30       59.50       67.20       73.90
 77.70       77.00       71.00       59.70       50.00       42.00


    NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    RALEIGH             NORTH CAROLINA
               AND STATION LATITUDE  =  35.87 DEGREES


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

                              LAYER DATA   1
-------------------------------------------------------------------------------

                           VALID FOR   5 YEARS


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                LAYER  1
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   0
           THICKNESS                   =     24.00   INCHES
           POROSITY                    =      0.5410 VOL/VOL
           FIELD CAPACITY              =      0.1870 VOL/VOL
           WILTING POINT               =      0.0470 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.3100 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                                LAYER  2
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   0
           THICKNESS                   =     24.00   INCHES
           POROSITY                    =      0.5410 VOL/VOL
           FIELD CAPACITY              =      0.1870 VOL/VOL
           WILTING POINT               =      0.0470 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.3100 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                                LAYER  3
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   0
           THICKNESS                   =     24.00   INCHES
           POROSITY                    =      0.5410 VOL/VOL
```

```
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       0.1600E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.5410 VOL/VOL
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       0.1600E-03 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.5410 VOL/VOL
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       0.1600E-03 CM/SEC


                        LAYER  6
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =      0.26   INCHES
POROSITY                     =      0.8500 VOL/VOL
FIELD CAPACITY               =      0.0100 VOL/VOL
WILTING POINT                =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=        9.700     CM/SEC
SLOPE                        =      2.00   PERCENT
DRAINAGE LENGTH              =    600.0    FEET


                        LAYER  7
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=       0.2000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      1.00   HOLES/ACRE
```

```
    FML PLACEMENT QUALITY       =  3 - GOOD


                             LAYER  8
                             --------

                  TYPE 3 - BARRIER SOIL LINER
                  MATERIAL TEXTURE NUMBER  17
    THICKNESS                  =      0.25   INCHES
    POROSITY                   =      0.7500 VOL/VOL
    FIELD CAPACITY             =      0.7470 VOL/VOL
    WILTING POINT              =      0.4000 VOL/VOL
    INITIAL SOIL WATER CONTENT  =     0.7500 VOL/VOL
    EFFECTIVE SAT. HYD. CONDUCT.=     0.3000E-08 CM/SEC


                             LAYER  9
                             --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  16
    THICKNESS                  =     18.00   INCHES
    POROSITY                   =      0.4270 VOL/VOL
    FIELD CAPACITY             =      0.4180 VOL/VOL
    WILTING POINT              =      0.3670 VOL/VOL
    INITIAL SOIL WATER CONTENT  =     0.4180 VOL/VOL
    EFFECTIVE SAT. HYD. CONDUCT.=     0.1000E-06 CM/SEC


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

              GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                       VALID FOR   5 YEARS


   NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
            SOIL DATA BASE USING SOIL TEXTURE # 9 WITH BARE
            GROUND CONDITIONS, A SURFACE SLOPE OF  2.% AND
            A SLOPE LENGTH OF 1000. FEET.

   SCS RUNOFF CURVE NUMBER             =     91.21
   FRACTION OF AREA ALLOWING RUNOFF    =      0.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =     18.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      5.580  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =      9.738  INCHES
   FIELD CAPACITY OF EVAPORATIVE ZONE  =      3.366  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.846  INCHES
   SOIL EVAPORATION ZONE DEPTH         =     18.000  INCHES
   INITIAL SNOW WATER                  =      0.000  INCHES
   INITIAL INTERCEPTION WATER          =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     44.914  INCHES
   TOTAL INITIAL WATER                 =     44.914  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR
```

```
******************************************************************************

                        EVAPOTRANSPIRATION DATA   1
------------------------------------------------------------------------------

                            VALID FOR   5 YEARS


         NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                RALEIGH             NORTH CAROLINA
             STATION LATITUDE                         =  35.87 DEGREES
             MAXIMUM LEAF AREA INDEX                  =   4.50
             START OF GROWING SEASON (JULIAN DATE)    =     86
             END OF GROWING SEASON (JULIAN DATE)      =    310
             EVAPORATIVE ZONE DEPTH                   =  18.0  INCHES
             AVERAGE ANNUAL WIND SPEED                =   7.70 MPH
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  66.0  %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  70.0  %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  78.0  %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  72.0  %

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



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                   FINAL WATER STORAGE AT END OF YEAR    5
------------------------------------------------------------------------------

                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1           7.0193          0.2925

                      2           6.3803          0.2658

                      3           4.8629          0.2026

                      4           5.4737          0.2281

                      5           5.6427          0.2351

                      6           0.0080          0.0313

                      7           0.0000          0.0000

                      8           0.1875          0.7500

                      9           7.5240          0.4180

    TOTAL WATER IN LAYERS        37.098

    SNOW WATER                    0.000

    INTERCEPTION WATER            0.000

    TOTAL FINAL WATER            37.098
```

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.28	22796.400
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 6	0.46927	1703.43982
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000002	0.00739
AVERAGE HEAD ON TOP OF LAYER 7	6.946	
MAXIMUM HEAD ON TOP OF LAYER 7	11.642	
LOCATION OF MAXIMUM HEAD IN LAYER 6 (DISTANCE FROM DRAIN)	97.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000002	0.00739
SNOW WATER	1.67	6061.1177
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.5112	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0470	

*** 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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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.26	2.82	4.37	2.63	3.53	5.42
	4.57	6.47	2.81	3.77	2.52	2.90

```
  STD. DEVIATIONS        2.96     0.95     1.30     1.89     2.64     1.99
                         2.29     6.38     1.69     2.69     1.66     1.28

RUNOFF
------
  TOTALS                 0.000    0.000    0.000    0.000    0.000    0.000
                         0.000    0.000    0.000    0.000    0.000    0.000

  STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                         0.000    0.000    0.000    0.000    0.000    0.000

POTENTIAL EVAPOTRANSPIRATION
----------------------------
  TOTALS                 1.892    2.205    3.293    4.787    6.327    6.770
                         7.049    5.890    4.466    3.365    2.345    1.543

  STD. DEVIATIONS        0.140    0.177    0.179    0.403    0.445    0.263
                         0.410    0.413    0.352    0.062    0.182    0.125

ACTUAL EVAPOTRANSPIRATION
-------------------------
  TOTALS                 1.193    1.541    2.190    3.180    4.706    4.073
                         4.978    3.914    2.729    1.267    0.914    0.791

  STD. DEVIATIONS        0.095    0.154    0.276    0.684    1.211    1.405
                         1.282    1.455    1.165    0.187    0.268    0.186

LATERAL DRAINAGE COLLECTED FROM LAYER  6
----------------------------------------
  TOTALS                 1.0921   1.5520   1.6936   1.2330   1.4686   1.2369
                         1.1256   1.0726   1.9861   1.2707   0.7960   0.6370

  STD. DEVIATIONS        1.1270   1.3140   1.5478   1.1602   0.6308   0.3112
                         0.1489   0.3622   2.5376   1.3439   0.6135   0.4182

LATERAL DRAINAGE RECIRCULATED FROM LAYER  6 INTO L.  1
------------------------------------------------------
  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

PERCOLATION/LEAKAGE THROUGH LAYER  8
------------------------------------
  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

PERCOLATION/LEAKAGE THROUGH LAYER  9
------------------------------------
  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 7

AVERAGES	0.0192	0.0301	0.0298	0.0224	0.0259	0.0225
	0.0198	0.0189	0.1901	0.0224	0.0145	0.0112
STD. DEVIATIONS	0.0198	0.0256	0.0272	0.0211	0.0111	0.0057
	0.0026	0.0064	0.3904	0.0237	0.0112	0.0074

****

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	45.08	(10.212)	163625.9	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
POTENTIAL EVAPOTRANSPIRATION	49.932	(0.3704)	181254.19	
ACTUAL EVAPOTRANSPIRATION	31.475	(1.0157)	114254.23	69.827
LATERAL DRAINAGE COLLECTED FROM LAYER 6	15.16413	(9.00048)	55045.793	33.64125
DRAINAGE RECIRCULATED FROM LAYER 6 INTO L. 1	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.00000	(0.00000)	0.017	0.00001
AVERAGE HEAD ON TOP OF LAYER 7	0.036	(0.042)		
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000	(0.00000)	0.017	0.00001
CHANGE IN WATER STORAGE	-1.563	(4.5454)	-5674.15	-3.468

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****

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D          (10 August 2012)               **
**                               developed at                               **
**        Institute of Soil Science, University of Hamburg, Germany         **
**                                 based on                                 **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


 TIME:  10.11     DATE:   8.03.2015


 PRECIPITATION DATA FILE:      C:\Users\mplummer\Desktop\HELP runs\Weather Data\SF
Charah Sanford 25 yr storm y3m8d16.d4
 TEMPERATURE DATA FILE:        C:\Users\mplummer\Desktop\HELP runs\Weather
Data\Charah Sanford.d7
 SOLAR RADIATION DATA FILE:    C:\Users\mplummer\Desktop\HELP runs\Weather
Data\Charah Sanford.d13
 EVAPOTRANSPIRATION DATA F. 1: C:\Users\mplummer\Desktop\HELP runs\Weather
Data\Charah Sanford.d11
 SOIL AND DESIGN DATA FILE  1: C:\Users\mplummer\Desktop\HELP runs\Mike's
runs\MPColon 5-2ft lifts no runoff 3%.d10
 OUTPUT DATA FILE:             C:\Users\mplummer\Desktop\HELP runs\3.0% MPRevised.out


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

      TITLE:  Coal Ash-First Lift (Five 2-foot Lifts, No Runoff)

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


                           WEATHER DATA SOURCES
------------------------------------------------------------------------------



         NOTE:  PRECIPITATION DATA FOR     RALEIGH             NORTH CAROLINA
                  WAS ENTERED BY THE USER.



         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    RALEIGH             NORTH CAROLINA

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
```

-------	-------	-------	-------	-------	-------
39.60	41.60	49.30	59.50	67.20	73.90
77.70	77.00	71.00	59.70	50.00	42.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.87 DEGREES

****

LAYER DATA 1

VALID FOR 5 YEARS

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.5410 VOL/VOL
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.5410 VOL/VOL
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.5410 VOL/VOL
```

```
FIELD CAPACITY               =     0.1870 VOL/VOL
WILTING POINT                =     0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =     0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER  4
                        --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   0
THICKNESS                    =    24.00   INCHES
POROSITY                     =     0.5410 VOL/VOL
FIELD CAPACITY               =     0.1870 VOL/VOL
WILTING POINT                =     0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =     0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER  5
                        --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   0
THICKNESS                    =    24.00   INCHES
POROSITY                     =     0.5410 VOL/VOL
FIELD CAPACITY               =     0.1870 VOL/VOL
WILTING POINT                =     0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =     0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER  6
                        --------

             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     0.26   INCHES
POROSITY                     =     0.8500 VOL/VOL
FIELD CAPACITY               =     0.0100 VOL/VOL
WILTING POINT                =     0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =     0.0100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       9.700     CM/SEC
SLOPE                        =     3.00   PERCENT
DRAINAGE LENGTH              =   840.0    FEET


                        LAYER  7
                        --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
THICKNESS                    =     0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
FML PINHOLE DENSITY          =     1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =     1.00   HOLES/ACRE
```

```
   FML PLACEMENT QUALITY       =  3 - GOOD


                         LAYER  8
                         --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
   THICKNESS                   =      0.25   INCHES
   POROSITY                    =      0.7500 VOL/VOL
   FIELD CAPACITY              =      0.7470 VOL/VOL
   WILTING POINT               =      0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. CONDUCT.=      0.3000E-08 CM/SEC


                         LAYER  9
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  16
   THICKNESS                   =     18.00   INCHES
   POROSITY                    =      0.4270 VOL/VOL
   FIELD CAPACITY              =      0.4180 VOL/VOL
   WILTING POINT               =      0.3670 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.4180 VOL/VOL
   EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-06 CM/SEC


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

                GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                      VALID FOR   5 YEARS


     NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
              SOIL DATA BASE USING SOIL TEXTURE # 9 WITH BARE
              GROUND CONDITIONS, A SURFACE SLOPE OF  2.% AND
              A SLOPE LENGTH OF 1000. FEET.

   SCS RUNOFF CURVE NUMBER              =     91.21
   FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH               =     18.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE    =      5.580  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE   =      9.738  INCHES
   FIELD CAPACITY OF EVAPORATIVE ZONE   =      3.366  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.846  INCHES
   SOIL EVAPORATION ZONE DEPTH          =     18.000  INCHES
   INITIAL SNOW WATER                   =      0.000  INCHES
   INITIAL INTERCEPTION WATER           =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS     =     44.914  INCHES
   TOTAL INITIAL WATER                  =     44.914  INCHES
   TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

```
******************************************************************************

                        EVAPOTRANSPIRATION DATA   1
------------------------------------------------------------------------------

                            VALID FOR   5 YEARS


         NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                 RALEIGH             NORTH CAROLINA
             STATION LATITUDE                        =  35.87 DEGREES
             MAXIMUM LEAF AREA INDEX                 =   4.50
             START OF GROWING SEASON (JULIAN DATE)  =     86
             END OF GROWING SEASON (JULIAN DATE)    =    310
             EVAPORATIVE ZONE DEPTH                  =  18.0  INCHES
             AVERAGE ANNUAL WIND SPEED               =   7.70 MPH
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  66.0  %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  70.0  %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  78.0  %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  72.0  %

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



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

                   FINAL WATER STORAGE AT END OF YEAR    5
------------------------------------------------------------------------------

                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1           7.0193         0.2925

                      2           6.3803         0.2658

                      3           4.8629         0.2026

                      4           5.4737         0.2281

                      5           5.6427         0.2351

                      6           0.0076         0.0299

                      7           0.0000         0.0000

                      8           0.1875         0.7500

                      9           7.5240         0.4180

    TOTAL WATER IN LAYERS        37.098

    SNOW WATER                    0.000

    INTERCEPTION WATER            0.000

    TOTAL FINAL WATER            37.098
```

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.28	22796.400
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 6	0.50193	1822.00183
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000002	0.00549
AVERAGE HEAD ON TOP OF LAYER 7	5.207	
MAXIMUM HEAD ON TOP OF LAYER 7	9.504	
LOCATION OF MAXIMUM HEAD IN LAYER 6 (DISTANCE FROM DRAIN)	71.8 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000002	0.00549
SNOW WATER	1.67	6061.1177
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.5112	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0470	

*** 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.

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.26	2.82	4.37	2.63	3.53	5.42
	4.57	6.47	2.81	3.77	2.52	2.90

```
  STD. DEVIATIONS        2.96     0.95     1.30     1.89     2.64     1.99
                         2.29     6.38     1.69     2.69     1.66     1.28

RUNOFF
------
  TOTALS                 0.000    0.000    0.000    0.000    0.000    0.000
                         0.000    0.000    0.000    0.000    0.000    0.000

  STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                         0.000    0.000    0.000    0.000    0.000    0.000

POTENTIAL EVAPOTRANSPIRATION
----------------------------
  TOTALS                 1.892    2.205    3.293    4.787    6.327    6.770
                         7.049    5.890    4.466    3.365    2.345    1.543

  STD. DEVIATIONS        0.140    0.177    0.179    0.403    0.445    0.263
                         0.410    0.413    0.352    0.062    0.182    0.125

ACTUAL EVAPOTRANSPIRATION
-------------------------
  TOTALS                 1.193    1.541    2.190    3.180    4.706    4.073
                         4.978    3.914    2.729    1.267    0.914    0.791

  STD. DEVIATIONS        0.095    0.154    0.276    0.684    1.211    1.405
                         1.282    1.455    1.165    0.187    0.268    0.186

LATERAL DRAINAGE COLLECTED FROM LAYER  6
----------------------------------------
  TOTALS                 1.0928   1.5526   1.6927   1.2334   1.4685   1.2365
                         1.1259   1.0721   1.9870   1.2699   0.7958   0.6370

  STD. DEVIATIONS        1.1282   1.3147   1.5474   1.1600   0.6302   0.3111
                         0.1489   0.3620   2.5399   1.3425   0.6131   0.4184

LATERAL DRAINAGE RECIRCULATED FROM LAYER  6 INTO L.  1
------------------------------------------------------
  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

PERCOLATION/LEAKAGE THROUGH LAYER  8
------------------------------------
  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

PERCOLATION/LEAKAGE THROUGH LAYER  9
------------------------------------
  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  7
  -------------------------------------
    AVERAGES                0.0180   0.0281   0.0278   0.0210   0.0241   0.0210
                            0.0185   0.0176   0.0668   0.0209   0.0135   0.0105

    STD. DEVIATIONS         0.0185   0.0240   0.0254   0.0197   0.0104   0.0053
                            0.0024   0.0060   0.1169   0.0221   0.0104   0.0069

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


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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------

                                     INCHES           CU. FEET       PERCENT
                               -------------------  -------------  ---------
 PRECIPITATION                  45.08    (  10.212)    163625.9     100.00

 RUNOFF                          0.000   (  0.0000)         0.00      0.000

 POTENTIAL EVAPOTRANSPIRATION   49.932   (  0.3704)    181254.19

 ACTUAL EVAPOTRANSPIRATION      31.475   (  1.0157)    114254.23     69.827

 LATERAL DRAINAGE COLLECTED     15.16420 (  9.00105)     55046.047   33.64141
   FROM LAYER  6

 DRAINAGE RECIRCULATED           0.00000 (  0.00000)         0.000    0.00000
   FROM LAYER  6 INTO L.  1

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.013     0.00001
   LAYER  8

 AVERAGE HEAD ON TOP             0.024   (    0.019)
   OF LAYER  7

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.013     0.00001
   LAYER  9

 CHANGE IN WATER STORAGE        -1.563   (  4.5452)      -5674.41     -3.468

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****************************************************************************
**                                                                        **
**                                                                        **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE             **
**                                                                        **
**              HELP Version 3.95 D          (10 August 2012)             **
**                               developed at                             **
**        Institute of Soil Science, University of Hamburg, Germany       **
**                                 based on                               **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)             **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                 **
**                    USAE WATERWAYS EXPERIMENT STATION                   **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
**                                                                        **
**                                                                        **
****************************************************************************
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 TIME:   5.14     DATE:   7.03.2015


 PRECIPITATION DATA FILE:      C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\SF Charah Sanford 25 yr storm y3m8d16.d4
 TEMPERATURE DATA FILE:        C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Charah Sanford.d7
 SOLAR RADIATION DATA FILE:    C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Charah Sanford.d13
 EVAPOTRANSPIRATION DATA F. 1: C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Charah Sanford.d11
 SOIL AND DESIGN DATA FILE  1: C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Actual Runs\SF Colon 10-2ft lifts no runoff.d10
 OUTPUT DATA FILE:             C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Actual Runs\Scenario 2 Actual.out


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     TITLE:  Coal Ash-Second Set of Lifts (Ten 2-foot Lifts, No Runoff)

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                           WEATHER DATA SOURCES
----------------------------------------------------------------------------



         NOTE:  PRECIPITATION DATA FOR     RALEIGH            NORTH CAROLINA
                  WAS ENTERED BY THE USER.



         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    RALEIGH            NORTH CAROLINA

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)
```

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
39.60	41.60	49.30	59.50	67.20	73.90
77.70	77.00	71.00	59.70	50.00	42.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.87 DEGREES

****

LAYER DATA 1

VALID FOR 5 YEARS

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00 INCHES
POROSITY	=	0.5410 VOL/VOL
FIELD CAPACITY	=	0.1870 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1600E-03 CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00 INCHES
POROSITY	=	0.5410 VOL/VOL
FIELD CAPACITY	=	0.1870 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1600E-03 CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00 INCHES

```
POROSITY                     =      0.5410 VOL/VOL
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.5410 VOL/VOL
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.5410 VOL/VOL
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.5410 VOL/VOL
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.5410 VOL/VOL
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
```

```
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER  8
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.5410 VOL/VOL
FIELD CAPACITY              =      0.1870 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER  9
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.5410 VOL/VOL
FIELD CAPACITY              =      0.1870 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER 10
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.5410 VOL/VOL
FIELD CAPACITY              =      0.1870 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER 11
                        --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.26   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       9.700     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    950.0    FEET
```

```
                          LAYER 12
                          --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
THICKNESS                     =      0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
FML PINHOLE DENSITY           =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS      =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD


                          LAYER 13
                          --------

                  TYPE 3 - BARRIER SOIL LINER
                  MATERIAL TEXTURE NUMBER  17
THICKNESS                     =      0.25   INCHES
POROSITY                      =      0.7500 VOL/VOL
FIELD CAPACITY                =      0.7470 VOL/VOL
WILTING POINT                 =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.3000E-08 CM/SEC


                          LAYER 14
                          --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  16
THICKNESS                     =     18.00   INCHES
POROSITY                      =      0.4270 VOL/VOL
FIELD CAPACITY                =      0.4180 VOL/VOL
WILTING POINT                 =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.4180 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-06 CM/SEC


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

                 GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                       VALID FOR   5 YEARS


         NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                  SOIL DATA BASE USING SOIL TEXTURE # 9 WITH BARE
                  GROUND CONDITIONS, A SURFACE SLOPE OF  2.% AND
                  A SLOPE LENGTH OF 1000. FEET.

        SCS RUNOFF CURVE NUMBER              =     91.21
        FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
        EVAPORATIVE ZONE DEPTH               =     18.0    INCHES
```

```
INITIAL WATER IN EVAPORATIVE ZONE   =      5.580  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      9.738  INCHES
FIELD CAPACITY OF EVAPORATIVE ZONE  =      3.366  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.846  INCHES
SOIL EVAPORATION ZONE DEPTH         =     18.000  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL INTERCEPTION WATER          =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =     82.114  INCHES
TOTAL INITIAL WATER                 =     82.114  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR
```

```
******************************************************************************

                        EVAPOTRANSPIRATION DATA   1
------------------------------------------------------------------------------

                            VALID FOR   5 YEARS


          NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                   RALEIGH             NORTH CAROLINA
              STATION LATITUDE                         =  35.87 DEGREES
              MAXIMUM LEAF AREA INDEX                  =   4.50
              START OF GROWING SEASON (JULIAN DATE)    =     86
              END OF GROWING SEASON (JULIAN DATE)      =    310
              EVAPORATIVE ZONE DEPTH                   =  18.0  INCHES
              AVERAGE ANNUAL WIND SPEED                =   7.70 MPH
              AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  66.0  %
              AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  70.0  %
              AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  78.0  %
              AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  72.0  %

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                   FINAL WATER STORAGE AT END OF YEAR    5
------------------------------------------------------------------------------
```

LAYER	(INCHES)	(VOL/VOL)
1	7.0193	0.2925
2	6.3803	0.2658
3	4.8629	0.2026
4	5.4737	0.2281
5	5.6427	0.2351
6	5.7991	0.2416
7	5.9906	0.2496

8	6.1845	0.2577
9	6.2898	0.2621
10	6.3880	0.2662
11	0.0274	0.1070
12	0.0000	0.0000
13	0.1875	0.7500
14	7.5240	0.4180

TOTAL WATER IN LAYERS	67.770
SNOW WATER	0.000
INTERCEPTION WATER	0.000
TOTAL FINAL WATER	67.770

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.28	22796.400
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 11	0.20818	755.70551
PERCOLATION/LEAKAGE THROUGH LAYER 13	0.000000	0.00013
AVERAGE HEAD ON TOP OF LAYER 12	0.180	
MAXIMUM HEAD ON TOP OF LAYER 12	0.357	
LOCATION OF MAXIMUM HEAD IN LAYER 11 (DISTANCE FROM DRAIN)	6.8 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 14	0.000000	0.00013
SNOW WATER	1.67	6061.1177
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.5112	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0470	

*** 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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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.26	2.82	4.37	2.63	3.53	5.42
	4.57	6.47	2.81	3.77	2.52	2.90
STD. DEVIATIONS	2.96	0.95	1.30	1.89	2.64	1.99
	2.29	6.38	1.69	2.69	1.66	1.28
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	1.892	2.205	3.293	4.787	6.327	6.770
	7.049	5.890	4.466	3.365	2.345	1.543
STD. DEVIATIONS	0.140	0.177	0.179	0.403	0.445	0.263
	0.410	0.413	0.352	0.062	0.182	0.125
ACTUAL EVAPOTRANSPIRATION						
TOTALS	1.193	1.541	2.190	3.180	4.706	4.073
	4.978	3.914	2.729	1.267	0.914	0.791
STD. DEVIATIONS	0.095	0.154	0.276	0.684	1.211	1.405
	1.282	1.455	1.165	0.187	0.268	0.186
LATERAL DRAINAGE COLLECTED FROM LAYER 11						
TOTALS	1.5868	1.3126	1.4316	1.3161	1.6209	1.4440
	1.2174	1.0987	1.0178	1.4159	1.6002	1.4077
STD. DEVIATIONS	0.9632	0.9105	1.0646	0.9410	1.1035	1.1316
	0.7112	0.6882	0.4925	1.0880	1.5254	0.8678
LATERAL DRAINAGE RECIRCULATED FROM LAYER 11 INTO L. 1						
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

PERCOLATION/LEAKAGE THROUGH LAYER 13
------------------------------------
  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

PERCOLATION/LEAKAGE THROUGH LAYER 14
------------------------------------
  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 12
-------------------------------------
  AVERAGES               0.0442   0.0402   0.0399   0.0379   0.0452   0.0416
                         0.0339   0.0306   0.0293   0.0395   0.0461   0.0392

  STD. DEVIATIONS        0.0268   0.0280   0.0297   0.0271   0.0308   0.0326
                         0.0198   0.0192   0.0142   0.0303   0.0439   0.0242

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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------

                                   INCHES           CU. FEET       PERCENT
                              -------------------  -------------  ---------
 PRECIPITATION                 45.08    (  10.212)     163625.9    100.00

 RUNOFF                         0.000   (  0.0000)         0.00      0.000

 POTENTIAL EVAPOTRANSPIRATION  49.932   (  0.3704)     181254.19

 ACTUAL EVAPOTRANSPIRATION     31.475   (  1.0157)     114254.23    69.827

 LATERAL DRAINAGE COLLECTED    16.46985 (  8.58991)     59785.562   36.53797
   FROM LAYER 11

 DRAINAGE RECIRCULATED          0.00000 (  0.00000)         0.000    0.00000
   FROM LAYER 11 INTO L.  1
```

PERCOLATION/LEAKAGE THROUGH LAYER 13	0.00000 (	0.00000)	0.015	0.00001
AVERAGE HEAD ON TOP OF LAYER 12	0.039 (	0.020)		
PERCOLATION/LEAKAGE THROUGH LAYER 14	0.00000 (	0.00000)	0.015	0.00001
CHANGE IN WATER STORAGE	-2.869 (	8.7784)	-10413.91	-6.364

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**                                                                        **
**                                                                        **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE             **
**                                                                        **
**              HELP Version 3.95 D          (10 August 2012)             **
**                               developed at                             **
**        Institute of Soil Science, University of Hamburg, Germany       **
**                                 based on                               **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)             **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                 **
**                    USAE WATERWAYS EXPERIMENT STATION                   **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
**                                                                        **
**                                                                        **
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 TIME:   6.00     DATE:   7.03.2015


 PRECIPITATION DATA FILE:      C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\SF Charah Sanford 25 yr storm y3m8d16.d4
 TEMPERATURE DATA FILE:        C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Charah Sanford.d7
 SOLAR RADIATION DATA FILE:    C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Charah Sanford.d13
 EVAPOTRANSPIRATION DATA F. 1: C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Charah Sanford.d11
 SOIL AND DESIGN DATA FILE  1: C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Actual Runs\SF Charh Colon-second lift.d10
 OUTPUT DATA FILE:             C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Actual Runs\Scenario 3 (old 2) Actual.out


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      TITLE:  Charah Colon - Two 20-foot Lifts

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                          WEATHER DATA SOURCES
----------------------------------------------------------------------------



         NOTE:  PRECIPITATION DATA FOR     RALEIGH             NORTH CAROLINA
                  WAS ENTERED BY THE USER.



         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    RALEIGH             NORTH CAROLINA

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)
```

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
39.60	41.60	49.30	59.50	67.20	73.90
77.70	77.00	71.00	59.70	50.00	42.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.87 DEGREES

****

LAYER DATA 1

VALID FOR 5 YEARS

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                    =    240.00   INCHES
POROSITY                     =      0.5410 VOL/VOL
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                    =    240.00   INCHES
POROSITY                     =      0.5410 VOL/VOL
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                    =      0.26   INCHES
```

```
POROSITY                    =     0.8500 VOL/VOL
FIELD CAPACITY              =     0.0100 VOL/VOL
WILTING POINT               =     0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.0100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      9.700     CM/SEC
SLOPE                       =     2.00   PERCENT
DRAINAGE LENGTH             =   950.0    FEET


                        LAYER  4
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =     0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=     0.2000E-12 CM/SEC
FML PINHOLE DENSITY         =     1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =     1.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  5
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =     0.25   INCHES
POROSITY                    =     0.7500 VOL/VOL
FIELD CAPACITY              =     0.7470 VOL/VOL
WILTING POINT               =     0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.7500 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=     0.3000E-08 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  16
THICKNESS                   =    18.00   INCHES
POROSITY                    =     0.4270 VOL/VOL
FIELD CAPACITY              =     0.4180 VOL/VOL
WILTING POINT               =     0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.4180 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=     0.1000E-06 CM/SEC
```

```
******************************************************************************

                GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                          VALID FOR   5 YEARS


        NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
```

```
            SOIL DATA BASE USING SOIL TEXTURE # 9 WITH BARE
            GROUND CONDITIONS, A SURFACE SLOPE OF  2.% AND
            A SLOPE LENGTH OF 1000. FEET.

        SCS RUNOFF CURVE NUMBER              =     91.21
        FRACTION OF AREA ALLOWING RUNOFF     =      0.0   PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
        EVAPORATIVE ZONE DEPTH               =     18.0   INCHES
        INITIAL WATER IN EVAPORATIVE ZONE   =      5.580  INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE  =      9.738  INCHES
        FIELD CAPACITY OF EVAPORATIVE ZONE  =      3.366  INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.846  INCHES
        SOIL EVAPORATION ZONE DEPTH          =     18.000  INCHES
        INITIAL SNOW WATER                   =      0.000  INCHES
        INITIAL INTERCEPTION WATER           =      0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS    =    156.514  INCHES
        TOTAL INITIAL WATER                  =    156.514  INCHES
        TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR


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

                        EVAPOTRANSPIRATION DATA   1
------------------------------------------------------------------------------

                            VALID FOR   5 YEARS


         NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                RALEIGH             NORTH CAROLINA
             STATION LATITUDE                          =  35.87 DEGREES
             MAXIMUM LEAF AREA INDEX                   =   4.50
             START OF GROWING SEASON (JULIAN DATE)    =     86
             END OF GROWING SEASON (JULIAN DATE)      =    310
             EVAPORATIVE ZONE DEPTH                    =  18.0  INCHES
             AVERAGE ANNUAL WIND SPEED                 =   7.70 MPH
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  66.0  %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  70.0  %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  78.0  %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  72.0  %

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                   FINAL WATER STORAGE AT END OF YEAR    5
------------------------------------------------------------------------------

                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1           58.8688         0.2453

                      2           62.4563         0.2602

                      3            0.0277         0.1081
```

4	0.0000	0.0000
5	0.1875	0.7500
6	7.5240	0.4180

TOTAL WATER IN LAYERS	129.064
SNOW WATER	0.000
INTERCEPTION WATER	0.000
TOTAL FINAL WATER	129.064

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.28	22796.400
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 3	0.18561	673.77380
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00012
AVERAGE HEAD ON TOP OF LAYER 4	0.160	
MAXIMUM HEAD ON TOP OF LAYER 4	0.317	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	11.4 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00012
SNOW WATER	1.67	6061.1177
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.5112	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0470	

*** 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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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.26	2.82	4.37	2.63	3.53	5.42
	4.57	6.47	2.81	3.77	2.52	2.90
STD. DEVIATIONS	2.96	0.95	1.30	1.89	2.64	1.99
	2.29	6.38	1.69	2.69	1.66	1.28
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	1.892	2.205	3.293	4.787	6.327	6.770
	7.049	5.890	4.466	3.365	2.345	1.543
STD. DEVIATIONS	0.140	0.177	0.179	0.403	0.445	0.263
	0.410	0.413	0.352	0.062	0.182	0.125
ACTUAL EVAPOTRANSPIRATION						
TOTALS	1.193	1.541	2.190	3.180	4.706	4.073
	4.978	3.914	2.729	1.267	0.914	0.791
STD. DEVIATIONS	0.095	0.154	0.276	0.684	1.211	1.405
	1.282	1.455	1.165	0.187	0.268	0.186
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	1.9890	1.6404	2.2497	1.5015	1.3223	1.2119
	1.6952	1.4709	1.5327	1.1494	1.5154	1.8126
STD. DEVIATIONS	0.6801	0.6694	1.2875	1.0303	1.0225	1.0078
	0.7345	1.0940	1.1075	0.8121	0.7054	0.9298
LATERAL DRAINAGE RECIRCULATED FROM LAYER 3 INTO L. 1						
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
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

PERCOLATION/LEAKAGE THROUGH LAYER 6

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	0.0554	0.0502	0.0627	0.0432	0.0369	0.0349
	0.0473	0.0410	0.0441	0.0320	0.0437	0.0505
STD. DEVIATIONS	0.0190	0.0203	0.0359	0.0297	0.0285	0.0290
	0.0205	0.0305	0.0319	0.0226	0.0203	0.0259

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	45.08	(10.212)	163625.9	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
POTENTIAL EVAPOTRANSPIRATION	49.932	(0.3704)	181254.19	
ACTUAL EVAPOTRANSPIRATION	31.475	(1.0157)	114254.23	69.827
LATERAL DRAINAGE COLLECTED FROM LAYER 3	19.09096	(8.58853)	69300.180	42.35283
DRAINAGE RECIRCULATED FROM LAYER 3 INTO L. 1	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.015	0.00001
AVERAGE HEAD ON TOP OF LAYER 4	0.045	(0.020)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.015	0.00001

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 CHANGE IN WATER STORAGE         -5.490   ( 15.0323)     -19928.54    -12.179

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D          (10 August 2012)               **
**                               developed at                               **
**        Institute of Soil Science, University of Hamburg, Germany         **
**                                 based on                                 **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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******************************************************************************


 TIME:   6.12     DATE:   7.03.2015


 PRECIPITATION DATA FILE:      C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\SF Charah Sanford 25 yr storm y3m8d16.d4
 TEMPERATURE DATA FILE:        C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Charah Sanford.d7
 SOLAR RADIATION DATA FILE:    C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Charah Sanford.d13
 EVAPOTRANSPIRATION DATA F. 1: C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Charah Sanford.d11
 SOIL AND DESIGN DATA FILE  1: C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Actual Runs\SF Charah Colon-third lift.d10
 OUTPUT DATA FILE:             C:\Users\sfutrell\Desktop\Sanford Reruns\After 4
Reruns\Actual Runs\Scenario 4 (old 3) Actual.out


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      TITLE:  Charah Colon- Three 20-ft Lifts

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                           WEATHER DATA SOURCES
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         NOTE:  PRECIPITATION DATA FOR     RALEIGH             NORTH CAROLINA
                  WAS ENTERED BY THE USER.



         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    RALEIGH             NORTH CAROLINA

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)
```

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
39.60	41.60	49.30	59.50	67.20	73.90
77.70	77.00	71.00	59.70	50.00	42.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.87 DEGREES

****

LAYER DATA 1

VALID FOR 5 YEARS

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	240.00 INCHES
POROSITY	=	0.5410 VOL/VOL
FIELD CAPACITY	=	0.1870 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1600E-03 CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	240.00 INCHES
POROSITY	=	0.5410 VOL/VOL
FIELD CAPACITY	=	0.1870 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1600E-03 CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	240.00 INCHES

```
POROSITY                     =      0.5410 VOL/VOL
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1600E-03 CM/SEC


                        LAYER  4
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =      0.26   INCHES
POROSITY                     =      0.8500 VOL/VOL
FIELD CAPACITY               =      0.0100 VOL/VOL
WILTING POINT                =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       9.700     CM/SEC
SLOPE                        =      2.00   PERCENT
DRAINAGE LENGTH              =    950.0    FEET


                        LAYER  5
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                        LAYER  6
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                    =      0.25   INCHES
POROSITY                     =      0.7500 VOL/VOL
FIELD CAPACITY               =      0.7470 VOL/VOL
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.3000E-08 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  16
THICKNESS                    =     18.00   INCHES
POROSITY                     =      0.4270 VOL/VOL
FIELD CAPACITY               =      0.4180 VOL/VOL
WILTING POINT                =      0.3670 VOL/VOL
```

```
          INITIAL SOIL WATER CONTENT  =      0.4180 VOL/VOL
          EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-06 CM/SEC


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

                GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                            VALID FOR   5 YEARS


        NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                 SOIL DATA BASE USING SOIL TEXTURE # 9 WITH BARE
                 GROUND CONDITIONS, A SURFACE SLOPE OF  2.% AND
                 A SLOPE LENGTH OF 1000. FEET.

       SCS RUNOFF CURVE NUMBER              =     91.21
       FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
       AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
       EVAPORATIVE ZONE DEPTH               =     18.0    INCHES
       INITIAL WATER IN EVAPORATIVE ZONE    =      5.580  INCHES
       UPPER LIMIT OF EVAPORATIVE STORAGE   =      9.738  INCHES
       FIELD CAPACITY OF EVAPORATIVE ZONE   =      3.366  INCHES
       LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.846  INCHES
       SOIL EVAPORATION ZONE DEPTH          =     18.000  INCHES
       INITIAL SNOW WATER                   =      0.000  INCHES
       INITIAL INTERCEPTION WATER           =      0.000  INCHES
       INITIAL WATER IN LAYER MATERIALS     =    230.914  INCHES
       TOTAL INITIAL WATER                  =    230.914  INCHES
       TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR


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

                       EVAPOTRANSPIRATION DATA   1
------------------------------------------------------------------------------

                           VALID FOR   5 YEARS


        NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                 RALEIGH             NORTH CAROLINA
            STATION LATITUDE                        =  35.87 DEGREES
            MAXIMUM LEAF AREA INDEX                 =   4.50
            START OF GROWING SEASON (JULIAN DATE)   =     86
            END OF GROWING SEASON (JULIAN DATE)     =    310
            EVAPORATIVE ZONE DEPTH                  =  18.0  INCHES
            AVERAGE ANNUAL WIND SPEED               =   7.70 MPH
            AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  66.0  %
            AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  70.0  %
            AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  78.0  %
            AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  72.0  %

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	58.8688	0.2453
2	62.4563	0.2602
3	62.2274	0.2593
4	0.0191	0.0744
5	0.0000	0.0000
6	0.1875	0.7500
7	7.5240	0.4180
TOTAL WATER IN LAYERS	191.283	
SNOW WATER	0.000	
INTERCEPTION WATER	0.000	
TOTAL FINAL WATER	191.283	

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.28	22796.400
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.15094	547.92310
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00010
AVERAGE HEAD ON TOP OF LAYER 5	0.130	
MAXIMUM HEAD ON TOP OF LAYER 5	0.259	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000000	0.00010
SNOW WATER	1.67	6061.1177

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5112

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0470

*** 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.

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.26	2.82	4.37	2.63	3.53	5.42
	4.57	6.47	2.81	3.77	2.52	2.90
STD. DEVIATIONS	2.96	0.95	1.30	1.89	2.64	1.99
	2.29	6.38	1.69	2.69	1.66	1.28
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	1.892	2.205	3.293	4.787	6.327	6.770
	7.049	5.890	4.466	3.365	2.345	1.543
STD. DEVIATIONS	0.140	0.177	0.179	0.403	0.445	0.263
	0.410	0.413	0.352	0.062	0.182	0.125
ACTUAL EVAPOTRANSPIRATION						
TOTALS	1.193	1.541	2.190	3.180	4.706	4.073
	4.978	3.914	2.729	1.267	0.914	0.791
STD. DEVIATIONS	0.095	0.154	0.276	0.684	1.211	1.405
	1.282	1.455	1.165	0.187	0.268	0.186
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	1.7299	1.8268	1.7892	2.0809	2.3858	2.0359

```
                         1.8881   1.6389   1.5860   1.5715   1.7124   1.2820

  STD. DEVIATIONS        1.0674   0.9114   0.4574   0.8264   0.9691   0.7580
                         0.8076   0.9788   0.9477   0.9047   0.7171   0.9394

 LATERAL DRAINAGE RECIRCULATED FROM LAYER  4 INTO L.  1
 ------------------------------------------------------
  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

 PERCOLATION/LEAKAGE THROUGH LAYER  6
 ------------------------------------
  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

 PERCOLATION/LEAKAGE THROUGH LAYER  7
 ------------------------------------
  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  5
 -------------------------------------
  AVERAGES               0.0482   0.0560   0.0499   0.0599   0.0665   0.0586
                         0.0526   0.0457   0.0457   0.0438   0.0493   0.0357

  STD. DEVIATIONS        0.0298   0.0281   0.0128   0.0238   0.0270   0.0218
                         0.0225   0.0273   0.0273   0.0252   0.0207   0.0262

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



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

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------

                                 INCHES            CU. FEET       PERCENT
                           -------------------   -------------   ---------
PRECIPITATION               45.08    (  10.212)     163625.9     100.00

RUNOFF                       0.000   (  0.0000)          0.00      0.000

POTENTIAL EVAPOTRANSPIRATION  49.932   (  0.3704)     181254.19
```

ACTUAL EVAPOTRANSPIRATION	31.475	(1.0157)	114254.23	69.827
LATERAL DRAINAGE COLLECTED FROM LAYER 4	21.52720	(9.29538)	78143.742	47.75758
DRAINAGE RECIRCULATED FROM LAYER 4 INTO L. 1	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.016	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.051	(0.022)		
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.00000	(0.00000)	0.016	0.00001
CHANGE IN WATER STORAGE	-7.926	(18.5106)	-28772.12	-17.584

****
****

Computed: M. Plummer	Date: 3/6/2015
Checked : P. Westmoreland	Date: 3/8/2015

Determination of Leachate Collection Pipe Capacity

Subject: Leachate Collection Pipe Flow Capacity for Colon Mine Site

Scope

Evaluate the maximum flow capacity of the leachate collection lines.

References

1. Merritt, F.S., Standard Handbook for Civil Engineers, 3rd Ed., McGraw-Hill, New York, 1983.
2. CP Chem Performance Pipe "Municipal & Industrial Series/IPS Pipe Data," May 2001.

Basis

- The leachate collection pipes are proposed to consist of 8-inch diameter SDR-11 HDPE pipes. The 8-inch pipes have a nominal outer diameter (OD) equal to 8.625-inches and an average inner diameter (ID) equal to 6.963-inches. The pipes must have adequate flow capacity to transport the leachate to the sumps. The flow capacity should be compared to the maximum amount of leachate expected to be generated.
- Expected leachate flow rates were determined by using the Hydrologic Evaluation of Landfill Performance (HELP) program and a 25-year, 24-hour design storm.

Results

Leachate collection and conveyance system should be designed based on 8-inch diameter SDR 11 HDPE pipe.

Analysis

LEACHATE COLLECTION PIPE DESIGN BASED ON PEAK LEACHATE GENERATION RATE

The leachate collection pipe system capacity analysis is based upon the cell layout and leachate collection pipe layout shown on the top of liner sheets. The leachate generation rate used to size the leachate collection pipes was based on a HELP run consisting of 5 - 2 ft coal combustion product (CCP) layers. The following parameters were also entered into the HELP model.

- No recirculation.
- Open cell conditions.
- The initial moisture content at 31%.
- Drainage length was determined at varying floor slopes from 0.5 to 3%. The leachate collection system has been designed to meet this requirement.

The results of the HELP run predict that the peak daily drainage discharging from CCP is 1,822 cf/acre (9.46 gpm per acre). The largest area draining to a leachate collection pipe is 29.4 acres. Using a maximum generation rate of 9.46 gpm per acre and an area of 29.4 acres, the total flow rate to a collection pipe is 278.1 gpm.

$$\mathbf{Q_{peak\ day\ avg} = 278.1\ gpm}$$

The following analysis illustrates the capacity of the 8-inch leachate collection lines in relationship to slope.

Manning's coefficient for HDPE pipe (n) is 0.009

The spreadsheet below calculates flow capacity in gpm based on Manning's Equation for HDPE pipes.

$$Qp = (1.49/n)\, A(R_H^{2/3})S^{0.5}$$

where: Qp = pipe capacity (gpm)
n = Manning's roughness coefficient
R_H = hydraulic radius
A = pipe cross-sectional area
S = slope of the pipe

Full Pipe Flow at Varying Slope
Manning's Formula
$Q=1.49/n*Rh^{2/3}*A*s^{1/2}$

	6-inch SDR 11	6-inch SDR 11	8-inch SDR 11	8-inch SDR 11	10-inch SDR 11	10-inch SDR 11	12-inch SDR 11	12-inch SDR 11	
I.D. (in.)	5.349	5.349	6.963	6.963	8.679	8.679	10.293	10.293	
Slope (ft/ft)	Qp (gpm)	Vp (fps)	Qp (gpm)	Vp (fps)	Qp (gpm)	Vp (fps)	Qp (gpm)	Vp (fps)	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	n = 0.009 for HDPE Pipe
0.005	189.9	2.7	383.6	3.2	690.2	3.7	1087.7	4.2	
0.01	268.5	3.8	542.4	4.6	976.1	5.3	1538.2	5.9	Rh/D = 0.25 for full flow
0.015	328.9	4.7	664.4	5.6	1195.4	6.5	1883.9	7.3	
0.02	379.7	5.4	767.1	6.5	1380.4	7.5	2175.3	8.4	

As shown in the above table, an HDPE SDR-11, 8-inch pipe with an average inner diameter equal to 6.963-inch at a minimum slope of 0.5% has a capacity of 383 gpm. Therefore, an 8-inch pipe can accommodate the maximum leachate generation rate from the 29.4 acre maximum drainage area at the Colon Mine Site.

ANALYSIS BASED ON LEACHATE/STORMWATER COLLECTION:

For initial stormwater/leachate drainage, assuming 6.28 inch depth in 24-hr 25-year storm event for Raleigh, NC, approximately 22,796 cf/ac/day of stormwater is collected. Total volume of stormwater/leachate collected within the largest (5.9 acre) subcell is 134,495 cf.

An 8-inch diameter pipe with 0.5% slope can convey 383 gpm. Considering a FS of 1.5 (meaning that the pipe is partially occluded), the pipe capacity is 255.3 gpm. Accordingly, a 136,778 cf (1,023,099 gallons) of storage volume will be emptied in approximately 67 hours assuming no other rain events during that period.

ANALYSIS FOR SOLID WALL LEACHATE CONVEYANCE PIPE:

The header is designed based on the leachate generated from largest drainage area. The largest area draining to a header pipe is approximately 29.4 acres. At 1,822 cf/day generation rate, the header is sufficient to handle the required flow.

Project	Charah Colon Mine	Computed	MDP	Date	3/6/2015
Subject	Leachate Collection Pipes	Checked	PAW	Date	3/8/2015
Task	Leachate Pipe Sizing	Sheet	1	Of	2

Objective: Determine the time to drain under several design conditions.

Equations:

Pipe capacity (Q) = $(D/16)^{8/3}/n*\sqrt{s}$ Mannings Equation

$Q = C_d * A * (2 * g * h)^{0.5}$ Orifice Equation

Inside pipe diameter (D) = $16(Qn/\sqrt{s})^{3/8}$

Inside pipe diameter (D) = $D_{outside} - 2*D_{outside}/SDR$

Std Dimension Ratio (SDR) = $D_{outside}$/wall thickness

Amount Drained = Allowable Flow/FS

Allowable Flow = Minimum of gravity flow and orifice flow under head.

Q = cfs, discharge

C_d = 0.6 coefficient of discharge

A = sf, cross sectional area

g = 32.2 ft/sec^2, gravity

h = ft, driving head (above center of the pipe)

Assumptions:

Use HDPE pipe w/ SDR = 11

Manning roughness coefficient, n = 0.009 HDPE

Pipe Size Min Factor of Safety = 1.5

Allowable design head on pipe = 6 feet

7.48052 gallons/cf

86,400 sec/day

Design Event 1: Peak HELP Model flowrate

Peak Leachate flow (cf/acre/day)= 1822 HELP Model analysis of Cell with 10' of fill at 3%

Largest cell, for leachate collection 29.4 acres

Peak Leachate flow 53,567 cf

Design Event 2: 25 yr storm in an open subcell

Design Storm (inches/day) = 6.28 **25 yr 24 hr**

Largest subcell for SW drainage 5.9 acres

Design Storm event 134,499 cf Governing event

Amount Drained (cf/day)	Pipe Outside Diameter (inches)						
Pipe Slope	6.625	8.625	10.75	12.75	13.375	14	16
0.10%	11,288	22,811	41,041	64,687	73,492	83,011	118,517
0.20%	15,964	32,260	58,040	91,482	103,934	117,395	167,608
0.30%	19,552	39,510	71,085	112,042	127,293	143,779	205,277
0.40%	22,576	45,623	82,082	129,375	146,985	166,021	237,033
0.50%	25,241	51,008	91,770	144,646	164,334	185,618	265,011
0.60%	27,650	55,876	100,529	158,451	180,019	203,334	290,305
0.70%	29,866	60,353	108,584	171,147	194,443	219,626	313,566
0.80%	31,928	64,520	116,081	182,964	207,868	234,790	335,216
0.90%	33,864	68,434	123,122	194,062	220,477	249,032	355,550
1.00%	35,696	72,136	129,782	204,560	232,404	262,503	374,783
1.20%	39,103	79,021	142,169	224,084	254,585	287,558	410,554
1.40%	42,236	85,352	153,560	242,038	274,984	310,598	443,449
1.80%	47,891	96,780	174,121	274,446	311,802	352,185	502,824
2.00%	50,482	102,015	183,540	289,291	328,668	371,235	530,023
2.25%	53,544	108,204	194,673	306,840	348,606	393,755	562,174
2.50%	56,441	114,057	205,204	323,437	367,462	415,054	592,583
2.75%	59,195	119,624	215,220	339,224	385,398	435,312	598,664
3.00%	61,828	124,943	224,790	354,308	402,535	454,669	598,664
3.50%	66,781	134,954	242,800	382,696	422,609	461,919	598,664
4.00%	71,392	144,271	259,565	384,953	422,609	461,919	598,664
5.00%	79,819	161,300	275,733	384,953	422,609	461,919	598,664
6.00%	87,437	176,696	275,733	384,953	422,609	461,919	598,664
8.00%	100,964	178,906	275,733	384,953	422,609	461,919	598,664

Project	Charah Colon Mine	Computed	MDP	Date	3/6/2015
Subject	Leachate Collection Pipes	Checked	PAW	Date	3/8/2015
Task	Leachate Pipe Sizing	Sheet	2	Of	2

Pipe X-Section (sf)	0.2	0.3	0.4	0.6	0.7	0.7	0.9
	Pipe Outside Diameter (inches)						
Allowable Flow in pipe Q (cfs)	6.625	8.625	10.75	12.75	13.375	14	16
Pipe Slope 0.10%	0.2	0.4	0.7	1.1	1.3	1.4	2.1
0.20%	0.3	0.6	1.0	1.6	1.8	2.0	2.9
0.30%	0.3	0.7	1.2	1.9	2.2	2.5	3.6
0.40%	0.4	0.8	1.4	2.2	2.6	2.9	4.1
0.50%	0.4	0.9	1.6	2.5	2.9	3.2	4.6
0.60%	0.5	1.0	1.7	2.8	3.1	3.5	5.0
0.70%	0.5	1.0	1.9	3.0	3.4	3.8	5.4
0.80%	0.6	1.1	2.0	3.2	3.6	4.1	5.8
0.90%	0.6	1.2	2.1	3.4	3.8	4.3	6.2
1.00%	0.6	1.3	2.3	3.6	4.0	4.6	6.5
1.20%	0.7	1.4	2.5	3.9	4.4	5.0	7.1
1.40%	0.7	1.5	2.7	4.2	4.8	5.4	7.7
1.80%	0.8	1.7	3.0	4.8	5.4	6.1	8.7
2.00%	0.9	1.8	3.2	5.0	5.7	6.4	9.2
2.25%	0.9	1.9	3.4	5.3	6.1	6.8	9.8
2.50%	1.0	2.0	3.6	5.6	6.4	7.2	10.3
2.75%	1.0	2.1	3.7	5.9	6.7	7.6	10.4
3.00%	1.1	2.2	3.9	6.2	7.0	7.9	10.4
3.50%	1.2	2.3	4.2	6.6	7.3	8.0	10.4
4.00%	1.2	2.5	4.5	6.7	7.3	8.0	10.4
5.00%	1.4	2.8	4.8	6.7	7.3	8.0	10.4
6.00%	1.5	3.1	4.8	6.7	7.3	8.0	10.4
8.00%	1.8	3.1	4.8	6.7	7.3	8.0	10.4

Conclusions:

Design storm generates greater amount of liquid to handle than is expected from the peak leachate production.
As the prefered minimum pipe size is 8" and the minimum pipe slope for the site is 0.5%

An 8 inch pipe with 0.5% slope can drain:

Design 1: The peak leachate flow volume will drain in 25.2 hours

Design 2: storm event volume will drain in 63.3 hours

HDR Computation

Job Number	453925-235691-018	No.	

Project	Charah Colon Mine	**Computed**	MDP	**Date**	3/6/2015
Subject	Permit Application	**Checked**	PAW	**Date**	3/6/2015
Task	Leachate Pipe Sizing	**Sheet**	1	**Of**	1

Objective:

Determine the required leachate collection pipe size based on drainage areas for each cell.

References:

1. "Waste Containment Systems, Waste Stabilization, and Landfills; Design and Evaluation"; Hari Sharma and Sangeeta
2. "Elements of Urban Stormwater Design"; H. Rooney Malcom; p. I-10

Calculations:

$$D_{REQD} = 16\left[\frac{Qn}{\sqrt{s}}\right]^{\frac{3}{8}}$$ (Ref. 2)

Volume (ft^3) = Peak Daily Volume (ft^3/acre) x Area (acre)
Peak Daily Volume is from the HELP Model runs
Q = Volume/time (convert to ft^3/sec)

Where:

D_{REQD} = theoretical pipe diamter (in.) for just-full flow
n = Manning roughness coefficient (dimensionless)
s = longitudinal slope (ft/ft)
Q = Required flow volume to drain in 24 hrs. (cfs)

Inputs:

Peak Daily Volume* = 1822 ft^3/Ac leachate collected in 24 hours
n = 0.009 Ref. 1, Table 9.3, p. 472 (HDPE)
* Peak Daily Volume from HELP model run for 10' ash with geocomposite as lateral drainage feature.

12 in/foot
43,560 square feet/acre
24 hours/day
60 min/hour
60 sec/min

Outputs:

Pipe Use	Area (AC)**	Volume (ft^3)	Q (ft^3/sec)***	Minimum Slope	D_{REQD} (in)	**D_{ACT} (in)**	Check
Cell 1 Header	22.4	40,813	0.472	0.5%	5.6	**8**	ok
Cell 2 Header	15.3	27,877	0.323	0.5%	4.8	**8**	ok
Cell 3 Header	19.3	35,165	0.407	1.0%	4.6	**8**	ok
Cell 4 Header	31.9	58,122	0.673	0.5%	6.4	**8**	ok
Cell 5 Header	29.4	53,567	0.620	0.5%	6.2	**8**	ok

** Denotes maximum drainage area for all laterals.
*** Assumes the entire area will be drained in a 24 hour period

Conclusion: 8-inch pipe has adequate capacity at the design pipe slopes for the peak flow predicted by the HELP Model.

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HDR Computation

Job Number 453925-235691-018

Project:	Charah Colon Mine	Computed:	MDP	Date:	3/6/2015
Subject:	Permit Application	Checked	PAW	Date:	3/8/2015
Task:	Leachate Pipe Perforations	Sheet	1	Of	1

Objective Determine the perforations in the collection pipes
Ensure that pipe perforations are sufficent for pipe flows

Equations

$Q = C_d * A (2 * g * h)^{0.5}$ Orifice Equation

Cd = 0.6 Typical Default value
g = 32.2 ft/sec^2, gravity
A = sf, cross sectional area of pipe
h = ft, driving head

7.84052 gals/cf
60 sec/min
86400 sec/day

HELP Model Avg Annual Lateral Drainage Collected	78,144.0	cf/yr/ac	0.002	cfs/acre
HELP Model Peak Daily Lateral Drainage Collected	1,822.0	cf/day/ac	0.021	cfs/acre

Calculations **Check Inlet Control of perforations for pipe under peak condition**

Basis	Area to Drain (Acres)	Q (cfs)	Pipe Diameter (in)	# of holes per ft of pipe	Hole Diameter (in)	Length (ft)	Inlet Cross Sectional Area (sf)	Required Head to fill pipe, h (in)	Depth of liquid @ pipe (in)
Entire Site	118.7	2.50	8	30	3/8	28	0.6	7.8	11.8
Largest Cell	29.4	0.62	8	30	3/8	7	0.2	7.7	11.7
Largest Subcell	6.0	0.13	8	30	3/8	2	0.0	3.9	7.9

Only 12 inch depth of liquid is required to fill the pipe at the design flow rate, assumming liquid is available

Conclusion There is adequate redundancy in pipe perforations to handle expected flows.

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HDR Computation

Job Number	453925-235691-018	No.	

Project:	Charah Colon Mine	**Computed**	MDP	**Date:**	3/6/2015
Subject:	Permit Application	**Checked**	PAW	**Date:**	3/8/2015
Task:	Leachate Pipe Orifice Sizing	**Sheet:**	1	**Of**	2

Objective: Determine if the leachate pipes and perforations are large enough to handle the peak daily leachate flow.

References:

1. Malcom, H. Rooney (1989). *Elements of Urban Stormwater Design* . Raleigh: NC State Univ.
2. Sharma, H. D., & Lewis, S. P. (1994). *Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation* . New York: John Wiley & Sons, Inc.

Calculations:

Eq. 1 $$Q = C_d A \sqrt{2gh}$$ Reference 1

Eq. 2 $$A = \pi \left(\frac{d}{2} \right)^2$$

Conversion factors

7.48	gal/cf
60	s/min
60	min/hr
24	hr/day
12	in/ft
43,560	sf/acre

Where:
- Q = Flow Rate (cfs)
- C_d = Coefficient of Discharge (dimensionless)
- A = Cross-sectional Area of Orifice (sf)
- g = gravity (ft/s^2)
- h = head (ft)
- d = diameter of opening (ft)

Given:

Select the Flow Rate per Acre based on HELP model runs

$Q_{peak\ daily}$ = 1822.00 cf/acre/day From HELP model run: 10' of ash

$Q_{peak\ daily}$ = 9.46 gal/acre/min

SDR	Pipe Size (inches)
11	8

Maximum Drainage distance = 950 feet

Area of Drainage per foot of pipe = 950 sf

Area of Drainage per foot of pipe = 0.022 ac

Required Drainage per foot of pipe = 0.206 gpm (actual flow rate per acre for the drainage area of the pipe)

Determine the maximum allowable flow in the pipe based on the perforations in the pipe and a maximum head

Diameter of perforation, $d_{perforation}$ = 0.375 in

$d_{perforation}$ = 0.03125 ft

$A_{perforation}$ = 0.00077 ft^2

Using Equation 1, determine the flow in the pipe

C_d = 0.6 typical default value (Ref. 1)

$A_{perforation}$ = 0.00077 ft^2

g = 32.2 ft/s^2

h = 8 in — The maximum head on the liner is 12 inches. The pipe is 8 inches in diameter.

h = 0.67 ft — The head was therefore assumed to be from the center of the pipe to 12 inches above the liner.

$Q_{perforation}$ = 0.003 cfs

$Q_{perforation}$ = 1.35 gpm per perforation

Number of Perforations per foot of pipe = 30 perforations per foot of pipe

$Q_{per\ foot\ of\ pipe}$ = 40.60 gpm

HDR Computation

Job Number	453925-235691-018	No.	

Project:	Charah Colon Mine	**Computed**	MDP	**Date:**	3/6/2015
Subject:	Permit Application	**Checked**	PAW	**Date:**	3/8/2015
Task:	Leachate Pipe Orifice Sizing	**Sheet:**	2	**Of**	2

Required Flow Rate		**Allowable Flow Rate**
gpm	**<**	**gpm**
0.206		**40.60**

Conclusion:
The allowable flow rate is greater than the required flow rate. Therefore the allowable flow rate based on pipe perforations will be sufficient to meet the actual expected flow rate.

Determine the maximum allowable flow in the pipe based on the pipe size and flowing full

Eq. 3 $$Q = \left(\frac{D}{16}\right)^{\frac{8}{3}} \frac{\sqrt{s}}{n}$$ Reference 1

Where:
Q = Flow Rate (cfs)
D = Theoretical Pipe Diameter (in) for just-full flow
n = Manning roughness coefficient (dimensionless)
s = Longitudinal slope (ft/ft)

D = 8 in
n = 0.009 Reference 2, page 472

Slope	Allowable Q (cfs)	Allowable Q (gpm)	Check
0.10%	0.55	248	Allowable Q is greater than Required Q
0.25%	0.87	393	Allowable Q is greater than Required Q
0.50%	1.24	555	Allowable Q is greater than Required Q
0.75%	1.52	680	Allowable Q is greater than Required Q
1.00%	1.75	785	Allowable Q is greater than Required Q
1.25%	1.96	878	Allowable Q is greater than Required Q
1.50%	2.14	962	Allowable Q is greater than Required Q
1.75%	2.31	1,039	Allowable Q is greater than Required Q
2.00%	2.47	1,111	Allowable Q is greater than Required Q
2.25%	2.62	1,178	Allowable Q is greater than Required Q
2.50%	2.77	1,242	Allowable Q is greater than Required Q
2.75%	2.90	1,302	Allowable Q is greater than Required Q
3.00%	3.03	1,360	Allowable Q is greater than Required Q
3.25%	3.15	1,416	Allowable Q is greater than Required Q
3.50%	3.27	1,469	Allowable Q is greater than Required Q
3.75%	3.39	1,521	Allowable Q is greater than Required Q

Conclusion:
The allowable flow rate is greater than the required flow rate for slopes 0.1% and above. Smaller pipe slopes were not run, but it is assumed that the bottom slope will not be smaller than 0.25% accounting for settlement. Therefore the allowable flow based on pipe size will be sufficient to meet the actual expected flow rate.

HDR Computation

Project	Charah Colon Mine	Computed	MDP	Date	3/6/2015		
Subject	Permit Application	Checked	PAW	Date	3/8/2015		
Task	Leachate Tank Sizing	Sheet	1	of	1		

Given: Determine Tank sizing options based on the required storage capacity
Tank sizes selected from attached chart for Aquastore Tanks.

Require:

0.5 feet of freeboard in tanks
110% Capacity of primary for secondary containment tank
Secondary tank must provide sufficient space to evaluate primary tank condition.

Evaluate the details of providing the original scenario and review viable alternatives.

Scenario	Primary Diameter (ft)	Primary Height (ft)	Number Primary Tanks	Primary Footprint (sf/tank)	Primary Sidewall Area (sf/tank)	Primary Capacity (gals/tank)	Secondary Capacity Required (Gals)	Secondary Diameter (ft)	Secondary Height (ft)	Secondary Tank Footprint (sf)	Secondary Sidewall Area (sf)	Secondary Capacity Provided (gals)	110% of Primary Tank Capacity?	Total Tank Sidewall Area (sf)	Total Operating Capacity (gals)	Est. Space around tanks
1	72.73	33.01	1	4,154	7542	1,010,336	1,111,370	103.5	23.84	8,413	7,752	1,468,937	Yes	15294	1,010,336	15.4
2	75.53	33.01	1	4,481	7833	1,089,626	1,198,589	103.5	23.84	8,413	7,752	1,468,937	Yes	15584	1,089,626	14.0
3	78.32	28.43	1	4,818	6995	1,006,556	1,107,212	103.5	23.84	8,413	7,752	1,468,937	Yes	14747	1,006,556	12.6
4	81.12	28.43	1	5,168	7245	1,079,813	1,187,794	103.5	23.84	8,413	7,752	1,468,937	Yes	14997	1,079,813	11.2
5	83.92	28.43	1	5,531	7495	1,155,643	1,271,207	103.5	23.84	8,413	7,752	1,468,937	Yes	15247	1,155,643	9.8
6	86.72	23.84	1	5,906	6495	1,031,243	1,134,367	103.5	23.84	8,413	7,752	1,468,937	Yes	14247	1,031,243	8.4
7	89.51	23.84	1	6,293	6704	1,098,666	1,208,532	103.5	23.84	8,413	7,752	1,468,937	Yes	14456	1,098,666	7.0
8	92.31	23.84	1	6,692	6914	1,168,477	1,285,324	160	10	20,106	5,027	1,428,845	Yes	11940	1,168,477	33.8
9	67.13	19.28	2	3,539	4066	497,222	546,944	150	10	17,671	4,712	1,004,298	Yes	12845	994,444	5.2
10	69.93	19.28	2	3,841	4236	539,566	593,522	150	10	17,671	4,712	982,878	Yes	13184	1,079,131	3.4
11	72.73	19.28	2	4,154	4405	583,639	642,003	150	10	17,671	4,712	960,583	Yes	13523	1,167,278	1.5
12	78.32	14.68	2	4,818	3612	511,026	562,129	175	10	24,053	5,498	1,366,946	Yes	12722	1,022,053	6.1

Calculate Tank Storage Capacity (amount of event that fits in tank assuming no other flows and empty tank at start)

Site	Event			Largest Subcell Area (acres)	Gallons Produced
Colon	Rainfall 25-year 24-hr storm	6.28	inches	5.9	1,006,051
Colon	Leachate Max Avg Annual generation	78144	cf/acre	5.9	584,517

Conclusion: Select primary and secondary tanks scenario to provide for approximate operating capacity of 1,000,000 gallons. Scenario 3 and 12 would meet the required operating capacity for the 25 year storm event. Cost anaylsis has not been included in these calculations.

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HDR Computation

Job Number	453925-235691-018	No.	

Project	Charah Colon Mine	Computed	MDP	Date	3/5/2015
Subject	Permit Application	Checked	PAW	Date	3/8/2015
Task	Subcell Divider Berms	Sheet	1	Of	1

Objective: Determine if the subcell berms are large enough to handle a 25-year, 24-hour storm event.

References:

1. NC Erosion and Sediment Control Planning and Design Manual.

Given:

6.28 in, 25-year, 24-hour precipitation event (Raleigh, NC) Ref 1

$$V_R = A \times \frac{43{,}560\, ft^2}{acre} \times p \times \frac{12 in}{ft}$$

$$V = \frac{1}{3} hA$$

Where:

V_R = Precipitation event volume (ft^3)
A = Area (acres)
p = precipitation event (in)

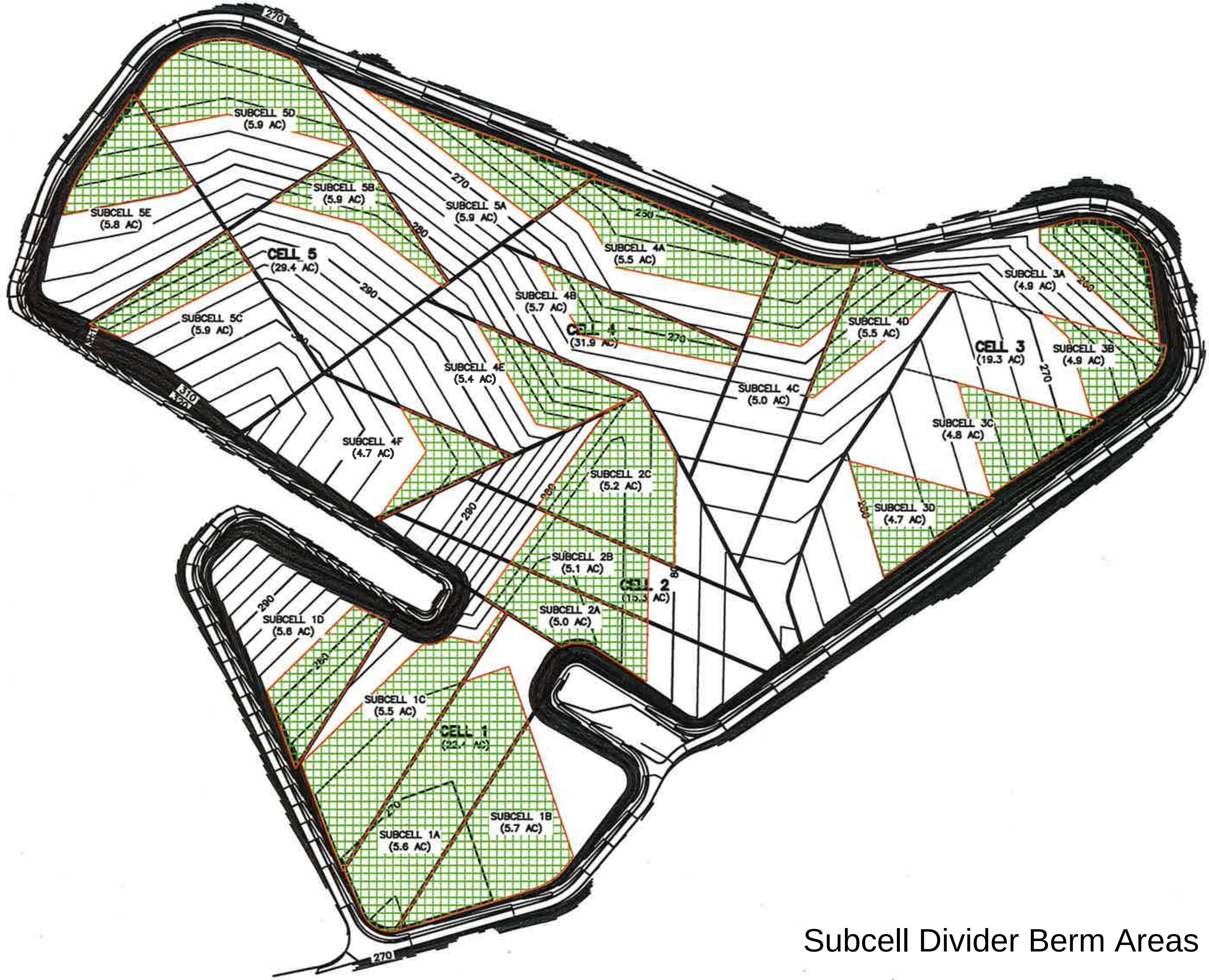
V = Volume of Pond (pyramid) (ft^3)
h = Height of the berm (pyramid) (ft)
A= Area of ponding (pyramid base) (ft^2)

Case 1: Will Subcell Divider Berm handle precipitation into one subcell?

Subcell	Subcell Area (acres)	Required Volume (ft^3)	Berm Height (ft)	Area of ponding behind berm (sf)	Area of Ponding (acres)	Available Volume (ft^3)	Factor of Safety	Check
1A	5.8	132,219	4	196,710	4.52	262,280	2.0	OK
1B	5.7	129,939	4	149,607	3.43	199,476	1.5	OK
1C	5.5	125,380	4	164,101	3.77	218,802	1.7	OK
1D	5.6	127,660	8	77,152	1.77	205,739	1.6	OK
2A	5.0	113,982	5	80,998	1.86	134,997	1.2	OK
2B	5.1	116,262	5	77,584	1.78	129,306	1.1	OK
2C	5.2	118,541	5	137,167	3.15	228,612	1.9	OK
3A	4.9	111,702	8	73,538	1.69	196,101	1.8	OK
3B	4.9	111,702	8	54,946	1.26	146,521	1.3	OK
3C	4.8	109,423	7	73,368	1.68	171,191	1.6	OK
3D	4.7	107,143	5	75,723	1.74	126,204	1.2	OK
4A	5.5	125,380	4	119,310	2.74	159,080	1.3	OK
4B	5.7	129,939	6	69,575	1.60	139,150	1.1	OK
4C	5.0	113,982	6	63,507	1.46	127,013	1.1	OK
4D	5.5	125,380	8	70,683	1.62	188,488	1.5	OK
4E	5.4	123,101	8	68,510	1.57	182,692	1.5	OK
4F	4.7	107,143	8	48,898	1.12	130,395	1.2	OK
5A	5.9	134,499	8	76,860	1.76	204,961	1.5	OK
5B	5.9	134,499	8	70,705	1.62	188,548	1.4	OK
5C	5.9	134,499	7	57,921	1.33	135,148	1.0	OK
5D	5.9	134,499	5	130,176	2.99	216,961	1.6	OK
5E	5.8	132,219	6	75,553	1.73	151,106	1.1	OK

Conclusion:

All individual subcells can contain the design storm event.
1 ft should be added to the Berm Height to maintain freeboard.



Subcell Divider Berm Areas

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HDR Computation

| Job No. 0453925-237673-018 |

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Sediment Basin #3	Sheet: 1	Of: 4

Objective Design the temporary sediment basin to contain the 25-year storm.

References

1. NC Erosion and Sediment Control Planning and Design Manual.
2. "Elements of Urban Stormwater Design" by H. Rooney Malcom, P.E.
3. NOAA Atlas 14, Volume 2, Version 3
4. VA Erosion and Sediment Control Handbook

Given

Phase	1	1	
Storm Event (yrs) =	10	25	
Total Drainage Area A (ac) =	3.1	3.1	
Disturbed Area (ac) =	3.1	3.1	
Curve Number CN =	91	91	Hydrographs
Rainfall Depth P (in) =	5.28	6.28	(24-hr rainfall) Ref 3
Peak Flow Q_p (cfs) =	20.57	24.96	Hydrographs

Design Criteria

Required sediment storage	1,800	cf / acre of drainage
Required sediment storage	5,580	cf
Required Surface Area	435	sf/cfs of the 10-yr storm peak flow (based on the largest Phase in cfs)
Required Surface Area (SF)	8,948	of the 10-yr storm peak flow (based on the largest Phase)

Determine Shape of Basin:
Measure the area of the Basin using AutoCADD.
Calculate Volume of the Basin using Truncated Pyramid Method.
Shape factor used in hydrographs basin depth may be gretaer than indicated below

Elevation (ft)	Depth (ft)	Area (sf)	Volume (cf)	Cumulative Vol (cf)	Cumulative Vol (cy)
244	0	0	-	-	-
244	0	4,877	0	0	0
245	1	6,254	5,551	5,551	206
246	2	7,709	6,969	12,520	464
247	3	9,244	8,465	20,985	777
248	4	10,857	10,040	31,025	1,149
249	5	12,549	11,693	42,717	1,582
250	6	14,321	13,425	56,143	2,079

Design Sediment Depth (ft) = 3
Sediment Storage (cf) = 20,985 *Required Sediment Storage Achieved*

Design Surface Area Depth (ft) = 3
Surface Area (sf) = 9,244 *Required Surface Area Achieved*

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Sediment Basin #3	Sheet: 2	Of: 4

Select Skimmer

A. R. Jarrett Method

$D = [Q / (2{,}310 * (H^{0.5})]^{0.5}$

D =Diameter of Orifice (inches)

Q = Dewater Rate (cf/day)

H = Head on orifice, varies based on skimmer size (ft)

Skimmer Sizes (Inches)	Head (ft)
1.5	0.125
2	0.167
2.5	0.167
3	0.250
4	0.333
5	0.333
6	0.417
8	0.500

Volume to Dewater (cf) =	20,985		
Number of Skimmers	1		
Days to Drain =	5	*assumed*	
Q each (cf/day) =	4,197		0.05 cfs

Selected Skimmer Size (inches) =	2.5
Head on Skimmer (feet) =	0.208
Diameter of Orifice (inches) =	2.0

Route the flow through the Basin

Riser is not perforated, but skimmer is attached.

$S = (1000/CN) - 10$

Runoff Depth Q* (inches) = $(P-0.2S)^2/(P+0.8S)$ Ref 2, III-4

T_P (min) = $60.5(Q^*)A/Q_P/1.39$

Phase	1	1
Storm Event (yrs) =	10	25
S =	0.99	0.99
Runoff Depth Q* (inches) =	4.25	5.23
Time to Peak T_p (min) =	27.91	28.28

Determine Pond Storage Elevation (Z_{Water}):

Pick one point near max expected water surface and the other at the mid depth.

Z_1 (ft) = 3 S_1 (cf)= 20,985

Z_2 (ft) = 6 S_2 (cf) = 56,143

b = $\ln(S_2/S_1)/\ln(Z_2/Z_1)$ = 1.4 Ref 2, III-8

$K_S = S_2/Z_2^b$ = 4,411

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Sediment Basin #3	Sheet: 3	Of: 4

Determine Settling Velocity

Conversion Factor = 3.281 ft/sec per m/sec

Gravitational Acceleration, g (m/s^2) = 9.81

Specific Gravity of soil (s_s)= 2.6

Kinematic Viscosity of water (ν) = 1.14E-06 n^2 / sec @ 20° C — Ref 2, IV-11

Diameter of the Design Particle d_{15} = 40.00E-06 m

Design Particle Settling Velocity = $(g / 18) * [(s_s - 1) / \upsilon] d^2$ = 4.02E-03 ft/sec

Route the Storm through the Basin using the Hydrograph Model

Set Height of Emergency Spillway at (ft) = 5.00

Set Top of Dam at (ft) = 6.00

See Hydrograph

Anti-Seep Collar:

Anti-Seep Collar Size = 2 * Barrel Dia

Anti-Seep Collar Size (ft) = 2

Use Anti-Seep Collar Size (ft) = 2 x 2

Minimum Concrete Base for Riser:

Diameter of Riser (in) = 24 — From Hydrograph

Avg Density of Concrete (lbs/cf) = 87.6

Density of Water (lbs/cf) = 62.4

Riser Displacement (cf) = 13.82 — Pi * $(D_R/24)^2$ * Total Ht of Riser

Convert cf to cy = 27^{-1}

Min Concrete Needed (cy) = 0.36

Width & Length (ft) = 3

Thickness (ft) = 1.1

Anti-Vortex Device:

Diameter of Riser (in) = 24 — From Hydrograph

Cylinder Diameter (in) = 36 — Ref 4, III-104, Table 3.14-D

Cylinder Thickness (gage) = 16

Cylinder Height (in) = 13

Project: Charah Colon Mine		Computed: PAW	Date: 3/4/15
Subject: Permit Application		Checked: MDP	Date: 3/6/15
Task: Sediment Basin #3		Sheet: 4	Of: 4

Determine Tailwater conditions to size outlet apron

Use Normal Depth Procedure (Manning's Eqn.) Ref 2, II-7

$A*R^{2/3} = Q*n/1.49\ s^{0.5}$ Area (A)= bd+z(d^2) $Z_{av} = A*R^{2/3}$

$Z_{req} = Q*n/1.49 s^{0.5}$ R=Area/(b+2d((z^2)+1)^.5)

n =	0.069	6-inch diameter Rip Rap, Lined Channel
Vp (ft/sec) =	9	Permissible Velocity for lining
Side Slope (z) =	5	enter X for X:1
s (ft/ft) =	0.02	Outlet Slope (estimated)
Bottom Width (ft) =	3	3 * Barrel Diameter
Q_B (cfs) =	4.1	Peak Flow out of the barrel 10-yr Hydrograph

Q (cfs)	Z_{req}	Flow Depth d (ft)	A (sf)	R (ft)	Z_{av}	V (ft/sec)
4.1	1.34	0.50	2.8	0.34	1.34	1.5

Flow Depth = Tailwater, d (ft) = 0.50 0.5* Barrel Diameter (ft) = 0.50 Ref 1, 8.06.3

Minimum Tailwater Conditions: d<0.5*Diameter of Outlet Pipe

Maximum Tailwater Conditions: d>0.5*Diameter of Outlet Pipe

Since the Tailwater is less than half of the diameter of the outlet, use Minimum Tailwater conditions.

Barrel Diameter (ft)	Entrance (ft)	Length (ft)	Outlet Width (ft)	Median Rip Rap Size d_{50}	Selected Rip Rap Size (in)
1	3	8	9	0.4	Class A

Conclusion

The temporary basin can contain the 25-yr storm.

HDR Computation

Job No. 0453925-237673-018

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Riser Pipe Perforations/Skimmer Flow	Sheet 1	Of 2

Diameter of Riser (in) =	24	
Circumference of Riser (in) =	75.4	
Height of Riser from bottom of barrel (in) =	53	From Hydrograph
Vertical spacing between holes (in) =	0	center to center
Water Stage increment (ft)	0.05	

Orifice Equation

$Q = C_d * A * (2 * g * h)^{0.5}$ Ref 1, p III-11

Q = cfs, discharge

C_d = 0.6 coefficient of discharge

A = sf, cross sectional area

g = 32.2 ft/sec^2, gravity

h = ft, driving head measured from the center of the pipe

	Perforations					Skimmer	
Row	1	2	3	4	5	1	# of skimmers
Holes per row	0	0	0	0	0		
Hole Diameter (in)	0.75	0.75	0.75	0.75	0.75		
Spacing edge to edge (in)							
Inlet Area (sf)	0.000	0.000	0.000	0.000	0.000		
Hole Stage (in)	0.50	0.50	0.50	0.50	0.50		
Hole Stage (ft)	0.04	0.04	0.04	0.04	0.04		

Water Stage (ft)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Total Flow (cfs)
0.00	0.00	0.00	0.00			0.00	0.00
0.04	0.00	0.00	0.00			0.00	0.00
0.09	0.00	0.00	0.00			0.00	0.00
0.14	0.00	0.00	0.00			0.00	0.00
0.19	0.00	0.00	0.00			0.00	0.00
0.24	0.00	0.00	0.00			0.05	0.05
0.29	0.00	0.00	0.00			0.05	0.05
0.34	0.00	0.00	0.00			0.05	0.05
0.39	0.00	0.00	0.00			0.05	0.05
0.44	0.00	0.00	0.00			0.05	0.05
0.49	0.00	0.00	0.00			0.05	0.05
0.54	0.00	0.00	0.00			0.05	0.05
0.59	0.00	0.00	0.00			0.05	0.05
0.64	0.00	0.00	0.00			0.05	0.05
0.69	0.00	0.00	0.00			0.05	0.05
0.74	0.00	0.00	0.00			0.05	0.05
0.79	0.00	0.00	0.00			0.05	0.05
0.84	0.00	0.00	0.00			0.05	0.05
0.89	0.00	0.00	0.00			0.05	0.05
0.94	0.00	0.00	0.00			0.05	0.05
0.99	0.00	0.00	0.00			0.05	0.05
1.04	0.00	0.00	0.00			0.05	0.05
1.09	0.00	0.00	0.00			0.05	0.05
1.14	0.00	0.00	0.00			0.05	0.05
1.19	0.00	0.00	0.00			0.05	0.05
1.24	0.00	0.00	0.00			0.05	0.05
1.29	0.00	0.00	0.00			0.05	0.05
1.34	0.00	0.00	0.00			0.05	0.05
1.39	0.00	0.00	0.00			0.05	0.05
1.44	0.00	0.00	0.00			0.05	0.05
1.49	0.00	0.00	0.00			0.05	0.05
1.54	0.00	0.00	0.00			0.05	0.05
1.59	0.00	0.00	0.00			0.05	0.05

HDR Computation

Job No. 0453925-237673-018

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Riser Pipe Perforations/Skimmer Flow	Sheet 2	Of 2

1.64	0.00	0.00	0.00	0.05	0.05
1.69	0.00	0.00	0.00	0.05	0.05
1.74	0.00	0.00	0.00	0.05	0.05
1.79	0.00	0.00	0.00	0.05	0.05
1.84	0.00	0.00	0.00	0.05	0.05
1.89	0.00	0.00	0.00	0.05	0.05
1.94	0.00	0.00	0.00	0.05	0.05
1.99	0.00	0.00	0.00	0.05	0.05
2.04	0.00	0.00	0.00	0.05	0.05
2.09	0.00	0.00	0.00	0.05	0.05
2.14	0.00	0.00	0.00	0.05	0.05
2.19	0.00	0.00	0.00	0.05	0.05
2.24	0.00	0.00	0.00	0.05	0.05
2.29	0.00	0.00	0.00	0.05	0.05
2.34	0.00	0.00	0.00	0.05	0.05
2.39	0.00	0.00	0.00	0.05	0.05
2.44	0.00	0.00	0.00	0.05	0.05
2.49	0.00	0.00	0.00	0.05	0.05
2.54	0.00	0.00	0.00	0.05	0.05
2.59	0.00	0.00	0.00	0.05	0.05
2.64	0.00	0.00	0.00	0.05	0.05
2.69	0.00	0.00	0.00	0.05	0.05
2.74	0.00	0.00	0.00	0.05	0.05
2.79	0.00	0.00	0.00	0.05	0.05
2.84	0.00	0.00	0.00	0.05	0.05
2.89	0.00	0.00	0.00	0.05	0.05
2.94	0.00	0.00	0.00	0.05	0.05
2.99	0.00	0.00	0.00	0.05	0.05
3.04	0.00	0.00	0.00	0.05	0.05
3.09	0.00	0.00	0.00	0.05	0.05
3.14	0.00	0.00	0.00	0.05	0.05
3.19	0.00	0.00	0.00	0.05	0.05
3.24	0.00	0.00	0.00	0.05	0.05
3.29	0.00	0.00	0.00	0.05	0.05
3.34	0.00	0.00	0.00	0.05	0.05
3.39	0.00	0.00	0.00	0.05	0.05
3.44	0.00	0.00	0.00	0.05	0.05
3.49	0.00	0.00	0.00	0.05	0.05
3.54	0.00	0.00	0.00	0.05	0.05
3.59	0.00	0.00	0.00	0.05	0.05
3.64	0.00	0.00	0.00	0.05	0.05
3.69	0.00	0.00	0.00	0.05	0.05
3.74	0.00	0.00	0.00	0.05	0.05
3.79	0.00	0.00	0.00	0.05	0.05
3.84	0.00	0.00	0.00	0.05	0.05
3.89	0.00	0.00	0.00	0.05	0.05
3.94	0.00	0.00	0.00	0.05	0.05
3.99	0.00	0.00	0.00	0.05	0.05

Sediment Basin # 3 Colon

Phase 1

10 - year Storm Event

Qp = 20.57 cfs
Tp = 27.91 minutes
dT = Max of 2 minutes
or 1.0% of increment to peak

b = 1.4
K_s = 4,411

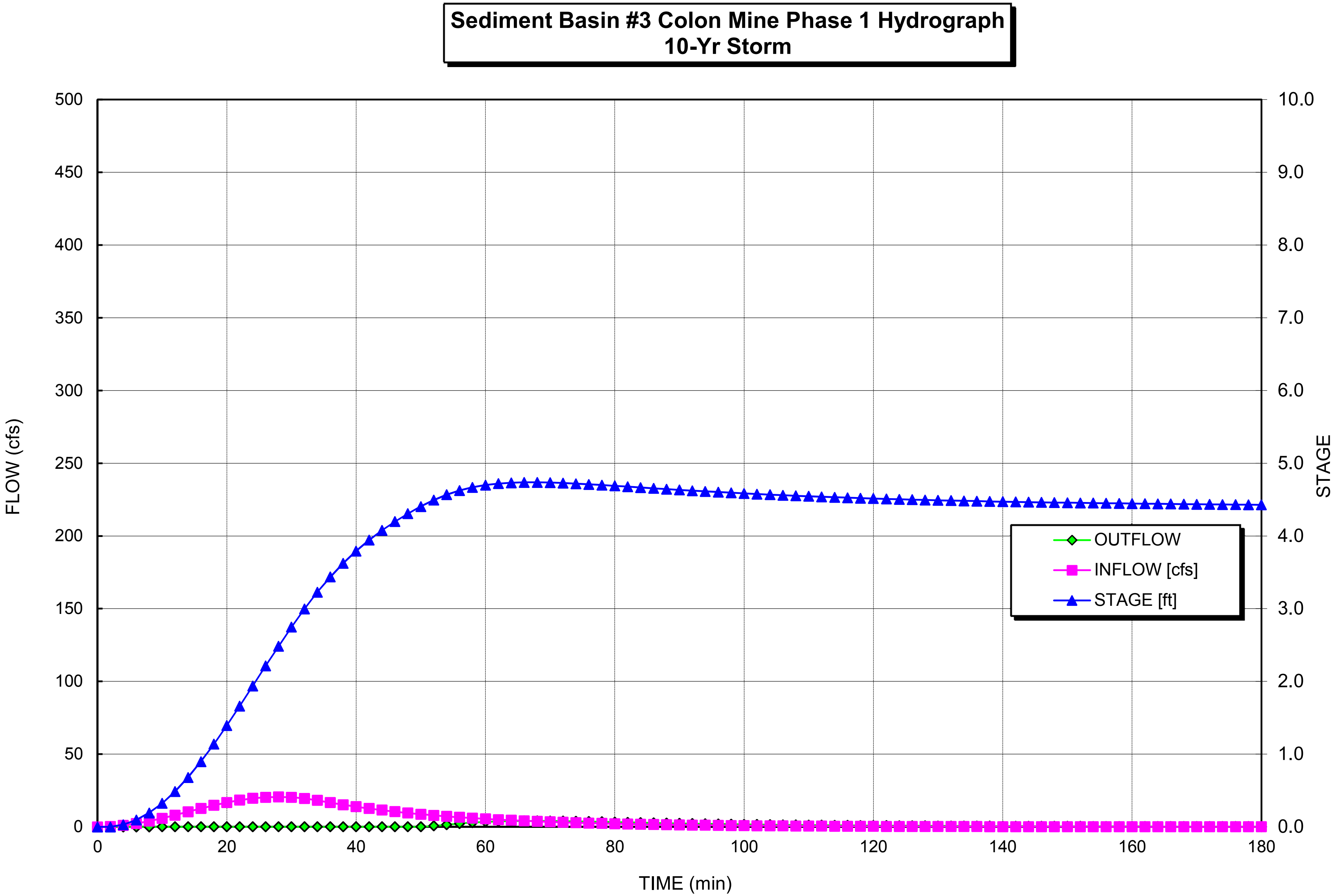
Number of Riser/Barrel Assemblies	1		
Diameter of Barrel =	12	(in)	
Height of Riser above barrel =	3.4	(ft)	
Height of Riser from bottom of barrel=	4.4	(ft) elevation	248.40
Emergency Spillway =	5.0	(ft) elevation	249.00
Total Height of Dam =	6.0	(ft) elevation	250.00
Length of Emergency Spillway =	10	(ft)	
Diameter of Riser =	24	(in)	
Permanent Pond Stage =	0	(ft) elevation	244.0

4.0E-03	Settling Velocity of design particle (fps)		
2	Effective number of cells (2 is construction site #)		
98%	Minimum Settling Efficiency		
4.7	ft Maximum Stage	248.74	msl elevation
4.1	cfs Peak outflow		
4.1	cfs Peak Riser/Barrel outflow		
0.0	cfs Peak Weir flow		

Notes:
1. Length of emergency spillway is the bottom width of the emergency spillway.
2. Settling efficiency neglects permanent pond volume

TIME (min)	INFLOW [cfs]	STORAGE [cu ft]	STAGE [ft]	Skimmer Flow [cfs]	RISER CAPACITY [cfs]	WEIR FLOW [cfs]	BARREL CAPACITY [cfs]	TOTAL OUTFLOW [cfs]	Bound Discharge [cfs]	Estimated Surface Area (sf)	Settling Efficiency [%]
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
2	0.3	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
4	1.0	31	0.0	0.00	0.00	0.00	0.00	0.00	3.19	1,448	N/A
6	2.3	154	0.1	0.00	0.00	0.00	0.00	0.00	5.11	2,323	N/A
8	3.9	425	0.2	0.00	0.00	0.00	0.00	0.00	6.90	3,136	N/A
10	5.9	893	0.3	0.05	0.05	0.00	0.05	0.05	8.59	3,905	100%
12	8.0	1,590	0.5	0.05	0.05	0.00	0.05	0.05	10.19	4,631	100%
14	10.3	2,549	0.7	0.05	0.05	0.00	0.05	0.05	11.72	5,325	100%
16	12.6	3,784	0.9	0.05	0.05	0.00	0.05	0.05	13.17	5,985	100%
18	14.8	5,294	1.1	0.05	0.05	0.00	0.05	0.05	14.54	6,610	100%
20	16.8	7,066	1.4	0.05	0.05	0.00	0.05	0.05	15.84	7,198	100%
22	18.4	9,071	1.7	0.05	0.05	0.00	0.05	0.05	17.05	7,750	100%
24	19.6	11,271	1.9	0.05	0.05	0.00	0.05	0.05	18.18	8,264	100%
26	20.3	13,616	2.2	0.05	0.05	0.00	0.05	0.05	19.23	8,739	100%
28	20.6	16,050	2.5	0.05	0.05	0.00	0.05	0.05	20.18	9,174	100%
30	20.3	18,513	2.7	0.05	0.05	0.00	0.05	0.05	21.05	9,570	100%
32	19.5	20,941	3.0	0.05	0.05	0.00	0.05	0.05	21.83	9,925	100%
34	18.2	23,275	3.2	0.05	0.05	0.00	0.05	0.05	22.53	10,240	100%
36	16.7	25,458	3.4	0.05	0.05	0.00	0.05	0.05	23.13	10,515	100%
38	15.2	27,455	3.6	0.05	0.05	0.00	0.05	0.05	23.66	10,752	100%
40	13.9	29,273	3.8	0.05	0.05	0.00	0.05	0.05	24.11	10,958	100%
42	12.6	30,929	3.9	0.05	0.05	0.00	0.05	0.05	24.50	11,138	100%
44	11.5	32,438	4.1	0.05	0.05	0.00	0.05	0.05	24.85	11,296	100%
46	10.5	33,811	4.2	0.05	0.05	0.00	0.05	0.05	25.16	11,435	100%
48	9.5	35,062	4.3	0.05	0.05	0.00	0.05	0.05	25.43	11,559	100%
50	8.7	36,201	4.4	0.05	0.06	0.00	7.46	0.06	25.67	11,668	100%
52	7.9	37,238	4.5	0.05	0.64	0.00	7.54	0.64	25.89	11,766	100%
54	7.2	38,111	4.6	0.05	1.47	0.00	7.61	1.47	26.06	11,847	100%
56	6.6	38,801	4.6	0.05	2.27	0.00	7.67	2.27	26.20	11,910	99%
58	6.0	39,318	4.7	0.05	2.94	0.00	7.71	2.94	26.30	11,957	99%
60	5.5	39,684	4.7	0.05	3.44	0.00	7.74	3.44	26.38	11,990	98%
62	5.0	39,926	4.7	0.05	3.79	0.00	7.76	3.79	26.42	12,011	98%
64	4.5	40,068	4.7	0.05	4.00	0.00	7.77	4.00	26.45	12,024	98%
66	4.1	40,131	4.7	0.05	4.09	0.00	7.77	4.09	26.46	12,029	98%
68	3.8	40,135	4.7	0.05	4.10	0.00	7.77	4.10	26.47	12,030	98%
70	3.4	40,094	4.7	0.05	4.04	0.00	7.77	4.04	26.46	12,026	98%
72	3.1	40,020	4.7	0.05	3.93	0.00	7.76	3.93	26.44	12,020	98%
74	2.8	39,923	4.7	0.05	3.79	0.00	7.76	3.79	26.42	12,011	98%
76	2.6	39,810	4.7	0.05	3.62	0.00	7.75	3.62	26.40	12,001	98%
78	2.4	39,686	4.7	0.05	3.44	0.00	7.74	3.44	26.38	11,990	98%
80	2.1	39,556	4.7	0.05	3.26	0.00	7.73	3.26	26.35	11,978	99%
82	2.0	39,422	4.7	0.05	3.08	0.00	7.72	3.08	26.33	11,966	99%

84	1.8	39,288	4.7	0.05	2.89	0.00	7.71	2.89	26.30	11,954	99%
86	1.6	39,155	4.7	0.05	2.72	0.00	7.70	2.72	26.27	11,942	99%
88	1.5	39,023	4.6	0.05	2.55	0.00	7.69	2.55	26.25	11,930	99%
90	1.3	38,896	4.6	0.05	2.38	0.00	7.68	2.38	26.22	11,919	99%
92	1.2	38,771	4.6	0.05	2.23	0.00	7.67	2.23	26.20	11,907	99%
94	1.1	38,651	4.6	0.05	2.08	0.00	7.66	2.08	26.17	11,896	99%
96	1.0	38,536	4.6	0.05	1.94	0.00	7.65	1.94	26.15	11,886	99%
98	0.9	38,425	4.6	0.05	1.82	0.00	7.64	1.82	26.13	11,876	99%
100	0.8	38,318	4.6	0.05	1.69	0.00	7.63	1.69	26.11	11,866	100%
102	0.8	38,217	4.6	0.05	1.58	0.00	7.62	1.58	26.08	11,857	100%
104	0.7	38,119	4.6	0.05	1.48	0.00	7.62	1.48	26.07	11,848	100%
106	0.6	38,027	4.6	0.05	1.38	0.00	7.61	1.38	26.05	11,839	100%
108	0.6	37,938	4.6	0.05	1.28	0.00	7.60	1.28	26.03	11,831	100%
110	0.5	37,854	4.5	0.05	1.20	0.00	7.59	1.20	26.01	11,823	100%
112	0.5	37,774	4.5	0.05	1.12	0.00	7.59	1.12	26.00	11,816	100%
114	0.4	37,698	4.5	0.05	1.05	0.00	7.58	1.05	25.98	11,809	100%
116	0.4	37,625	4.5	0.05	0.98	0.00	7.58	0.98	25.96	11,802	100%
118	0.4	37,556	4.5	0.05	0.91	0.00	7.57	0.91	25.95	11,796	100%
120	0.3	37,490	4.5	0.05	0.85	0.00	7.57	0.85	25.94	11,790	100%
122	0.3	37,428	4.5	0.05	0.80	0.00	7.56	0.80	25.92	11,784	100%
124	0.3	37,369	4.5	0.05	0.75	0.00	7.56	0.75	25.91	11,778	100%
126	0.3	37,312	4.5	0.05	0.70	0.00	7.55	0.70	25.90	11,773	100%
128	0.2	37,258	4.5	0.05	0.66	0.00	7.55	0.66	25.89	11,768	100%
130	0.2	37,207	4.5	0.05	0.61	0.00	7.54	0.61	25.88	11,763	100%
132	0.2	37,159	4.5	0.05	0.58	0.00	7.54	0.58	25.87	11,759	100%
134	0.2	37,112	4.5	0.05	0.54	0.00	7.53	0.54	25.86	11,754	100%
136	0.2	37,068	4.5	0.05	0.51	0.00	7.53	0.51	25.85	11,750	100%
138	0.1	37,026	4.5	0.05	0.48	0.00	7.53	0.48	25.84	11,746	100%
140	0.1	36,987	4.5	0.05	0.45	0.00	7.52	0.45	25.83	11,743	100%
142	0.1	36,949	4.5	0.05	0.42	0.00	7.52	0.42	25.83	11,739	100%
144	0.1	36,912	4.5	0.05	0.40	0.00	7.52	0.40	25.82	11,736	100%
146	0.1	36,878	4.5	0.05	0.37	0.00	7.52	0.37	25.81	11,732	100%
148	0.1	36,845	4.5	0.05	0.35	0.00	7.51	0.35	25.80	11,729	100%
150	0.1	36,814	4.5	0.05	0.33	0.00	7.51	0.33	25.80	11,726	100%
152	0.1	36,784	4.5	0.05	0.31	0.00	7.51	0.31	25.79	11,724	100%
154	0.1	36,755	4.5	0.05	0.30	0.00	7.51	0.30	25.79	11,721	100%
156	0.1	36,728	4.4	0.05	0.28	0.00	7.50	0.28	25.78	11,718	100%
158	0.1	36,702	4.4	0.05	0.26	0.00	7.50	0.26	25.77	11,716	100%
160	0.1	36,677	4.4	0.05	0.25	0.00	7.50	0.25	25.77	11,714	100%
162	0.0	36,653	4.4	0.05	0.24	0.00	7.50	0.24	25.76	11,711	100%
164	0.0	36,631	4.4	0.05	0.22	0.00	7.50	0.22	25.76	11,709	100%
166	0.0	36,609	4.4	0.05	0.21	0.00	7.49	0.21	25.76	11,707	100%
168	0.0	36,588	4.4	0.05	0.20	0.00	7.49	0.20	25.75	11,705	100%
170	0.0	36,568	4.4	0.05	0.19	0.00	7.49	0.19	25.75	11,703	100%
172	0.0	36,549	4.4	0.05	0.18	0.00	7.49	0.18	25.74	11,701	100%
174	0.0	36,531	4.4	0.05	0.17	0.00	7.49	0.17	25.74	11,700	100%
176	0.0	36,513	4.4	0.05	0.16	0.00	7.49	0.16	25.74	11,698	100%
178	0.0	36,497	4.4	0.05	0.16	0.00	7.49	0.16	25.73	11,696	100%
180	0.0	36,481	4.4	0.05	0.15	0.00	7.48	0.15	25.73	11,695	100%
182	0.0	36,465	4.4	0.05	0.14	0.00	7.48	0.14	25.73	11,693	100%
184	0.0	36,450	4.4	0.05	0.14	0.00	7.48	0.14	25.72	11,692	100%
186	0.0	36,436	4.4	0.05	0.13	0.00	7.48	0.13	25.72	11,691	100%
188	0.0	36,422	4.4	0.05	0.12	0.00	7.48	0.12	25.72	11,689	100%
190	0.0	36,409	4.4	0.05	0.12	0.00	7.48	0.12	25.71	11,688	100%
192	0.0	36,396	4.4	0.05	0.11	0.00	7.48	0.11	25.71	11,687	100%
194	0.0	36,384	4.4	0.05	0.11	0.00	7.48	0.11	25.71	11,686	100%
196	0.0	36,372	4.4	0.05	0.10	0.00	7.47	0.10	25.71	11,685	100%
198	0.0	36,361	4.4	0.05	0.10	0.00	7.47	0.10	25.70	11,684	100%
200	0.0	36,350	4.4	0.05	0.10	0.00	7.47	0.10	25.70	11,683	100%
202	0.0	36,339	4.4	0.05	0.09	0.00	7.47	0.09	25.70	11,682	100%
204	0.0	36,329	4.4	0.05	0.09	0.00	7.47	0.09	25.70	11,681	100%
206	0.0	36,319	4.4	0.05	0.09	0.00	7.47	0.09	25.70	11,680	100%


Sediment Basin #3 Colon Mine Phase 1 Hydrograph
10-Yr Storm
FLOW (cfs)
STAGE
TIME (min)
OUTFLOW
INFLOW [cfs]
STAGE [ft]
0
50
100
150
200
250
300
350
400
450
500
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
0
20
40
60
80
100
120
140
160
180

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Computed By: PAW Date: 3/5/15

Checked By: MDP Date: 3/6/15

Sheet: __1__of _2___

Sediment Basin # 3 Colon

Phase 1

25 - year Storm Event

Qp = 24.96 cfs
Tp = 28.28 minutes
dT = Max of 2 minutes
or 1.0% of increment to peak

b = 1.4
K_s = 4,411

Number of Riser/Barrel Assemblies	1		
Diameter of Barrel =	12	(in)	
Height of Riser above barrel =	3.4	(ft)	
Height of Riser from bottom of barrel=	4.4	(ft) elevation	248.40
Emergency Spillway =	5.0	(ft) elevation	249.00
Total Height of Dam =	6.0	(ft) elevation	250.00
Length of Emergency Spillway =	10	(ft)	
Diameter of Riser =	24	(in)	
Permanent Pond Stage =	0	(ft) elevation	244.0

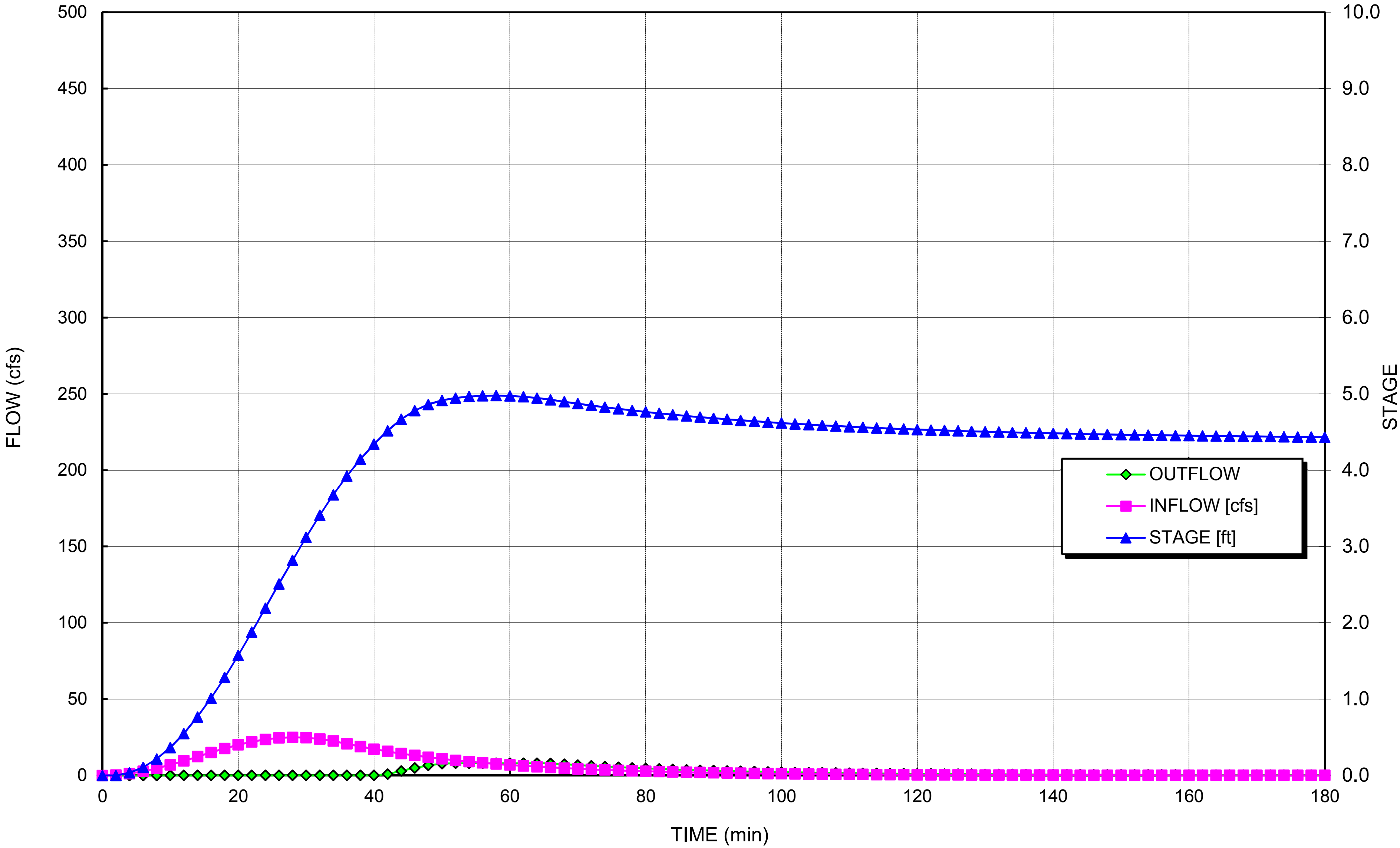
4.0E-03	Settling Velocity of design particle (fps)		
2	Effective number of cells (2 is construction site #)		
94%	Minimum Settling Efficiency		
5.0	ft Maximum Stage	248.98	msl elevation
8.0	cfs Peak outflow		
8.0	cfs Peak Riser/Barrel outflow		
0.0	cfs Peak Weir flow		

Notes:
1. Length of emergency spillway is the bottom width of the emergency spillway.
2. Settling efficiency neglects permanent pond volume

TIME (min)	INFLOW [cfs]	STORAGE [cu ft]	STAGE [ft]	Skimmer Flow [cfs]	RISER CAPACITY [cfs]	WEIR FLOW [cfs]	BARREL CAPACITY [cfs]	TOTAL OUTFLOW [cfs]	Bound Discharge [cfs]	Estimated Surface Area (sf)	Settling Efficiency [%]
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
2	0.3	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
4	1.2	37	0.0	0.00	0.00	0.00	0.00	0.00	3.35	1,521	N/A
6	2.7	182	0.1	0.00	0.00	0.00	0.00	0.00	5.37	2,441	N/A
8	4.6	503	0.2	0.00	0.00	0.00	0.00	0.00	7.25	3,295	N/A
10	6.9	1,056	0.4	0.05	0.05	0.00	0.05	0.05	9.03	4,104	100%
12	9.5	1,883	0.5	0.05	0.05	0.00	0.05	0.05	10.71	4,869	100%
14	12.3	3,022	0.8	0.05	0.05	0.00	0.05	0.05	12.32	5,600	100%
16	15.0	4,491	1.0	0.05	0.05	0.00	0.05	0.05	13.85	6,296	100%
18	17.7	6,290	1.3	0.05	0.05	0.00	0.05	0.05	15.30	6,955	100%
20	20.0	8,404	1.6	0.05	0.05	0.00	0.05	0.05	16.67	7,577	100%
22	22.0	10,803	1.9	0.05	0.05	0.00	0.05	0.05	17.95	8,161	100%
24	23.6	13,443	2.2	0.05	0.05	0.00	0.05	0.05	19.15	8,706	100%
26	24.6	16,266	2.5	0.05	0.05	0.00	0.05	0.05	20.26	9,211	100%
28	25.0	19,208	2.8	0.05	0.05	0.00	0.05	0.05	21.28	9,675	100%
30	24.7	22,196	3.1	0.05	0.05	0.00	0.05	0.05	22.21	10,097	100%
32	23.9	25,158	3.4	0.05	0.05	0.00	0.05	0.05	23.05	10,478	100%
34	22.5	28,022	3.7	0.05	0.05	0.00	0.05	0.05	23.80	10,817	100%
36	20.7	30,719	3.9	0.05	0.05	0.00	0.05	0.05	24.45	11,115	100%
38	18.9	33,197	4.1	0.05	0.05	0.00	0.05	0.05	25.02	11,373	100%
40	17.2	35,458	4.3	0.05	0.05	0.00	0.05	0.05	25.51	11,597	100%
42	15.7	37,519	4.5	0.05	0.88	0.00	7.57	0.88	25.94	11,792	100%
44	14.3	39,299	4.7	0.05	2.91	0.00	7.71	2.91	26.30	11,955	99%
46	13.1	40,670	4.8	0.05	4.93	0.00	7.81	4.93	26.57	12,077	97%
48	11.9	41,648	4.9	0.05	6.55	0.00	7.89	6.55	26.76	12,162	96%
50	10.9	42,292	4.9	0.05	7.70	0.00	7.93	7.70	26.88	12,217	94%
52	9.9	42,673	4.9	0.05	8.41	0.00	7.96	7.96	26.95	12,250	94%
54	9.1	42,908	5.0	0.05	8.85	0.00	7.98	7.98	26.99	12,270	94%
56	8.3	43,037	5.0	0.05	9.10	0.00	7.99	7.99	27.02	12,281	94%
58	7.5	43,069	5.0	0.05	9.16	0.00	7.99	7.99	27.02	12,283	94%
60	6.9	43,014	5.0	0.05	9.06	0.00	7.99	7.99	27.01	12,279	94%
62	6.3	42,880	5.0	0.05	8.80	0.00	7.98	7.98	26.99	12,267	94%
64	5.7	42,675	4.9	0.05	8.41	0.00	7.96	7.96	26.95	12,250	94%
66	5.2	42,405	4.9	0.05	7.91	0.00	7.94	7.91	26.90	12,227	94%
68	4.8	42,082	4.9	0.05	7.32	0.00	7.92	7.32	26.84	12,199	95%
70	4.3	41,774	4.9	0.05	6.77	0.00	7.89	6.77	26.78	12,173	95%
72	4.0	41,481	4.8	0.05	6.27	0.00	7.87	6.27	26.72	12,148	96%
74	3.6	41,204	4.8	0.05	5.80	0.00	7.85	5.80	26.67	12,124	96%
76	3.3	40,941	4.8	0.05	5.36	0.00	7.83	5.36	26.62	12,101	97%
78	3.0	40,693	4.8	0.05	4.96	0.00	7.81	4.96	26.57	12,079	97%
80	2.7	40,457	4.8	0.05	4.59	0.00	7.80	4.59	26.53	12,058	97%
82	2.5	40,235	4.7	0.05	4.25	0.00	7.78	4.25	26.48	12,039	98%

84	2.3	40,025	4.7	0.05	3.94	0.00	7.76	3.94	26.44	12,020	98%
86	2.1	39,826	4.7	0.05	3.64	0.00	7.75	3.64	26.40	12,002	98%
88	1.9	39,638	4.7	0.05	3.38	0.00	7.73	3.38	26.37	11,985	98%
90	1.7	39,461	4.7	0.05	3.13	0.00	7.72	3.13	26.33	11,970	99%
92	1.6	39,293	4.7	0.05	2.90	0.00	7.71	2.90	26.30	11,955	99%
94	1.4	39,134	4.7	0.05	2.69	0.00	7.69	2.69	26.27	11,940	99%
96	1.3	38,984	4.6	0.05	2.50	0.00	7.68	2.50	26.24	11,927	99%
98	1.2	38,842	4.6	0.05	2.32	0.00	7.67	2.32	26.21	11,914	99%
100	1.1	38,708	4.6	0.05	2.15	0.00	7.66	2.15	26.18	11,902	99%
102	1.0	38,581	4.6	0.05	2.00	0.00	7.65	2.00	26.16	11,890	99%
104	0.9	38,460	4.6	0.05	1.86	0.00	7.64	1.86	26.13	11,879	99%
106	0.8	38,347	4.6	0.05	1.73	0.00	7.63	1.73	26.11	11,869	100%
108	0.8	38,239	4.6	0.05	1.61	0.00	7.62	1.61	26.09	11,859	100%
110	0.7	38,137	4.6	0.05	1.49	0.00	7.62	1.49	26.07	11,849	100%
112	0.6	38,041	4.6	0.05	1.39	0.00	7.61	1.39	26.05	11,841	100%
114	0.6	37,949	4.6	0.05	1.30	0.00	7.60	1.30	26.03	11,832	100%
116	0.5	37,863	4.5	0.05	1.21	0.00	7.59	1.21	26.01	11,824	100%
118	0.5	37,780	4.5	0.05	1.13	0.00	7.59	1.13	26.00	11,817	100%
120	0.4	37,703	4.5	0.05	1.05	0.00	7.58	1.05	25.98	11,809	100%
122	0.4	37,629	4.5	0.05	0.98	0.00	7.58	0.98	25.97	11,803	100%
124	0.4	37,559	4.5	0.05	0.92	0.00	7.57	0.92	25.95	11,796	100%
126	0.3	37,492	4.5	0.05	0.86	0.00	7.57	0.86	25.94	11,790	100%
128	0.3	37,429	4.5	0.05	0.80	0.00	7.56	0.80	25.92	11,784	100%
130	0.3	37,370	4.5	0.05	0.75	0.00	7.56	0.75	25.91	11,778	100%
132	0.3	37,313	4.5	0.05	0.70	0.00	7.55	0.70	25.90	11,773	100%
134	0.2	37,259	4.5	0.05	0.66	0.00	7.55	0.66	25.89	11,768	100%
136	0.2	37,208	4.5	0.05	0.61	0.00	7.54	0.61	25.88	11,763	100%
138	0.2	37,159	4.5	0.05	0.58	0.00	7.54	0.58	25.87	11,759	100%
140	0.2	37,113	4.5	0.05	0.54	0.00	7.53	0.54	25.86	11,754	100%
142	0.2	37,069	4.5	0.05	0.51	0.00	7.53	0.51	25.85	11,750	100%
144	0.1	37,027	4.5	0.05	0.48	0.00	7.53	0.48	25.84	11,746	100%
146	0.1	36,987	4.5	0.05	0.45	0.00	7.52	0.45	25.83	11,743	100%
148	0.1	36,949	4.5	0.05	0.42	0.00	7.52	0.42	25.83	11,739	100%
150	0.1	36,913	4.5	0.05	0.40	0.00	7.52	0.40	25.82	11,736	100%
152	0.1	36,878	4.5	0.05	0.37	0.00	7.52	0.37	25.81	11,732	100%
154	0.1	36,846	4.5	0.05	0.35	0.00	7.51	0.35	25.80	11,729	100%
156	0.1	36,814	4.5	0.05	0.33	0.00	7.51	0.33	25.80	11,726	100%
158	0.1	36,784	4.5	0.05	0.31	0.00	7.51	0.31	25.79	11,724	100%
160	0.1	36,756	4.5	0.05	0.30	0.00	7.51	0.30	25.79	11,721	100%
162	0.1	36,729	4.4	0.05	0.28	0.00	7.50	0.28	25.78	11,718	100%
164	0.1	36,703	4.4	0.05	0.26	0.00	7.50	0.26	25.78	11,716	100%
166	0.1	36,678	4.4	0.05	0.25	0.00	7.50	0.25	25.77	11,714	100%
168	0.0	36,654	4.4	0.05	0.24	0.00	7.50	0.24	25.76	11,711	100%
170	0.0	36,632	4.4	0.05	0.22	0.00	7.50	0.22	25.76	11,709	100%
172	0.0	36,610	4.4	0.05	0.21	0.00	7.49	0.21	25.76	11,707	100%
174	0.0	36,589	4.4	0.05	0.20	0.00	7.49	0.20	25.75	11,705	100%
176	0.0	36,569	4.4	0.05	0.19	0.00	7.49	0.19	25.75	11,703	100%
178	0.0	36,550	4.4	0.05	0.18	0.00	7.49	0.18	25.74	11,702	100%
180	0.0	36,532	4.4	0.05	0.17	0.00	7.49	0.17	25.74	11,700	100%
182	0.0	36,515	4.4	0.05	0.16	0.00	7.49	0.16	25.74	11,698	100%
184	0.0	36,498	4.4	0.05	0.16	0.00	7.49	0.16	25.73	11,697	100%
186	0.0	36,482	4.4	0.05	0.15	0.00	7.48	0.15	25.73	11,695	100%
188	0.0	36,466	4.4	0.05	0.14	0.00	7.48	0.14	25.73	11,694	100%
190	0.0	36,451	4.4	0.05	0.14	0.00	7.48	0.14	25.72	11,692	100%
192	0.0	36,437	4.4	0.05	0.13	0.00	7.48	0.13	25.72	11,691	100%
194	0.0	36,423	4.4	0.05	0.12	0.00	7.48	0.12	25.72	11,689	100%
196	0.0	36,410	4.4	0.05	0.12	0.00	7.48	0.12	25.71	11,688	100%
198	0.0	36,397	4.4	0.05	0.11	0.00	7.48	0.11	25.71	11,687	100%
200	0.0	36,385	4.4	0.05	0.11	0.00	7.48	0.11	25.71	11,686	100%
202	0.0	36,373	4.4	0.05	0.11	0.00	7.47	0.11	25.71	11,685	100%
204	0.0	36,362	4.4	0.05	0.10	0.00	7.47	0.10	25.70	11,684	100%
206	0.0	36,351	4.4	0.05	0.10	0.00	7.47	0.10	25.70	11,683	100%

Sediment Basin #3 Colon Mine Phase 1 Hydrograph
25-Yr Storm



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Project: Charah Colon Mine		Computed: PAW	Date: 3/4/15
Subject: Permit Application		Checked: MDP	Date: 3/6/15
Task: Sediment Basin #4		Sheet: 1	Of: 4

Objective Design the temporary sediment basin to contain the 25-year storm.

References

1. NC Erosion and Sediment Control Planning and Design Manual.
2. "Elements of Urban Stormwater Design" by H. Rooney Malcom, P.E.
3. NOAA Atlas 14, Volume 2, Version 3
4. VA Erosion and Sediment Control Handbook

Given

Phase	1	1	
Storm Event (yrs) =	10	25	
Total Drainage Area A (ac) =	12.7	12.7	
Disturbed Area (ac) =	12.7	12.7	
Curve Number CN =	89	89	Hydrographs
Rainfall Depth P (in) =	5.28	6.28	(24-hr rainfall) Ref 3
Peak Flow Q_p (cfs) =	77.74	95.13	Hydrographs

Design Criteria

Required sediment storage	1,800	cf / acre of drainage
Required sediment storage	22,860	cf
Required Surface Area	435	sf/cfs of the 10-yr storm peak flow (based on the largest Phase in cfs)
Required Surface Area (SF)	41,382	of the 10-yr storm peak flow (based on the largest Phase)

Determine Shape of Basin:
Measure the area of the Basin using AutoCADD.
Calculate Volume of the Basin using Truncated Pyramid Method.
Shape factor used in hydrographs basin depth may be gretaer than indicated below

Elevation (ft)	Depth (ft)	Area (sf)	Volume (cf)	Cumulative Vol (cf)	Cumulative Vol (cy)
261	0	26,486	0	0	0
262	1	29,254	27,859	27,859	1,032
263	2	32,108	30,670	58,528	2,168
264	3	35,046	33,566	92,095	3,411
265	4	38,057	36,541	128,636	4,764
266	5	41,127	39,582	168,218	6,230
267	6	44,258	42,683	210,901	7,811

Design Sediment Depth (ft) = 3
Sediment Storage (cf) = 92,095 *Required Sediment Storage Achieved*

Design Surface Area Depth (ft) = 3
Surface Area (sf) = 35,046 *Increase Surface Area*

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Sediment Basin #4	Sheet: 2	Of: 4

Select Skimmer

A. R. Jarrett Method

$D = [Q / (2{,}310 * (H^{0.5})]^{0.5}$

D =Diameter of Orifice (inches)

Q = Dewater Rate (cf/day)

H = Head on orifice, varies based on skimmer size (ft)

Skimmer Sizes (Inches)	Head (ft)
1.5	0.125
2	0.167
2.5	0.167
3	0.250
4	0.333
5	0.333
6	0.417
8	0.500

Volume to Dewater (cf) =	92,095		
Number of Skimmers	1		
Days to Drain =	5	*assumed*	
Q each (cf/day) =	18,419		0.21 cfs

Selected Skimmer Size (inches) =	4
Head on Skimmer (feet) =	0.333
Diameter of Orifice (inches) =	3.7

Route the flow through the Basin

Riser is not perforated, but skimmer is attached.

$S = (1000/CN) - 10$

Runoff Depth Q* (inches) = $(P-0.2S)^2/(P+0.8S)$ Ref 2, III-4

T_P (min) = $60.5(Q^*)A/Q_P/1.39$

Phase	1	1
Storm Event (yrs) =	10	25
S =	1.24	1.24
Runoff Depth Q* (inches) =	4.04	5.01
Time to Peak T_p (min) =	28.73	29.09

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Sediment Basin #4	Sheet: 3	Of: 4

Determine Pond Storage Elevation (Z_{Water}):

Pick one point near max expected water surface and the other at the mid depth.

Z_1 (ft) = 3 S_1 (cf)= 92,095

Z_2 (ft) = 5 S_2 (cf) = 168,218

b = $\ln(S_2/S_1)/\ln(Z_2/Z_1)$ = 1.2 Ref 2, III-8

$K_S = S_2/Z_2^b$ = 25,208

Determine Settling Velocity

Conversion Factor = 3.281 ft/sec per m/sec

Gravitational Acceleration, g (m/s^2) = 9.81

Specific Gravity of soil (s_s)= 2.6

Kinematic Viscosity of water (ν) = 1.14E-06 m^2 / sec @ 20° C Ref 2, IV-11

Diameter of the Design Particle d_{15} = 40.00E-06 m

Design Particle Settling Velocity = $(g / 18) * [(s_s - 1) / \upsilon] d^2$ = 4.02E-03 ft/sec

Route the Storm through the Basin using the Hydrograph Model

Set Height of Emergency Spillway at (ft) = 6.00 *See Hydrograph*

Set Top of Dam at (ft) = 6.60

Anti-Seep Collar:

Anti-Seep Collar Size = 2 * Barrel Dia

Anti-Seep Collar Size (ft) = 2

Use Anti-Seep Collar Size (ft) = 2 x 2

Minimum Concrete Base for Riser:

Diameter of Riser (in) = 24 From Hydrograph

Avg Density of Concrete (lbs/cf) = 87.6

Density of Water (lbs/cf) = 62.4

Riser Displacement (cf) = 16.65 Pi * $(D_R/24)^2$ * Total Ht of Riser

Convert cf to cy = 27^{-1}

Min Concrete Needed (cy) = 0.44

Width & Length (ft) = 3

Thickness (ft) = 1.3

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Sediment Basin #4	Sheet: 4	Of: 4

Anti-Vortex Device:

Diameter of Riser (in) = 24 From Hydrograph
Cylinder Diameter (in) = 36 Ref 4, III-104, Table 3.14-D
Cylinder Thickness (gage) = 16
Cylinder Height (in) = 13

Determine Tailwater conditions to size outlet apron

Use Normal Depth Procedure (Manning's Eqn.) Ref 2, II-7

$A*R^{2/3} = Q*n/1.49\ s^{0.5}$ Area (A)= bd+z(d^2) $Z_{av} = A*R^{2/3}$

$Z_{req} = Q*n/1.49s^{0.5}$ R=Area/(b+2d((z^2)+1)^.5)

n =	0.069	6-inch diameter Rip Rap, Lined Channel
Vp (ft/sec) =	9	Permissible Velocity for lining
Side Slope (z) =	5	enter X for X:1
s (ft/ft) =	0.02	Outlet Slope (estimated)
Bottom Width (ft) =	3	3 * Barrel Diameter
Q_B (cfs) =	0.7	Peak Flow out of the barrel 10-yr Hydrograph

Q (cfs)	Z_{req}	Flow Depth d (ft)	A (sf)	R (ft)	Z_{av}	V (ft/sec)
0.7	0.24	0.20	0.8	0.16	0.24	0.9

Flow Depth = Tailwater, d (ft) = 0.20 0.5* Barrel Diameter (ft) = 0.50 Ref 1, 8.06.3
Minimum Tailwater Conditions: d<0.5*Diameter of Outlet Pipe
Maximum Tailwater Conditions: d>0.5*Diameter of Outlet Pipe
Since the Tailwater is less than half of the diameter of the outlet, use Minimum Tailwater conditions.

Barrel Diameter (ft)	Entrance (ft)	Length (ft)	Outlet Width (ft)	Median Rip Rap Size d_{50}	Selected Rip Rap Size (in)
1	3	8	9	0.4	Class A

Conclusion

The temporary basin can contain the 25-yr storm.

Project: Charah Colon Mine		Computed: PAW	Date: 3/4/15
Subject: Permit Application		Checked: MDP	Date: 3/6/15
Task: Riser Pipe Perforations/Skimmer Flow		Sheet: 1	Of: 2

Diameter of Riser (in) =	24	
Circumference of Riser (in) =	75.4	
Height of Riser from bottom of barrel (in) =	64	From Hydrograph
Vertical spacing between holes (in) =	0	center to center
Water Stage increment (ft)	0.05	

Orifice Equation

$Q = C_d * A * (2 * g * h)^{0.5}$ Ref 1, p III-11

Q = cfs, discharge

C_d = 0.6 coefficient of discharge

A = sf, cross sectional area

g = 32.2 ft/sec^2, gravity

h = ft, driving head measured from the center of the pipe

	Perforations					Skimmer	
Row	1	2	3	4	5	1	# of skimmers
Holes per row	0	0	0	0	0		
Hole Diameter (in)	0.75	0.75	0.75	0.75	0.75		
Spacing edge to edge (in)							
Inlet Area (sf)	0.000	0.000	0.000	0.000	0.000		
Hole Stage (in)	0.50	0.50	0.50	0.50	0.50		
Hole Stage (ft)	0.04	0.04	0.04	0.04	0.04		

Water Stage (ft)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Total Flow (cfs)
0.00	0.00	0.00	0.00			0.00	0.00
0.04	0.00	0.00	0.00			0.00	0.00
0.09	0.00	0.00	0.00			0.00	0.00
0.14	0.00	0.00	0.00			0.00	0.00
0.19	0.00	0.00	0.00			0.00	0.00
0.24	0.00	0.00	0.00			0.00	0.00
0.29	0.00	0.00	0.00			0.00	0.00
0.34	0.00	0.00	0.00			0.21	0.21
0.39	0.00	0.00	0.00			0.21	0.21
0.44	0.00	0.00	0.00			0.21	0.21
0.49	0.00	0.00	0.00			0.21	0.21
0.54	0.00	0.00	0.00			0.21	0.21
0.59	0.00	0.00	0.00			0.21	0.21
0.64	0.00	0.00	0.00			0.21	0.21
0.69	0.00	0.00	0.00			0.21	0.21
0.74	0.00	0.00	0.00			0.21	0.21
0.79	0.00	0.00	0.00			0.21	0.21
0.84	0.00	0.00	0.00			0.21	0.21
0.89	0.00	0.00	0.00			0.21	0.21
0.94	0.00	0.00	0.00			0.21	0.21
0.99	0.00	0.00	0.00			0.21	0.21
1.04	0.00	0.00	0.00			0.21	0.21
1.09	0.00	0.00	0.00			0.21	0.21
1.14	0.00	0.00	0.00			0.21	0.21
1.19	0.00	0.00	0.00			0.21	0.21
1.24	0.00	0.00	0.00			0.21	0.21
1.29	0.00	0.00	0.00			0.21	0.21
1.34	0.00	0.00	0.00			0.21	0.21
1.39	0.00	0.00	0.00			0.21	0.21
1.44	0.00	0.00	0.00			0.21	0.21
1.49	0.00	0.00	0.00			0.21	0.21
1.54	0.00	0.00	0.00			0.21	0.21
1.59	0.00	0.00	0.00			0.21	0.21

1.64	0.00	0.00	0.00	0.21	0.21
1.69	0.00	0.00	0.00	0.21	0.21
1.74	0.00	0.00	0.00	0.21	0.21
1.79	0.00	0.00	0.00	0.21	0.21
1.84	0.00	0.00	0.00	0.21	0.21
1.89	0.00	0.00	0.00	0.21	0.21
1.94	0.00	0.00	0.00	0.21	0.21
1.99	0.00	0.00	0.00	0.21	0.21
2.04	0.00	0.00	0.00	0.21	0.21
2.09	0.00	0.00	0.00	0.21	0.21
2.14	0.00	0.00	0.00	0.21	0.21
2.19	0.00	0.00	0.00	0.21	0.21
2.24	0.00	0.00	0.00	0.21	0.21
2.29	0.00	0.00	0.00	0.21	0.21
2.34	0.00	0.00	0.00	0.21	0.21
2.39	0.00	0.00	0.00	0.21	0.21
2.44	0.00	0.00	0.00	0.21	0.21
2.49	0.00	0.00	0.00	0.21	0.21
2.54	0.00	0.00	0.00	0.21	0.21
2.59	0.00	0.00	0.00	0.21	0.21
2.64	0.00	0.00	0.00	0.21	0.21
2.69	0.00	0.00	0.00	0.21	0.21
2.74	0.00	0.00	0.00	0.21	0.21
2.79	0.00	0.00	0.00	0.21	0.21
2.84	0.00	0.00	0.00	0.21	0.21
2.89	0.00	0.00	0.00	0.21	0.21
2.94	0.00	0.00	0.00	0.21	0.21
2.99	0.00	0.00	0.00	0.21	0.21
3.04	0.00	0.00	0.00	0.21	0.21
3.09	0.00	0.00	0.00	0.21	0.21
3.14	0.00	0.00	0.00	0.21	0.21
3.19	0.00	0.00	0.00	0.21	0.21
3.24	0.00	0.00	0.00	0.21	0.21
3.29	0.00	0.00	0.00	0.21	0.21
3.34	0.00	0.00	0.00	0.21	0.21
3.39	0.00	0.00	0.00	0.21	0.21
3.44	0.00	0.00	0.00	0.21	0.21
3.49	0.00	0.00	0.00	0.21	0.21
3.54	0.00	0.00	0.00	0.21	0.21
3.59	0.00	0.00	0.00	0.21	0.21
3.64	0.00	0.00	0.00	0.21	0.21
3.69	0.00	0.00	0.00	0.21	0.21
3.74	0.00	0.00	0.00	0.21	0.21
3.79	0.00	0.00	0.00	0.21	0.21
3.84	0.00	0.00	0.00	0.21	0.21
3.89	0.00	0.00	0.00	0.21	0.21
3.94	0.00	0.00	0.00	0.21	0.21
3.99	0.00	0.00	0.00	0.21	0.21

Sediment Basin # 4 Colon

Phase 1

10 - year Storm Event

Qp = 77.74 cfs
Tp = 28.73 minutes
dT = Max of 2 minutes
or 1.0% of increment to peak

b = 1.2
K_s = 25,208

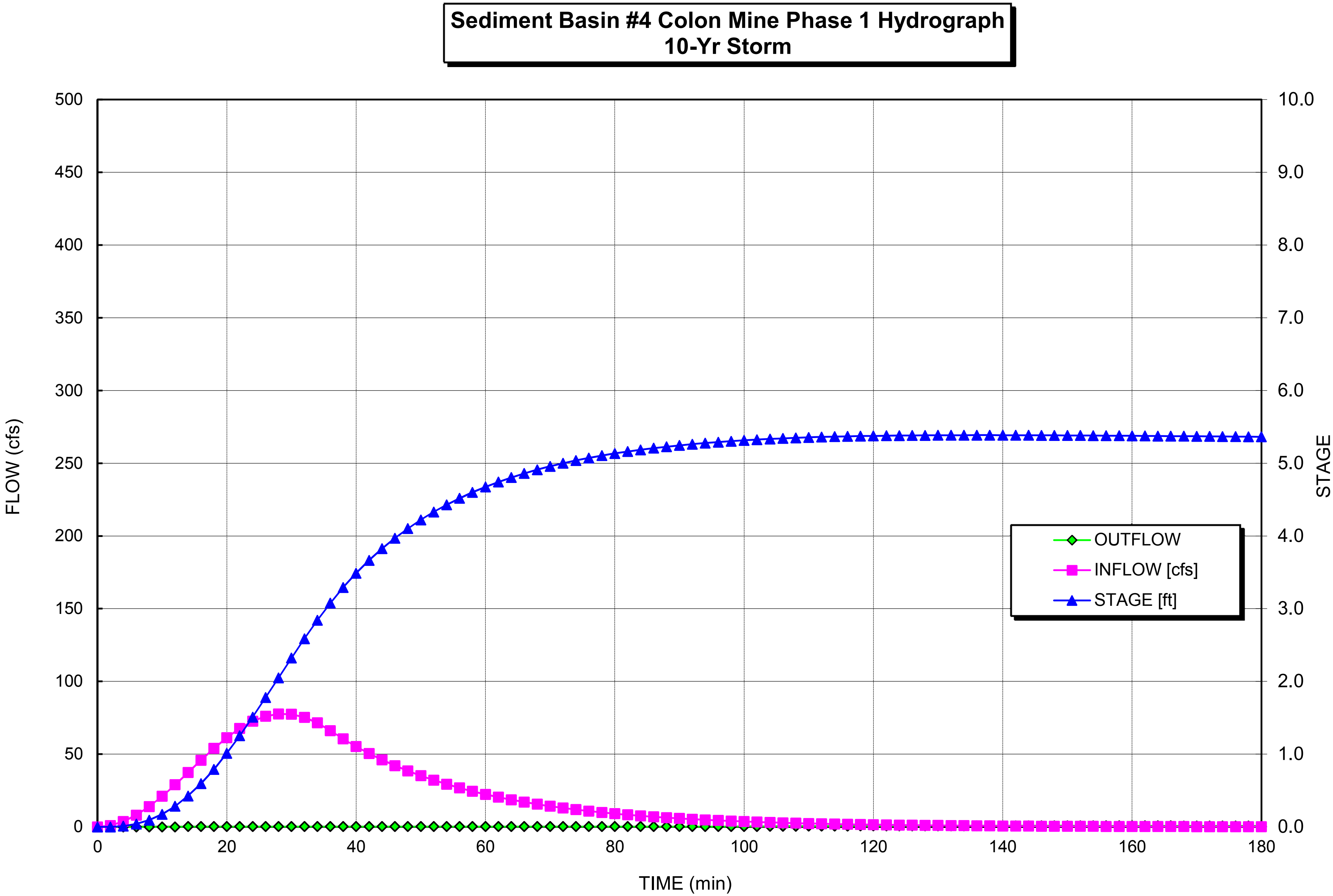
Number of Riser/Barrel Assemblies	1		
Diameter of Barrel =	12	(in)	
Height of Riser above barrel =	4.3	(ft)	
Height of Riser from bottom of barrel=	5.3	(ft) elevation	266.30
Emergency Spillway =	6.0	(ft) elevation	267.00
Total Height of Dam =	6.6	(ft) elevation	267.60
Length of Emergency Spillway =	20	(ft)	
Diameter of Riser =	24	(in)	
Permanent Pond Stage =	0	(ft) elevation	261.0

4.0E-03	Settling Velocity of design particle (fps)		
2	Effective number of cells (2 is construction site #)		
100%	Minimum Settling Efficiency		
5.4	ft Maximum Stage	266.39	msl elevation
0.7	cfs Peak outflow		
0.7	cfs Peak Riser/Barrel outflow		
0.0	cfs Peak Weir flow		

Notes:
1. Length of emergency spillway is the bottom width of the emergency spillway.
2. Settling efficiency neglects permanent pond volume

TIME (min)	INFLOW [cfs]	STORAGE [cu ft]	STAGE [ft]	Skimmer Flow [cfs]	RISER CAPACITY [cfs]	WEIR FLOW [cfs]	BARREL CAPACITY [cfs]	TOTAL OUTFLOW [cfs]	Bound Discharge [cfs]	Estimated Surface Area (sf)	Settling Efficiency [%]
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
2	0.9	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
4	3.7	111	0.0	0.00	0.00	0.00	0.00	0.00	28.66	13,029	N/A
6	8.1	550	0.0	0.00	0.00	0.00	0.00	0.00	36.56	16,618	N/A
8	13.9	1,519	0.1	0.00	0.00	0.00	0.00	0.00	42.66	19,393	N/A
10	21.0	3,192	0.2	0.00	0.00	0.00	0.00	0.00	47.77	21,712	N/A
12	28.9	5,714	0.3	0.00	0.00	0.00	0.00	0.00	52.19	23,722	N/A
14	37.3	9,185	0.4	0.21	0.21	0.00	0.21	0.21	56.10	25,498	100%
16	45.8	13,638	0.6	0.21	0.21	0.00	0.21	0.21	59.57	27,078	100%
18	53.9	19,106	0.8	0.21	0.21	0.00	0.21	0.21	62.71	28,502	100%
20	61.3	25,551	1.0	0.21	0.21	0.00	0.21	0.21	65.54	29,790	100%
22	67.7	32,885	1.3	0.21	0.21	0.00	0.21	0.21	68.10	30,956	100%
24	72.7	40,981	1.5	0.21	0.21	0.00	0.21	0.21	70.42	32,010	100%
26	76.0	49,674	1.8	0.21	0.21	0.00	0.21	0.21	72.51	32,960	100%
28	77.6	58,771	2.0	0.21	0.21	0.00	0.21	0.21	74.39	33,814	100%
30	77.4	68,060	2.3	0.21	0.21	0.00	0.21	0.21	76.07	34,577	100%
32	75.3	77,318	2.6	0.21	0.21	0.00	0.21	0.21	77.56	35,254	100%
34	71.5	86,326	2.8	0.21	0.21	0.00	0.21	0.21	78.87	35,850	100%
36	66.2	94,876	3.1	0.21	0.21	0.00	0.21	0.21	80.01	36,368	100%
38	60.4	102,791	3.3	0.21	0.21	0.00	0.21	0.21	80.99	36,814	100%
40	55.2	110,020	3.5	0.21	0.21	0.00	0.21	0.21	81.83	37,197	100%
42	50.4	116,620	3.7	0.21	0.21	0.00	0.21	0.21	82.56	37,528	100%
44	46.1	122,648	3.8	0.21	0.21	0.00	0.21	0.21	83.20	37,816	100%
46	42.1	128,151	4.0	0.21	0.21	0.00	0.21	0.21	83.75	38,070	100%
48	38.4	133,177	4.1	0.21	0.21	0.00	0.21	0.21	84.24	38,293	100%
50	35.1	137,765	4.2	0.21	0.21	0.00	0.21	0.21	84.68	38,491	100%
52	32.1	141,954	4.3	0.21	0.21	0.00	0.21	0.21	85.07	38,666	100%
54	29.3	145,778	4.4	0.21	0.21	0.00	0.21	0.21	85.41	38,823	100%
56	26.8	149,269	4.5	0.21	0.21	0.00	0.21	0.21	85.72	38,963	100%
58	24.5	152,456	4.6	0.21	0.21	0.00	0.21	0.21	85.99	39,088	100%
60	22.3	155,365	4.7	0.21	0.21	0.00	0.21	0.21	86.24	39,201	100%
62	20.4	158,020	4.7	0.21	0.21	0.00	0.21	0.21	86.46	39,302	100%
64	18.6	160,444	4.8	0.21	0.21	0.00	0.21	0.21	86.66	39,393	100%
66	17.0	162,655	4.9	0.21	0.21	0.00	0.21	0.21	86.85	39,475	100%
68	15.6	164,673	4.9	0.21	0.21	0.00	0.21	0.21	87.01	39,549	100%
70	14.2	166,514	5.0	0.21	0.21	0.00	0.21	0.21	87.16	39,616	100%
72	13.0	168,193	5.0	0.21	0.21	0.00	0.21	0.21	87.29	39,677	100%
74	11.9	169,725	5.0	0.21	0.21	0.00	0.21	0.21	87.41	39,731	100%
76	10.8	171,122	5.1	0.21	0.21	0.00	0.21	0.21	87.52	39,781	100%
78	9.9	172,396	5.1	0.21	0.21	0.00	0.21	0.21	87.62	39,826	100%
80	9.0	173,558	5.1	0.21	0.21	0.00	0.21	0.21	87.71	39,867	100%
82	8.3	174,617	5.2	0.21	0.21	0.00	0.21	0.21	87.79	39,904	100%

84	7.5	175,582	5.2	0.21	0.21	0.00	0.21	0.21	87.86	39,937	100%
86	6.9	176,461	5.2	0.21	0.21	0.00	0.21	0.21	87.93	39,967	100%
88	6.3	177,262	5.2	0.21	0.21	0.00	0.21	0.21	87.99	39,995	100%
90	5.7	177,992	5.2	0.21	0.21	0.00	0.21	0.21	88.04	40,020	100%
92	5.3	178,656	5.3	0.21	0.21	0.00	0.21	0.21	88.09	40,043	100%
94	4.8	179,260	5.3	0.21	0.21	0.00	0.21	0.21	88.14	40,063	100%
96	4.4	179,810	5.3	0.21	0.21	0.00	0.21	0.21	88.18	40,082	100%
98	4.0	180,311	5.3	0.21	0.22	0.00	8.27	0.22	88.22	40,099	100%
100	3.7	180,765	5.3	0.21	0.25	0.00	8.28	0.25	88.25	40,114	100%
102	3.3	181,174	5.3	0.21	0.29	0.00	8.29	0.29	88.28	40,128	100%
104	3.1	181,539	5.3	0.21	0.34	0.00	8.30	0.34	88.31	40,140	100%
106	2.8	181,864	5.3	0.21	0.39	0.00	8.31	0.39	88.33	40,151	100%
108	2.5	182,152	5.3	0.21	0.44	0.00	8.31	0.44	88.35	40,161	100%
110	2.3	182,405	5.4	0.21	0.48	0.00	8.32	0.48	88.37	40,169	100%
112	2.1	182,626	5.4	0.21	0.52	0.00	8.32	0.52	88.39	40,177	100%
114	1.9	182,818	5.4	0.21	0.56	0.00	8.33	0.56	88.40	40,183	100%
116	1.8	182,983	5.4	0.21	0.59	0.00	8.33	0.59	88.41	40,189	100%
118	1.6	183,125	5.4	0.21	0.62	0.00	8.33	0.62	88.43	40,193	100%
120	1.5	183,244	5.4	0.21	0.65	0.00	8.34	0.65	88.43	40,197	100%
122	1.4	183,343	5.4	0.21	0.67	0.00	8.34	0.67	88.44	40,201	100%
124	1.2	183,425	5.4	0.21	0.69	0.00	8.34	0.69	88.45	40,203	100%
126	1.1	183,491	5.4	0.21	0.70	0.00	8.34	0.70	88.45	40,205	100%
128	1.0	183,541	5.4	0.21	0.71	0.00	8.34	0.71	88.46	40,207	100%
130	0.9	183,579	5.4	0.21	0.72	0.00	8.34	0.72	88.46	40,208	100%
132	0.9	183,605	5.4	0.21	0.73	0.00	8.35	0.73	88.46	40,209	100%
134	0.8	183,621	5.4	0.21	0.73	0.00	8.35	0.73	88.46	40,210	100%
136	0.7	183,627	5.4	0.21	0.73	0.00	8.35	0.73	88.46	40,210	100%
138	0.7	183,625	5.4	0.21	0.73	0.00	8.35	0.73	88.46	40,210	100%
140	0.6	183,616	5.4	0.21	0.73	0.00	8.35	0.73	88.46	40,210	100%
142	0.5	183,600	5.4	0.21	0.73	0.00	8.35	0.73	88.46	40,209	100%
144	0.5	183,578	5.4	0.21	0.72	0.00	8.34	0.72	88.46	40,208	100%
146	0.5	183,552	5.4	0.21	0.72	0.00	8.34	0.72	88.46	40,207	100%
148	0.4	183,520	5.4	0.21	0.71	0.00	8.34	0.71	88.45	40,206	100%
150	0.4	183,485	5.4	0.21	0.70	0.00	8.34	0.70	88.45	40,205	100%
152	0.3	183,447	5.4	0.21	0.69	0.00	8.34	0.69	88.45	40,204	100%
154	0.3	183,405	5.4	0.21	0.68	0.00	8.34	0.68	88.45	40,203	100%
156	0.3	183,361	5.4	0.21	0.67	0.00	8.34	0.67	88.44	40,201	100%
158	0.3	183,315	5.4	0.21	0.66	0.00	8.34	0.66	88.44	40,200	100%
160	0.2	183,267	5.4	0.21	0.65	0.00	8.34	0.65	88.44	40,198	100%
162	0.2	183,217	5.4	0.21	0.64	0.00	8.34	0.64	88.43	40,196	100%
164	0.2	183,167	5.4	0.21	0.63	0.00	8.34	0.63	88.43	40,195	100%
166	0.2	183,115	5.4	0.21	0.62	0.00	8.33	0.62	88.42	40,193	100%
168	0.2	183,062	5.4	0.21	0.61	0.00	8.33	0.61	88.42	40,191	100%
170	0.2	183,009	5.4	0.21	0.60	0.00	8.33	0.60	88.42	40,189	100%
172	0.1	182,956	5.4	0.21	0.59	0.00	8.33	0.59	88.41	40,188	100%
174	0.1	182,902	5.4	0.21	0.58	0.00	8.33	0.58	88.41	40,186	100%
176	0.1	182,848	5.4	0.21	0.57	0.00	8.33	0.57	88.40	40,184	100%
178	0.1	182,794	5.4	0.21	0.56	0.00	8.33	0.56	88.40	40,182	100%
180	0.1	182,740	5.4	0.21	0.55	0.00	8.33	0.55	88.40	40,180	100%
182	0.1	182,686	5.4	0.21	0.54	0.00	8.33	0.54	88.39	40,179	100%
184	0.1	182,633	5.4	0.21	0.53	0.00	8.32	0.53	88.39	40,177	100%
186	0.1	182,579	5.4	0.21	0.52	0.00	8.32	0.52	88.39	40,175	100%
188	0.1	182,526	5.4	0.21	0.51	0.00	8.32	0.51	88.38	40,173	100%
190	0.1	182,474	5.4	0.21	0.50	0.00	8.32	0.50	88.38	40,172	100%
192	0.1	182,422	5.4	0.21	0.49	0.00	8.32	0.49	88.37	40,170	100%
194	0.1	182,370	5.4	0.21	0.48	0.00	8.32	0.48	88.37	40,168	100%
196	0.0	182,319	5.4	0.21	0.47	0.00	8.32	0.47	88.37	40,166	100%
198	0.0	182,269	5.4	0.21	0.46	0.00	8.32	0.46	88.36	40,165	100%
200	0.0	182,219	5.4	0.21	0.45	0.00	8.32	0.45	88.36	40,163	100%
202	0.0	182,170	5.3	0.21	0.44	0.00	8.31	0.44	88.35	40,161	100%
204	0.0	182,121	5.3	0.21	0.43	0.00	8.31	0.43	88.35	40,160	100%
206	0.0	182,073	5.3	0.21	0.42	0.00	8.31	0.42	88.35	40,158	100%


Sediment Basin #4 Colon Mine Phase 1 Hydrograph
10-Yr Storm
FLOW (cfs)
STAGE
TIME (min)
OUTFLOW
INFLOW [cfs]
STAGE [ft]
0
50
100
150
200
250
300
350
400
450
500
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
0
20
40
60
80
100
120
140
160
180

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Sediment Basin # 4 Colon

Phase 1

25 - year Storm Event

Qp = 95.13 cfs
Tp = 29.09 minutes
dT = Max of 2 minutes
or 1.0% of increment to peak

b = 1.2
K_s = 25,208

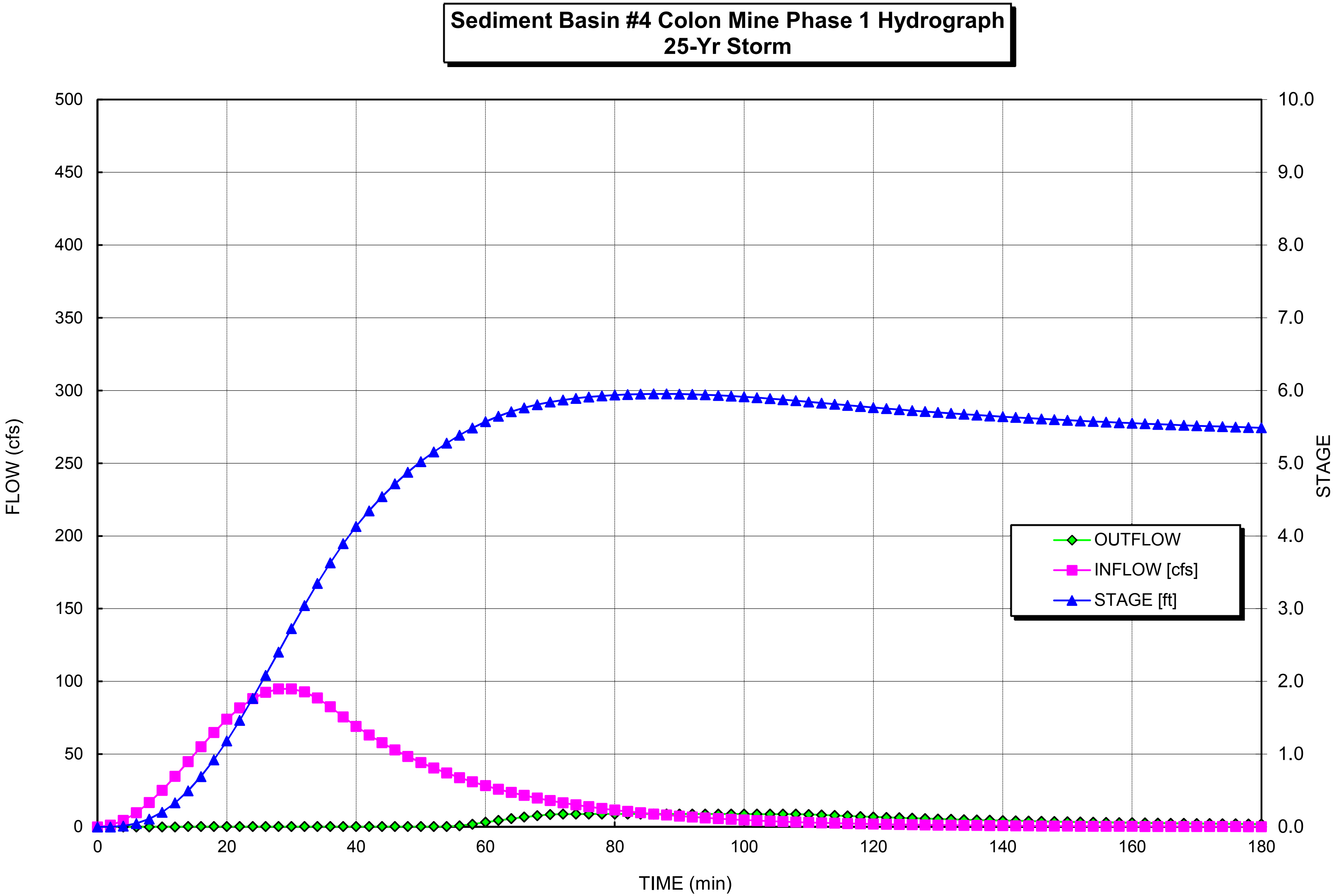
Number of Riser/Barrel Assemblies	1		
Diameter of Barrel =	12	(in)	
Height of Riser above barrel =	4.3	(ft)	
Height of Riser from bottom of barrel=	5.3	(ft) elevation	266.30
Emergency Spillway =	6	(ft) elevation	267.00
Total Height of Dam =	6.6	(ft) elevation	267.60
Length of Emergency Spillway =	20	(ft)	
Diameter of Riser =	24	(in)	
Permanent Pond Stage =	0	(ft) elevation	261.0

4.0E-03	Settling Velocity of design particle (fps)		
2	Effective number of cells (2 is construction site #)		
99%	Minimum Settling Efficiency		
6.0	ft Maximum Stage	266.95	msl elevation
8.8	cfs Peak outflow		
8.8	cfs Peak Riser/Barrel outflow		
0.0	cfs Peak Weir flow		

Notes:
1. Length of emergency spillway is the bottom width of the emergency spillway.
2. Settling efficiency neglects permanent pond volume

TIME (min)	INFLOW [cfs]	STORAGE [cu ft]	STAGE [ft]	Skimmer Flow [cfs]	RISER CAPACITY [cfs]	WEIR FLOW [cfs]	BARREL CAPACITY [cfs]	TOTAL OUTFLOW [cfs]	Bound Discharge [cfs]	Estimated Surface Area (sf)	Settling Efficiency [%]
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
2	1.1	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
4	4.4	133	0.0	0.00	0.00	0.00	0.00	0.00	29.45	13,384	N/A
6	9.6	657	0.0	0.00	0.00	0.00	0.00	0.00	37.56	17,072	N/A
8	16.7	1,813	0.1	0.00	0.00	0.00	0.00	0.00	43.83	19,923	N/A
10	25.1	3,814	0.2	0.00	0.00	0.00	0.00	0.00	49.08	22,308	N/A
12	34.6	6,830	0.3	0.00	0.00	0.00	0.00	0.00	53.62	24,375	N/A
14	44.8	10,988	0.5	0.21	0.21	0.00	0.21	0.21	57.65	26,203	100%
16	55.0	16,333	0.7	0.21	0.21	0.00	0.21	0.21	61.23	27,831	100%
18	64.9	22,907	0.9	0.21	0.21	0.00	0.21	0.21	64.46	29,300	100%
20	74.0	30,669	1.2	0.21	0.21	0.00	0.21	0.21	67.38	30,629	100%
22	81.8	39,521	1.5	0.21	0.21	0.00	0.21	0.21	70.03	31,833	100%
24	88.1	49,317	1.8	0.21	0.21	0.00	0.21	0.21	72.43	32,924	100%
26	92.5	59,865	2.1	0.21	0.21	0.00	0.21	0.21	74.60	33,909	100%
28	94.8	70,939	2.4	0.21	0.21	0.00	0.21	0.21	76.55	34,795	100%
30	94.9	82,289	2.7	0.21	0.21	0.00	0.21	0.21	78.30	35,589	100%
32	92.8	93,652	3.0	0.21	0.21	0.00	0.21	0.21	79.85	36,296	100%
34	88.6	104,763	3.3	0.21	0.21	0.00	0.21	0.21	81.23	36,921	100%
36	82.5	115,371	3.6	0.21	0.21	0.00	0.21	0.21	82.43	37,466	100%
38	75.6	125,246	3.9	0.21	0.21	0.00	0.21	0.21	83.46	37,937	100%
40	69.1	134,290	4.1	0.21	0.21	0.00	0.21	0.21	84.35	38,341	100%
42	63.2	142,559	4.3	0.21	0.21	0.00	0.21	0.21	85.12	38,691	100%
44	57.8	150,118	4.5	0.21	0.21	0.00	0.21	0.21	85.79	38,997	100%
46	52.9	157,029	4.7	0.21	0.21	0.00	0.21	0.21	86.38	39,264	100%
48	48.3	163,348	4.9	0.21	0.21	0.00	0.21	0.21	86.90	39,501	100%
50	44.2	169,123	5.0	0.21	0.21	0.00	0.21	0.21	87.36	39,710	100%
52	40.4	174,403	5.2	0.21	0.21	0.00	0.21	0.21	87.77	39,896	100%
54	37.0	179,229	5.3	0.21	0.21	0.00	0.21	0.21	88.14	40,062	100%
56	33.8	183,641	5.4	0.21	0.74	0.00	8.35	0.74	88.46	40,210	100%
58	30.9	187,610	5.5	0.21	1.86	0.00	8.43	1.86	88.75	40,341	100%
60	28.3	191,098	5.6	0.21	3.14	0.00	8.50	3.14	89.00	40,455	100%
62	25.9	194,115	5.6	0.21	4.42	0.00	8.56	4.42	89.21	40,551	100%
64	23.7	196,688	5.7	0.21	5.63	0.00	8.62	5.63	89.39	40,632	100%
66	21.6	198,850	5.8	0.21	6.72	0.00	8.66	6.72	89.54	40,700	99%
68	19.8	200,639	5.8	0.21	7.67	0.00	8.70	7.67	89.66	40,755	99%
70	18.1	202,091	5.8	0.21	8.48	0.00	8.73	8.48	89.76	40,800	99%
72	16.5	203,245	5.9	0.21	9.13	0.00	8.75	8.75	89.84	40,836	99%
74	15.1	204,180	5.9	0.21	9.67	0.00	8.77	8.77	89.90	40,864	99%
76	13.8	204,944	5.9	0.21	10.13	0.00	8.78	8.78	89.95	40,887	99%
78	12.7	205,550	5.9	0.21	10.49	0.00	8.80	8.80	89.99	40,906	99%
80	11.6	206,013	5.9	0.21	10.77	0.00	8.80	8.80	90.02	40,920	99%
82	10.6	206,345	5.9	0.21	10.97	0.00	8.81	8.81	90.05	40,930	99%

84	9.7	206,557	6.0	0.21	11.10	0.00	8.82	8.82	90.06	40,936	99%
86	8.9	206,661	6.0	0.21	11.16	0.00	8.82	8.82	90.07	40,939	99%
88	8.1	206,665	6.0	0.21	11.17	0.00	8.82	8.82	90.07	40,939	99%
90	7.4	206,578	6.0	0.21	11.11	0.00	8.82	8.82	90.06	40,937	99%
92	6.8	206,408	5.9	0.21	11.01	0.00	8.81	8.81	90.05	40,932	99%
94	6.2	206,163	5.9	0.21	10.86	0.00	8.81	8.81	90.03	40,924	99%
96	5.7	205,849	5.9	0.21	10.67	0.00	8.80	8.80	90.01	40,915	99%
98	5.2	205,472	5.9	0.21	10.44	0.00	8.79	8.79	89.99	40,903	99%
100	4.7	205,038	5.9	0.21	10.18	0.00	8.79	8.79	89.96	40,890	99%
102	4.3	204,552	5.9	0.21	9.89	0.00	8.78	8.78	89.93	40,875	99%
104	4.0	204,019	5.9	0.21	9.58	0.00	8.76	8.76	89.89	40,859	99%
106	3.6	203,442	5.9	0.21	9.25	0.00	8.75	8.75	89.85	40,842	99%
108	3.3	202,826	5.9	0.21	8.89	0.00	8.74	8.74	89.81	40,823	99%
110	3.0	202,175	5.8	0.21	8.52	0.00	8.73	8.52	89.77	40,803	99%
112	2.8	201,515	5.8	0.21	8.16	0.00	8.71	8.16	89.72	40,782	99%
114	2.5	200,869	5.8	0.21	7.80	0.00	8.70	7.80	89.68	40,763	99%
116	2.3	200,237	5.8	0.21	7.46	0.00	8.69	7.46	89.63	40,743	99%
118	2.1	199,620	5.8	0.21	7.13	0.00	8.68	7.13	89.59	40,724	99%
120	1.9	199,019	5.8	0.21	6.81	0.00	8.66	6.81	89.55	40,705	99%
122	1.8	198,434	5.8	0.21	6.51	0.00	8.65	6.51	89.51	40,687	99%
124	1.6	197,865	5.7	0.21	6.22	0.00	8.64	6.22	89.47	40,669	99%
126	1.5	197,313	5.7	0.21	5.94	0.00	8.63	5.94	89.43	40,652	100%
128	1.4	196,778	5.7	0.21	5.68	0.00	8.62	5.68	89.40	40,635	100%
130	1.2	196,259	5.7	0.21	5.43	0.00	8.61	5.43	89.36	40,619	100%
132	1.1	195,757	5.7	0.21	5.18	0.00	8.60	5.18	89.33	40,603	100%
134	1.0	195,271	5.7	0.21	4.95	0.00	8.59	4.95	89.29	40,588	100%
136	0.9	194,800	5.7	0.21	4.74	0.00	8.58	4.74	89.26	40,573	100%
138	0.9	194,346	5.7	0.21	4.53	0.00	8.57	4.53	89.23	40,558	100%
140	0.8	193,906	5.6	0.21	4.33	0.00	8.56	4.33	89.20	40,544	100%
142	0.7	193,482	5.6	0.21	4.14	0.00	8.55	4.14	89.17	40,531	100%
144	0.7	193,072	5.6	0.21	3.96	0.00	8.54	3.96	89.14	40,518	100%
146	0.6	192,676	5.6	0.21	3.79	0.00	8.54	3.79	89.11	40,505	100%
148	0.6	192,294	5.6	0.21	3.63	0.00	8.53	3.63	89.08	40,493	100%
150	0.5	191,925	5.6	0.21	3.47	0.00	8.52	3.47	89.06	40,481	100%
152	0.5	191,569	5.6	0.21	3.33	0.00	8.51	3.33	89.03	40,470	100%
154	0.4	191,225	5.6	0.21	3.19	0.00	8.51	3.19	89.01	40,459	100%
156	0.4	190,893	5.6	0.21	3.06	0.00	8.50	3.06	88.99	40,448	100%
158	0.4	190,573	5.6	0.21	2.93	0.00	8.49	2.93	88.96	40,438	100%
160	0.3	190,264	5.6	0.21	2.81	0.00	8.49	2.81	88.94	40,428	100%
162	0.3	189,966	5.5	0.21	2.70	0.00	8.48	2.70	88.92	40,418	100%
164	0.3	189,678	5.5	0.21	2.59	0.00	8.47	2.59	88.90	40,409	100%
166	0.2	189,400	5.5	0.21	2.48	0.00	8.47	2.48	88.88	40,400	100%
168	0.2	189,131	5.5	0.21	2.39	0.00	8.46	2.39	88.86	40,391	100%
170	0.2	188,872	5.5	0.21	2.29	0.00	8.46	2.29	88.84	40,383	100%
172	0.2	188,622	5.5	0.21	2.20	0.00	8.45	2.20	88.82	40,374	100%
174	0.2	188,380	5.5	0.21	2.12	0.00	8.45	2.12	88.81	40,367	100%
176	0.2	188,146	5.5	0.21	2.04	0.00	8.44	2.04	88.79	40,359	100%
178	0.1	187,921	5.5	0.21	1.96	0.00	8.44	1.96	88.77	40,352	100%
180	0.1	187,703	5.5	0.21	1.89	0.00	8.43	1.89	88.76	40,344	100%
182	0.1	187,492	5.5	0.21	1.82	0.00	8.43	1.82	88.74	40,338	100%
184	0.1	187,288	5.5	0.21	1.75	0.00	8.42	1.75	88.73	40,331	100%
186	0.1	187,091	5.5	0.21	1.69	0.00	8.42	1.69	88.71	40,324	100%
188	0.1	186,901	5.5	0.21	1.63	0.00	8.41	1.63	88.70	40,318	100%
190	0.1	186,716	5.5	0.21	1.57	0.00	8.41	1.57	88.69	40,312	100%
192	0.1	186,538	5.5	0.21	1.52	0.00	8.41	1.52	88.67	40,306	100%
194	0.1	186,365	5.5	0.21	1.46	0.00	8.40	1.46	88.66	40,301	100%
196	0.1	186,198	5.4	0.21	1.41	0.00	8.40	1.41	88.65	40,295	100%
198	0.1	186,037	5.4	0.21	1.37	0.00	8.40	1.37	88.64	40,290	100%
200	0.1	185,880	5.4	0.21	1.32	0.00	8.39	1.32	88.63	40,285	100%
202	0.0	185,728	5.4	0.21	1.28	0.00	8.39	1.28	88.62	40,280	100%
204	0.0	185,581	5.4	0.21	1.23	0.00	8.39	1.23	88.60	40,275	100%
206	0.0	185,438	5.4	0.21	1.19	0.00	8.38	1.19	88.59	40,270	100%



Sediment Basin #4 Colon Mine Phase 1 Hydrograph
25-Yr Storm
FLOW (cfs)
STAGE
TIME (min)
OUTFLOW
INFLOW [cfs]
STAGE [ft]
0
50
100
150
200
250
300
350
400
450
500
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
0
20
40
60
80
100
120
140
160
180

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Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Sediment Basin #6	Sheet: 1	Of: 4

Objective Design the temporary sediment basin to contain the 25-year storm.

References

1. NC Erosion and Sediment Control Planning and Design Manual.
2. "Elements of Urban Stormwater Design" by H. Rooney Malcom, P.E.
3. NOAA Atlas 14, Volume 2, Version 3
4. VA Erosion and Sediment Control Handbook

Given

Phase	1	1		
Storm Event (yrs) =	10	25		
Total Drainage Area A (ac) =	15.3	15.3		
Disturbed Area (ac) =	15.3	15.3		
Curve Number CN =	89	89	Hydrographs	
Rainfall Depth P (in) =	5.28	6.28	(24-hr rainfall)	Ref 3
Peak Flow Q_p (cfs) =	93.60	114.53	Hydrographs	

Design Criteria

Required sediment storage	1,800	cf / acre of drainage
Required sediment storage	27,540	cf
Required Surface Area	435	sf/cfs of the 10-yr storm peak flow (based on the largest Phase in cfs)
Required Surface Area (SF)	49,821	of the 10-yr storm peak flow (based on the largest Phase)

Determine Shape of Basin:

Measure the area of the Basin using AutoCADD.
Calculate Volume of the Basin using Truncated Pyramid Method.
Shape factor used in hydrographs basin depth may be gretaer than indicated below

Elevation (ft)	Depth (ft)	Area (sf)	Volume (cf)	Cumulative Vol (cf)	Cumulative Vol (cy)
249	0	30,723	-	-	-
250	1	34,084	32,389	32,389	1,200
251	2	37,519	35,788	68,177	2,525
252	3	41,027	39,260	107,437	3,979
253	4	44,808	42,904	150,340	5,568
254	5	48,997	46,887	197,227	7,305
255	6	52,981	50,976	248,203	9,193

Design Sediment Depth (ft) = 3
Sediment Storage (cf) = 107,437 *Required Sediment Storage Achieved*

Design Surface Area Depth (ft) = 3
Surface Area (sf) = 41,027 *Increase Surface Area*

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Sediment Basin #6	Sheet: 2	Of: 4

Select Skimmer

A. R. Jarrett Method

$D = [Q / (2{,}310 * (H^{0.5})]^{0.5}$

D =Diameter of Orifice (inches)

Q = Dewater Rate (cf/day)

H = Head on orifice, varies based on skimmer size (ft)

Skimmer Sizes (Inches)	Head (ft)
1.5	0.125
2	0.167
2.5	0.167
3	0.250
4	0.333
5	0.333
6	0.417
8	0.500

Volume to Dewater (cf) =	107,437		
Number of Skimmers	1		
Days to Drain =	5	*assumed*	
Q each (cf/day) =	21,487		0.25 cfs

Selected Skimmer Size (inches) =	5
Head on Skimmer (feet) =	0.333
Diameter of Orifice (inches) =	4.0

Route the flow through the Basin

Riser is not perforated, but skimmer is attached.

$S = (1000/CN) - 10$

Runoff Depth Q* (inches) = $(P-0.2S)^2/(P+0.8S)$ Ref 2, III-4

T_P (min) = $60.5(Q^*)A/Q_P/1.39$

Phase	1	1
Storm Event (yrs) =	10	25
S =	1.24	1.24
Runoff Depth Q* (inches) =	4.04	5.01
Time to Peak T_p (min) =	28.75	29.11

Determine Pond Storage Elevation (Z_{Water}):

Pick one point near max expected water surface and the other at the mid depth.

Z_1 (ft) = 3 S_1 (cf)= 107,437

Z_2 (ft) = 5 S_2 (cf) = 197,227

b = $\ln(S_2/S_1)/\ln(Z_2/Z_1)$ = 1.2 Ref 2, III-8

$K_S = S_2/Z_2^{\,b}$ = 29,092

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Sediment Basin #6	Sheet: 3	Of: 4

Determine Settling Velocity

Conversion Factor = 3.281 ft/sec per m/sec

Gravitational Acceleration, g (m/s^2) = 9.81

Specific Gravity of soil (s_s)= 2.6

Kinematic Viscosity of water (v) = 1.14E-06 n^2 / sec @ 20^o C — Ref 2, IV-11

Diameter of the Design Particle d_{15} = 40.00E-06 m

Design Particle Settling Velocity = $(g / 18) * [(s_s - 1) / \upsilon] d^2$ = 4.02E-03 ft/sec

Route the Storm through the Basin using the Hydrograph Model

Set Height of Emergency Spillway at (ft) = 6.10

Set Top of Dam at (ft) = 7.00

See Hydrograph

Anti-Seep Collar:

Anti-Seep Collar Size = 2 * Barrel Dia

Anti-Seep Collar Size (ft) = 2

Use Anti-Seep Collar Size (ft) = 2 x 2

Minimum Concrete Base for Riser:

Diameter of Riser (in) = 18 — From Hydrograph

Avg Density of Concrete (lbs/cf) = 87.6

Density of Water (lbs/cf) = 62.4

Riser Displacement (cf) = 8.84 — $Pi * (D_R/24)^2$ * Total Ht of Riser

Convert cf to cy = 27^{-1}

Min Concrete Needed (cy) = 0.23

Width & Length (ft) = 2.5

Thickness (ft) = 1.0

Anti-Vortex Device:

Diameter of Riser (in) = 18 — From Hydrograph

Cylinder Diameter (in) = 27 — Ref 4, III-104, Table 3.14-D

Cylinder Thickness (gage) = 16

Cylinder Height (in) = 8

Project: Charah Colon Mine		Computed: PAW	Date: 3/4/15
Subject: Permit Application		Checked: MDP	Date: 3/6/15
Task: Sediment Basin #6		Sheet: 4	Of: 4

Determine Tailwater conditions to size outlet apron

Use Normal Depth Procedure (Manning's Eqn.) Ref 2, II-7

$A*R^{2/3} = Q*n/1.49\ s^{0.5}$ Area (A)= bd+z(d^2) $Z_{av} = A*R^{2/3}$

$Z_{req} = Q*n/1.49s^{0.5}$ R=Area/(b+2d((z^2)+1)^.5)

n =	0.069	6-inch diameter Rip Rap, Lined Channel
Vp (ft/sec) =	9	Permissible Velocity for lining
Side Slope (z) =	5	enter X for X:1
s (ft/ft) =	0.02	Outlet Slope (estimated)
Bottom Width (ft) =	3	3 * Barrel Diameter
Q_B (cfs) =	3.6	Peak Flow out of the barrel 10-yr Hydrograph

Q (cfs)	Z_{req}	Flow Depth d (ft)	A (sf)	R (ft)	Z_{av}	V (ft/sec)
3.6	1.18	0.47	2.5	0.32	1.18	1.4

Flow Depth = Tailwater, d (ft) = 0.47 0.5* Barrel Diameter (ft) = 0.50 Ref 1, 8.06.3

Minimum Tailwater Conditions: d<0.5*Diameter of Outlet Pipe

Maximum Tailwater Conditions: d>0.5*Diameter of Outlet Pipe

Since the Tailwater is less than half of the diameter of the outlet, use Minimum Tailwater conditions.

Barrel Diameter (ft)	Entrance (ft)	Length (ft)	Outlet Width (ft)	Median Rip Rap Size d_{50}	Selected Rip Rap Size (in)
1	3	8	9	0.3	Class A

Conclusion

The temporary basin can contain the 25-yr storm.

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Riser Pipe Perforations/Skimmer Flow	Sheet: 1	Of: 2

Diameter of Riser (in) =	18	
Circumference of Riser (in) =	56.5	
Height of Riser from bottom of barrel (in) =	60	From Hydrograph
Vertical spacing between holes (in) =	0	center to center
Water Stage increment (ft)	0.05	

Orifice Equation

$Q = C_d * A * (2 * g * h)^{0.5}$ Ref 1, p III-11

Q = cfs, discharge

C_d = 0.6 coefficient of discharge

A = sf, cross sectional area

g = 32.2 ft/sec^2, gravity

h = ft, driving head measured from the center of the pipe

	Perforations					Skimmer	
Row	1	2	3	4	5	1	# of skimmers
Holes per row	0	0	0	0	0		
Hole Diameter (in)	0.75	0.75	0.75	0.75	0.75		
Spacing edge to edge (in)							
Inlet Area (sf)	0.000	0.000	0.000	0.000	0.000		
Hole Stage (in)	0.50	0.50	0.50	0.50	0.50		
Hole Stage (ft)	0.04	0.04	0.04	0.04	0.04		

Water Stage (ft)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Total Flow (cfs)
0.00	0.00	0.00	0.00			0.00	0.00
0.04	0.00	0.00	0.00			0.00	0.00
0.09	0.00	0.00	0.00			0.00	0.00
0.14	0.00	0.00	0.00			0.00	0.00
0.19	0.00	0.00	0.00			0.00	0.00
0.24	0.00	0.00	0.00			0.00	0.00
0.29	0.00	0.00	0.00			0.00	0.00
0.34	0.00	0.00	0.00			0.25	0.25
0.39	0.00	0.00	0.00			0.25	0.25
0.44	0.00	0.00	0.00			0.25	0.25
0.49	0.00	0.00	0.00			0.25	0.25
0.54	0.00	0.00	0.00			0.25	0.25
0.59	0.00	0.00	0.00			0.25	0.25
0.64	0.00	0.00	0.00			0.25	0.25
0.69	0.00	0.00	0.00			0.25	0.25
0.74	0.00	0.00	0.00			0.25	0.25
0.79	0.00	0.00	0.00			0.25	0.25
0.84	0.00	0.00	0.00			0.25	0.25
0.89	0.00	0.00	0.00			0.25	0.25
0.94	0.00	0.00	0.00			0.25	0.25
0.99	0.00	0.00	0.00			0.25	0.25
1.04	0.00	0.00	0.00			0.25	0.25
1.09	0.00	0.00	0.00			0.25	0.25
1.14	0.00	0.00	0.00			0.25	0.25
1.19	0.00	0.00	0.00			0.25	0.25
1.24	0.00	0.00	0.00			0.25	0.25
1.29	0.00	0.00	0.00			0.25	0.25
1.34	0.00	0.00	0.00			0.25	0.25
1.39	0.00	0.00	0.00			0.25	0.25
1.44	0.00	0.00	0.00			0.25	0.25
1.49	0.00	0.00	0.00			0.25	0.25
1.54	0.00	0.00	0.00			0.25	0.25
1.59	0.00	0.00	0.00			0.25	0.25

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Riser Pipe Perforations/Skimmer Flow	Sheet: 2	Of: 2

1.64	0.00	0.00	0.00	0.25	0.25
1.69	0.00	0.00	0.00	0.25	0.25
1.74	0.00	0.00	0.00	0.25	0.25
1.79	0.00	0.00	0.00	0.25	0.25
1.84	0.00	0.00	0.00	0.25	0.25
1.89	0.00	0.00	0.00	0.25	0.25
1.94	0.00	0.00	0.00	0.25	0.25
1.99	0.00	0.00	0.00	0.25	0.25
2.04	0.00	0.00	0.00	0.25	0.25
2.09	0.00	0.00	0.00	0.25	0.25
2.14	0.00	0.00	0.00	0.25	0.25
2.19	0.00	0.00	0.00	0.25	0.25
2.24	0.00	0.00	0.00	0.25	0.25
2.29	0.00	0.00	0.00	0.25	0.25
2.34	0.00	0.00	0.00	0.25	0.25
2.39	0.00	0.00	0.00	0.25	0.25
2.44	0.00	0.00	0.00	0.25	0.25
2.49	0.00	0.00	0.00	0.25	0.25
2.54	0.00	0.00	0.00	0.25	0.25
2.59	0.00	0.00	0.00	0.25	0.25
2.64	0.00	0.00	0.00	0.25	0.25
2.69	0.00	0.00	0.00	0.25	0.25
2.74	0.00	0.00	0.00	0.25	0.25
2.79	0.00	0.00	0.00	0.25	0.25
2.84	0.00	0.00	0.00	0.25	0.25
2.89	0.00	0.00	0.00	0.25	0.25
2.94	0.00	0.00	0.00	0.25	0.25
2.99	0.00	0.00	0.00	0.25	0.25
3.04	0.00	0.00	0.00	0.25	0.25
3.09	0.00	0.00	0.00	0.25	0.25
3.14	0.00	0.00	0.00	0.25	0.25
3.19	0.00	0.00	0.00	0.25	0.25
3.24	0.00	0.00	0.00	0.25	0.25
3.29	0.00	0.00	0.00	0.25	0.25
3.34	0.00	0.00	0.00	0.25	0.25
3.39	0.00	0.00	0.00	0.25	0.25
3.44	0.00	0.00	0.00	0.25	0.25
3.49	0.00	0.00	0.00	0.25	0.25
3.54	0.00	0.00	0.00	0.25	0.25
3.59	0.00	0.00	0.00	0.25	0.25
3.64	0.00	0.00	0.00	0.25	0.25
3.69	0.00	0.00	0.00	0.25	0.25
3.74	0.00	0.00	0.00	0.25	0.25
3.79	0.00	0.00	0.00	0.25	0.25
3.84	0.00	0.00	0.00	0.25	0.25
3.89	0.00	0.00	0.00	0.25	0.25
3.94	0.00	0.00	0.00	0.25	0.25
3.99	0.00	0.00	0.00	0.25	0.25

Sediment Basin # 6 Colon

Phase 1

10 - year Storm Event

Qp = 93.60 cfs
Tp = 28.75 minutes
dT = Max of 2 minutes
or 1.0% of increment to peak

b = 1.2
K_s = 29,092

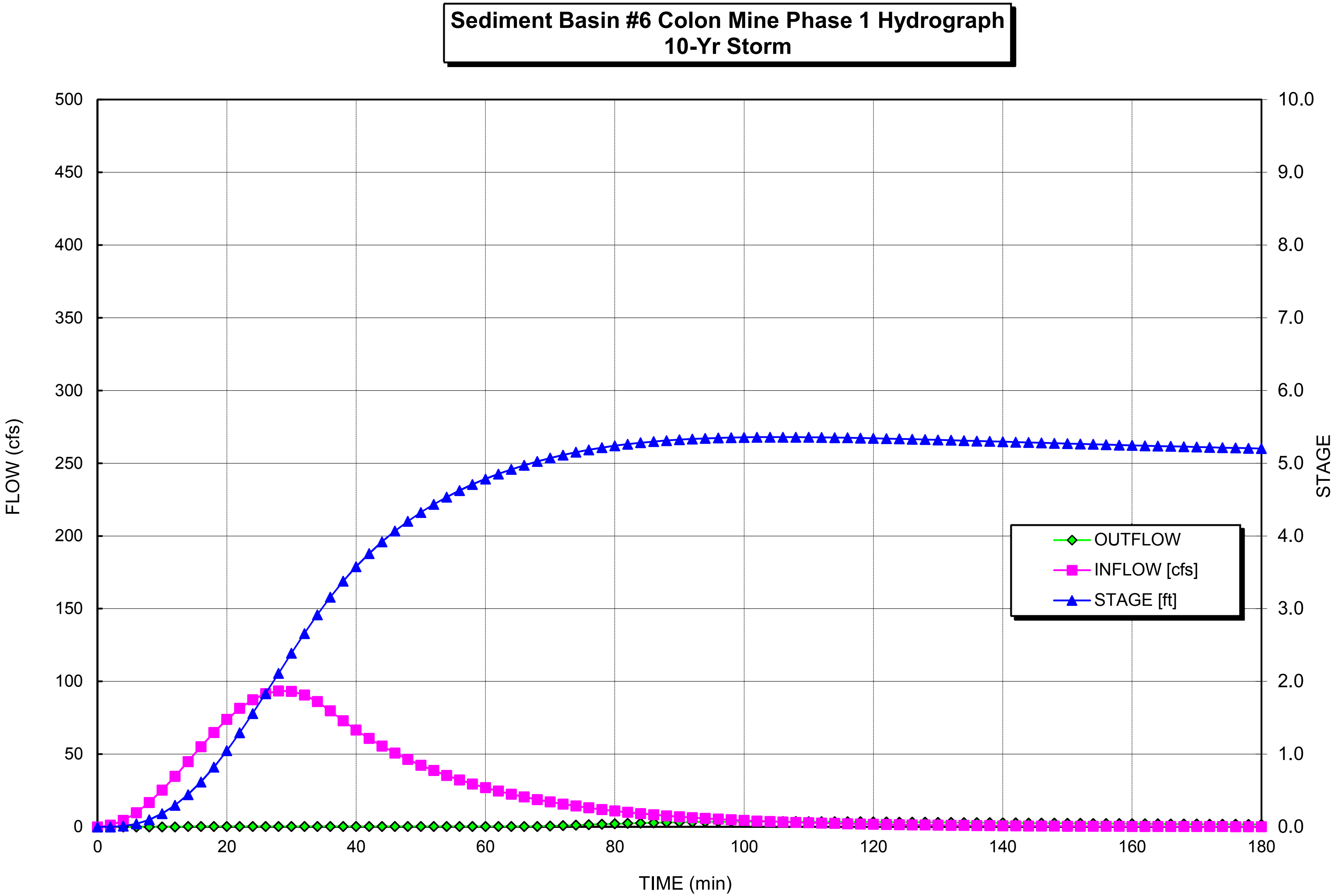
Number of Riser/Barrel Assemblies	1		
Diameter of Barrel =	12	(in)	
Height of Riser above barrel =	4.0	(ft)	
Height of Riser from bottom of barrel=	5.0	(ft) elevation	254.00
Emergency Spillway =	6.1	(ft) elevation	255.10
Total Height of Dam =	7.0	(ft) elevation	256.00
Length of Emergency Spillway =	10	(ft)	
Diameter of Riser =	18	(in)	
Permanent Pond Stage =	0	(ft) elevation	249.0

4.0E-03	Settling Velocity of design particle (fps)		
2	Effective number of cells (2 is construction site #)		
100%	Minimum Settling Efficiency		
5.4	ft Maximum Stage	254.36	msl elevation
3.6	cfs Peak outflow		
3.6	cfs Peak Riser/Barrel outflow		
0.0	cfs Peak Weir flow		

Notes:
1. Length of emergency spillway is the bottom width of the emergency spillway.
2. Settling efficiency neglects permanent pond volume

TIME (min)	INFLOW [cfs]	STORAGE [cu ft]	STAGE [ft]	Skimmer Flow [cfs]	RISER CAPACITY [cfs]	WEIR FLOW [cfs]	BARREL CAPACITY [cfs]	TOTAL OUTFLOW [cfs]	Bound Discharge [cfs]	Estimated Surface Area (sf)	Settling Efficiency [%]
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
2	1.1	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
4	4.4	134	0.0	0.00	0.00	0.00	0.00	0.00	32.33	14,693	N/A
6	9.7	662	0.0	0.00	0.00	0.00	0.00	0.00	41.69	18,952	N/A
8	16.8	1,826	0.1	0.00	0.00	0.00	0.00	0.00	49.00	22,273	N/A
10	25.3	3,839	0.2	0.00	0.00	0.00	0.00	0.00	55.15	25,068	N/A
12	34.8	6,872	0.3	0.00	0.00	0.00	0.00	0.00	60.50	27,500	N/A
14	44.9	11,048	0.4	0.25	0.25	0.00	0.25	0.25	65.25	29,657	100%
16	55.1	16,405	0.6	0.25	0.25	0.00	0.25	0.25	69.48	31,582	100%
18	64.9	22,984	0.8	0.25	0.25	0.00	0.25	0.25	73.31	33,322	100%
20	73.8	30,738	1.0	0.25	0.25	0.00	0.25	0.25	76.78	34,900	100%
22	81.4	39,564	1.3	0.25	0.25	0.00	0.25	0.25	79.92	36,329	100%
24	87.4	49,307	1.6	0.25	0.25	0.00	0.25	0.25	82.77	37,624	100%
26	91.5	59,770	1.8	0.25	0.25	0.00	0.25	0.25	85.35	38,794	100%
28	93.4	70,721	2.1	0.25	0.25	0.00	0.25	0.25	87.66	39,846	100%
30	93.2	81,905	2.4	0.25	0.25	0.00	0.25	0.25	89.73	40,787	100%
32	90.7	93,054	2.7	0.25	0.25	0.00	0.25	0.25	91.57	41,624	100%
34	86.1	103,905	2.9	0.25	0.25	0.00	0.25	0.25	93.19	42,361	100%
36	79.8	114,207	3.2	0.25	0.25	0.00	0.25	0.25	94.61	43,003	100%
38	72.9	123,747	3.4	0.25	0.25	0.00	0.25	0.25	95.82	43,555	100%
40	66.6	132,460	3.6	0.25	0.25	0.00	0.25	0.25	96.86	44,029	100%
42	60.8	140,417	3.8	0.25	0.25	0.00	0.25	0.25	97.77	44,439	100%
44	55.5	147,683	3.9	0.25	0.25	0.00	0.25	0.25	98.55	44,797	100%
46	50.7	154,318	4.1	0.25	0.25	0.00	0.25	0.25	99.25	45,112	100%
48	46.4	160,377	4.2	0.25	0.25	0.00	0.25	0.25	99.86	45,389	100%
50	42.3	165,910	4.3	0.25	0.25	0.00	0.25	0.25	100.40	45,634	100%
52	38.7	170,961	4.4	0.25	0.25	0.00	0.25	0.25	100.88	45,853	100%
54	35.3	175,573	4.5	0.25	0.25	0.00	0.25	0.25	101.30	46,047	100%
56	32.3	179,784	4.6	0.25	0.25	0.00	0.25	0.25	101.69	46,221	100%
58	29.5	183,627	4.7	0.25	0.25	0.00	0.25	0.25	102.03	46,377	100%
60	26.9	187,136	4.8	0.25	0.25	0.00	0.25	0.25	102.34	46,517	100%
62	24.6	190,339	4.9	0.25	0.25	0.00	0.25	0.25	102.61	46,643	100%
64	22.5	193,263	4.9	0.25	0.25	0.00	0.25	0.25	102.86	46,756	100%
66	20.5	195,931	5.0	0.25	0.25	0.00	0.25	0.25	103.09	46,858	100%
68	18.8	198,365	5.0	0.25	0.31	0.00	8.03	0.31	103.29	46,950	100%
70	17.1	200,580	5.1	0.25	0.55	0.00	8.07	0.55	103.47	47,033	100%
72	15.7	202,571	5.1	0.25	0.84	0.00	8.11	0.84	103.64	47,107	100%
74	14.3	204,349	5.2	0.25	1.16	0.00	8.14	1.16	103.78	47,172	100%
76	13.1	205,925	5.2	0.25	1.48	0.00	8.17	1.48	103.91	47,230	100%
78	11.9	207,315	5.2	0.25	1.79	0.00	8.20	1.79	104.02	47,281	100%
80	10.9	208,533	5.2	0.25	2.08	0.00	8.22	2.08	104.11	47,325	100%
82	10.0	209,592	5.3	0.25	2.34	0.00	8.24	2.34	104.20	47,363	100%

84	9.1	210,507	5.3	0.25	2.57	0.00	8.26	2.57	104.27	47,396	100%
86	8.3	211,290	5.3	0.25	2.78	0.00	8.27	2.78	104.33	47,424	100%
88	7.6	211,954	5.3	0.25	2.96	0.00	8.28	2.96	104.38	47,447	100%
90	6.9	212,510	5.3	0.25	3.11	0.00	8.29	3.11	104.43	47,467	100%
92	6.3	212,969	5.3	0.25	3.24	0.00	8.30	3.24	104.46	47,484	100%
94	5.8	213,340	5.3	0.25	3.35	0.00	8.31	3.35	104.49	47,497	100%
96	5.3	213,633	5.3	0.25	3.43	0.00	8.31	3.43	104.52	47,507	100%
98	4.8	213,855	5.4	0.25	3.50	0.00	8.32	3.50	104.53	47,515	100%
100	4.4	214,015	5.4	0.25	3.55	0.00	8.32	3.55	104.55	47,521	100%
102	4.0	214,119	5.4	0.25	3.58	0.00	8.32	3.58	104.55	47,524	100%
104	3.7	214,174	5.4	0.25	3.59	0.00	8.32	3.59	104.56	47,526	100%
106	3.4	214,185	5.4	0.25	3.60	0.00	8.32	3.60	104.56	47,527	100%
108	3.1	214,157	5.4	0.25	3.59	0.00	8.32	3.59	104.56	47,526	100%
110	2.8	214,096	5.4	0.25	3.57	0.00	8.32	3.57	104.55	47,523	100%
112	2.6	214,004	5.4	0.25	3.54	0.00	8.32	3.54	104.54	47,520	100%
114	2.3	213,887	5.4	0.25	3.51	0.00	8.32	3.51	104.54	47,516	100%
116	2.1	213,747	5.3	0.25	3.47	0.00	8.31	3.47	104.52	47,511	100%
118	2.0	213,588	5.3	0.25	3.42	0.00	8.31	3.42	104.51	47,505	100%
120	1.8	213,412	5.3	0.25	3.37	0.00	8.31	3.37	104.50	47,499	100%
122	1.6	213,222	5.3	0.25	3.32	0.00	8.31	3.32	104.48	47,493	100%
124	1.5	213,020	5.3	0.25	3.26	0.00	8.30	3.26	104.47	47,485	100%
126	1.4	212,808	5.3	0.25	3.20	0.00	8.30	3.20	104.45	47,478	100%
128	1.2	212,588	5.3	0.25	3.14	0.00	8.29	3.14	104.43	47,470	100%
130	1.1	212,360	5.3	0.25	3.07	0.00	8.29	3.07	104.42	47,462	100%
132	1.0	212,128	5.3	0.25	3.01	0.00	8.29	3.01	104.40	47,454	100%
134	0.9	211,892	5.3	0.25	2.94	0.00	8.28	2.94	104.38	47,445	100%
136	0.9	211,652	5.3	0.25	2.88	0.00	8.28	2.88	104.36	47,437	100%
138	0.8	211,411	5.3	0.25	2.81	0.00	8.27	2.81	104.34	47,428	100%
140	0.7	211,168	5.3	0.25	2.75	0.00	8.27	2.75	104.32	47,419	100%
142	0.7	210,925	5.3	0.25	2.68	0.00	8.26	2.68	104.30	47,411	100%
144	0.6	210,683	5.3	0.25	2.62	0.00	8.26	2.62	104.28	47,402	100%
146	0.6	210,441	5.3	0.25	2.56	0.00	8.26	2.56	104.27	47,393	100%
148	0.5	210,200	5.3	0.25	2.49	0.00	8.25	2.49	104.25	47,385	100%
150	0.5	209,962	5.3	0.25	2.43	0.00	8.25	2.43	104.23	47,376	100%
152	0.4	209,725	5.3	0.25	2.37	0.00	8.24	2.37	104.21	47,368	100%
154	0.4	209,491	5.3	0.25	2.31	0.00	8.24	2.31	104.19	47,359	100%
156	0.4	209,259	5.3	0.25	2.25	0.00	8.23	2.25	104.17	47,351	100%
158	0.3	209,031	5.3	0.25	2.20	0.00	8.23	2.20	104.15	47,343	100%
160	0.3	208,806	5.2	0.25	2.14	0.00	8.23	2.14	104.14	47,335	100%
162	0.3	208,584	5.2	0.25	2.09	0.00	8.22	2.09	104.12	47,327	100%
164	0.2	208,365	5.2	0.25	2.04	0.00	8.22	2.04	104.10	47,319	100%
166	0.2	208,150	5.2	0.25	1.98	0.00	8.21	1.98	104.08	47,311	100%
168	0.2	207,939	5.2	0.25	1.93	0.00	8.21	1.93	104.07	47,303	100%
170	0.2	207,731	5.2	0.25	1.89	0.00	8.21	1.89	104.05	47,296	100%
172	0.2	207,527	5.2	0.25	1.84	0.00	8.20	1.84	104.03	47,288	100%
174	0.2	207,327	5.2	0.25	1.79	0.00	8.20	1.79	104.02	47,281	100%
176	0.1	207,130	5.2	0.25	1.75	0.00	8.19	1.75	104.00	47,274	100%
178	0.1	206,937	5.2	0.25	1.70	0.00	8.19	1.70	103.99	47,267	100%
180	0.1	206,748	5.2	0.25	1.66	0.00	8.19	1.66	103.97	47,260	100%
182	0.1	206,563	5.2	0.25	1.62	0.00	8.18	1.62	103.96	47,253	100%
184	0.1	206,381	5.2	0.25	1.58	0.00	8.18	1.58	103.94	47,247	100%
186	0.1	206,203	5.2	0.25	1.54	0.00	8.18	1.54	103.93	47,240	100%
188	0.1	206,029	5.2	0.25	1.51	0.00	8.17	1.51	103.91	47,234	100%
190	0.1	205,858	5.2	0.25	1.47	0.00	8.17	1.47	103.90	47,228	100%
192	0.1	205,691	5.2	0.25	1.43	0.00	8.17	1.43	103.89	47,222	100%
194	0.1	205,527	5.2	0.25	1.40	0.00	8.16	1.40	103.87	47,216	100%
196	0.1	205,366	5.2	0.25	1.37	0.00	8.16	1.37	103.86	47,210	100%
198	0.1	205,209	5.2	0.25	1.34	0.00	8.16	1.34	103.85	47,204	100%
200	0.0	205,055	5.2	0.25	1.30	0.00	8.16	1.30	103.84	47,198	100%
202	0.0	204,905	5.2	0.25	1.27	0.00	8.15	1.27	103.82	47,193	100%
204	0.0	204,757	5.2	0.25	1.24	0.00	8.15	1.24	103.81	47,187	100%
206	0.0	204,612	5.2	0.25	1.22	0.00	8.15	1.22	103.80	47,182	100%



Sediment Basin #6 Colon Mine Phase 1 Hydrograph
10-Yr Storm
FLOW (cfs)
STAGE
TIME (min)
OUTFLOW
INFLOW [cfs]
STAGE [ft]
0
50
100
150
200
250
300
350
400
450
500
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
0
20
40
60
80
100
120
140
160
180

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Qp = 114.53 cfs

Tp = 29.11 minutes

dT = Max of 2 minutes

or 1.0% of increment to peak

Sediment Basin # 6 Colon

Phase 1

25 - year Storm Event

b = 1.2

K_s = 29,092

Number of Riser/Barrel Assemblies	1		
Diameter of Barrel =	12	(in)	
Height of Riser above barrel =	4	(ft)	
Height of Riser from bottom of barrel=	5	(ft) elevation	254.00
Emergency Spillway =	6.1	(ft) elevation	255.10
Total Height of Dam =	7	(ft) elevation	256.00
Length of Emergency Spillway =	10	(ft)	
Diameter of Riser =	18	(in)	
Permanent Pond Stage =	0	(ft) elevation	249.0

4.0E-03 Settling Velocity of design particle (fps)

2 Effective number of cells (2 is construction site #)

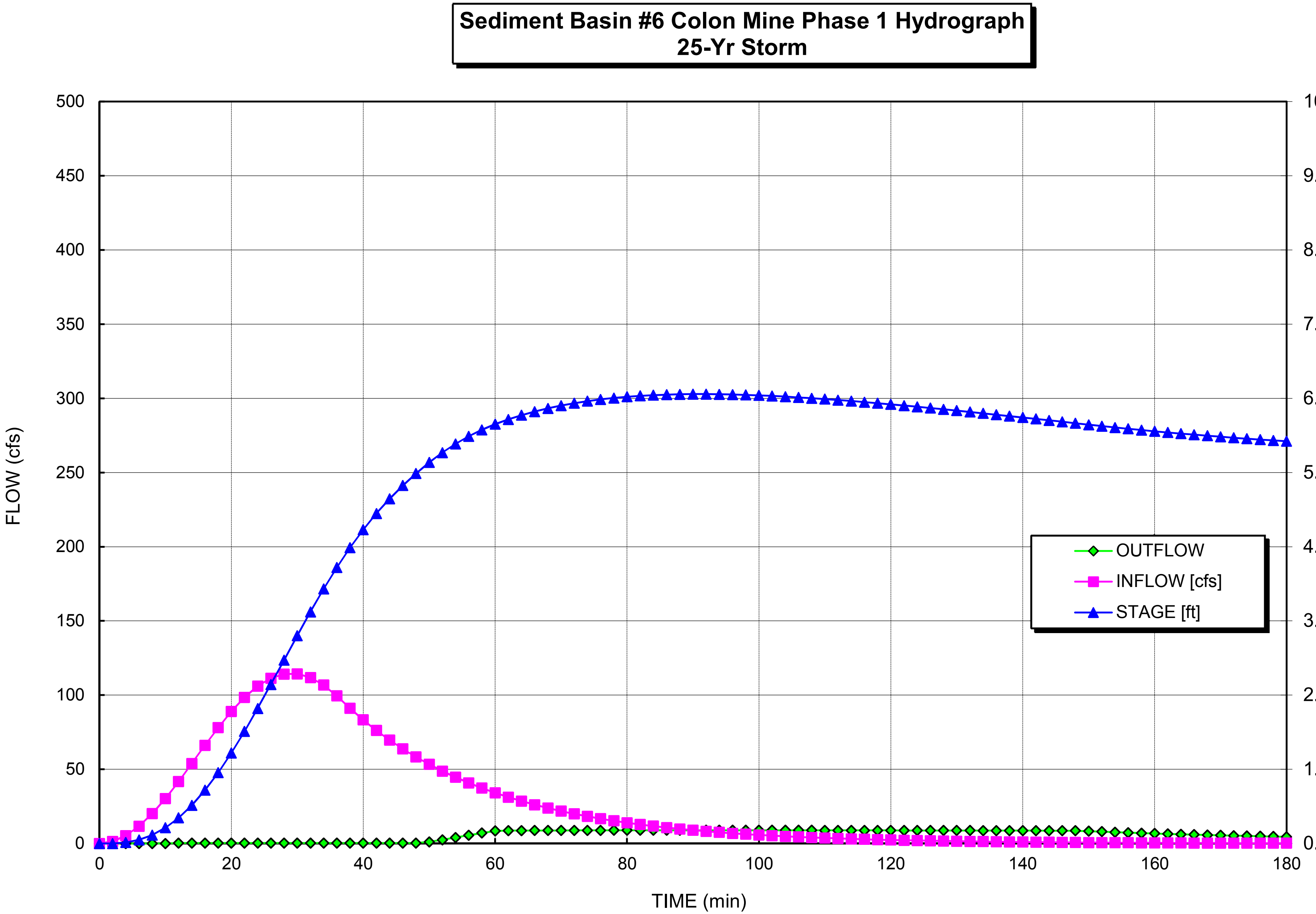
99%	Minimum Settling Efficiency		
6.1	ft Maximum Stage	255.06	msl elevation
8.9	cfs Peak outflow		
8.9	cfs Peak Riser/Barrel outflow		
0.0	cfs Peak Weir flow		

Notes:

1. Length of emergency spillway is the bottom width of the emergency spillway.
2. Settling efficiency neglects permanent pond volume

TIME (min)	INFLOW [cfs]	STORAGE [cu ft]	STAGE [ft]	Skimmer Flow [cfs]	RISER CAPACITY [cfs]	WEIR FLOW [cfs]	BARREL CAPACITY [cfs]	TOTAL OUTFLOW [cfs]	Bound Discharge [cfs]	Estimated Surface Area (sf)	Settling Efficiency [%]
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
2	1.3	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
4	5.3	159	0.0	0.00	0.00	0.00	0.00	0.00	33.25	15,112	N/A
6	11.6	790	0.0	0.00	0.00	0.00	0.00	0.00	42.88	19,492	N/A
8	20.0	2,180	0.1	0.00	0.00	0.00	0.00	0.00	50.40	22,910	N/A
10	30.2	4,586	0.2	0.00	0.00	0.00	0.00	0.00	56.73	25,786	N/A
12	41.7	8,213	0.3	0.25	0.25	0.00	0.25	0.25	62.24	28,291	100%
14	53.8	13,183	0.5	0.25	0.25	0.00	0.25	0.25	67.11	30,503	100%
16	66.1	19,613	0.7	0.25	0.25	0.00	0.25	0.25	71.48	32,492	100%
18	78.1	27,521	1.0	0.25	0.25	0.00	0.25	0.25	75.44	34,291	100%
20	89.0	36,858	1.2	0.25	0.25	0.00	0.25	0.25	79.03	35,922	100%
22	98.5	47,508	1.5	0.25	0.25	0.00	0.25	0.25	82.29	37,402	100%
24	106.0	59,295	1.8	0.25	0.25	0.00	0.25	0.25	85.24	38,745	100%
26	111.3	71,989	2.1	0.25	0.25	0.00	0.25	0.25	87.91	39,959	100%
28	114.1	85,318	2.5	0.25	0.25	0.00	0.25	0.25	90.32	41,053	100%
30	114.3	98,983	2.8	0.25	0.25	0.00	0.25	0.25	92.48	42,035	100%
32	111.8	112,665	3.1	0.25	0.25	0.00	0.25	0.25	94.40	42,910	100%
34	106.8	126,048	3.4	0.25	0.25	0.00	0.25	0.25	96.10	43,683	100%
36	99.4	138,828	3.7	0.25	0.25	0.00	0.25	0.25	97.59	44,359	100%
38	91.1	150,730	4.0	0.25	0.25	0.00	0.25	0.25	98.87	44,943	100%
40	83.3	161,632	4.2	0.25	0.25	0.00	0.25	0.25	99.98	45,445	100%
42	76.2	171,599	4.4	0.25	0.25	0.00	0.25	0.25	100.94	45,880	100%
44	69.7	180,713	4.6	0.25	0.25	0.00	0.25	0.25	101.77	46,259	100%
46	63.7	189,045	4.8	0.25	0.25	0.00	0.25	0.25	102.50	46,592	100%
48	58.3	196,663	5.0	0.25	0.25	0.00	0.25	0.25	103.15	46,886	100%
50	53.3	203,627	5.1	0.25	1.03	0.00	8.13	1.03	103.72	47,146	100%
52	48.8	209,900	5.3	0.25	2.42	0.00	8.25	2.42	104.22	47,374	100%
54	44.6	215,461	5.4	0.25	3.98	0.00	8.35	3.98	104.66	47,571	100%
56	40.8	220,334	5.5	0.25	5.55	0.00	8.43	5.55	105.03	47,741	100%
58	37.3	224,561	5.6	0.25	7.06	0.00	8.51	7.06	105.35	47,886	100%
60	34.1	228,189	5.7	0.25	8.44	0.00	8.57	8.44	105.62	48,008	99%
62	31.2	231,269	5.7	0.25	9.68	0.00	8.62	8.62	105.84	48,110	99%
64	28.5	233,977	5.8	0.25	10.81	0.00	8.67	8.67	106.04	48,199	99%
66	26.1	236,360	5.8	0.25	11.84	0.00	8.71	8.71	106.21	48,277	99%
68	23.9	238,446	5.9	0.25	12.76	0.00	8.75	8.75	106.36	48,345	99%
70	21.8	240,260	5.9	0.25	13.59	0.00	8.78	8.78	106.49	48,403	99%
72	20.0	241,826	5.9	0.25	14.31	0.00	8.80	8.80	106.60	48,453	99%
74	18.3	243,165	6.0	0.25	14.94	0.00	8.82	8.82	106.69	48,496	99%
76	16.7	244,296	6.0	0.25	15.47	0.00	8.84	8.84	106.77	48,532	99%
78	15.3	245,238	6.0	0.25	15.93	0.00	8.86	8.86	106.83	48,561	99%
80	14.0	246,007	6.0	0.25	16.30	0.00	8.87	8.87	106.89	48,585	99%
82	12.8	246,618	6.0	0.25	16.59	0.00	8.88	8.88	106.93	48,605	99%

84	11.7	247,085	6.0	0.25	16.82	0.00	8.89	8.89	106.96	48,619	99%
86	10.7	247,420	6.1	0.25	16.99	0.00	8.90	8.90	106.99	48,630	99%
88	9.8	247,634	6.1	0.25	17.09	0.00	8.90	8.90	107.00	48,636	99%
90	8.9	247,739	6.1	0.25	17.14	0.00	8.90	8.90	107.01	48,640	99%
92	8.2	247,743	6.1	0.25	17.15	0.00	8.90	8.90	107.01	48,640	99%
94	7.5	247,655	6.1	0.25	17.10	0.00	8.90	8.90	107.00	48,637	99%
96	6.8	247,484	6.1	0.25	17.02	0.00	8.90	8.90	106.99	48,632	99%
98	6.3	247,237	6.0	0.25	16.90	0.00	8.89	8.89	106.97	48,624	99%
100	5.7	246,920	6.0	0.25	16.74	0.00	8.89	8.89	106.95	48,614	99%
102	5.2	246,540	6.0	0.25	16.56	0.00	8.88	8.88	106.92	48,602	99%
104	4.8	246,101	6.0	0.25	16.34	0.00	8.87	8.87	106.89	48,588	99%
106	4.4	245,610	6.0	0.25	16.10	0.00	8.87	8.87	106.86	48,573	99%
108	4.0	245,071	6.0	0.25	15.84	0.00	8.86	8.86	106.82	48,556	99%
110	3.7	244,488	6.0	0.25	15.57	0.00	8.85	8.85	106.78	48,538	99%
112	3.3	243,866	6.0	0.25	15.27	0.00	8.84	8.84	106.74	48,518	99%
114	3.1	243,207	6.0	0.25	14.96	0.00	8.83	8.83	106.69	48,497	99%
116	2.8	242,515	5.9	0.25	14.63	0.00	8.81	8.81	106.65	48,475	99%
118	2.6	241,793	5.9	0.25	14.29	0.00	8.80	8.80	106.59	48,452	99%
120	2.3	241,044	5.9	0.25	13.95	0.00	8.79	8.79	106.54	48,428	99%
122	2.1	240,270	5.9	0.25	13.59	0.00	8.78	8.78	106.49	48,403	99%
124	2.0	239,474	5.9	0.25	13.23	0.00	8.76	8.76	106.43	48,378	99%
126	1.8	238,657	5.9	0.25	12.86	0.00	8.75	8.75	106.37	48,352	99%
128	1.6	237,822	5.9	0.25	12.48	0.00	8.74	8.74	106.31	48,325	99%
130	1.5	236,970	5.8	0.25	12.11	0.00	8.72	8.72	106.25	48,297	99%
132	1.4	236,104	5.8	0.25	11.73	0.00	8.71	8.71	106.19	48,269	99%
134	1.3	235,223	5.8	0.25	11.34	0.00	8.69	8.69	106.13	48,240	99%
136	1.1	234,331	5.8	0.25	10.96	0.00	8.68	8.68	106.06	48,211	99%
138	1.0	233,427	5.8	0.25	10.58	0.00	8.66	8.66	106.00	48,181	99%
140	1.0	232,513	5.7	0.25	10.19	0.00	8.64	8.64	105.93	48,151	99%
142	0.9	231,591	5.7	0.25	9.81	0.00	8.63	8.63	105.87	48,121	99%
144	0.8	230,661	5.7	0.25	9.43	0.00	8.61	8.61	105.80	48,090	99%
146	0.7	229,723	5.7	0.25	9.05	0.00	8.60	8.60	105.73	48,059	99%
148	0.7	228,780	5.7	0.25	8.67	0.00	8.58	8.58	105.66	48,028	99%
150	0.6	227,830	5.6	0.25	8.30	0.00	8.56	8.30	105.59	47,996	99%
152	0.6	226,908	5.6	0.25	7.94	0.00	8.55	7.94	105.52	47,965	99%
154	0.5	226,022	5.6	0.25	7.61	0.00	8.53	7.61	105.46	47,935	99%
156	0.5	225,171	5.6	0.25	7.28	0.00	8.52	7.28	105.39	47,906	100%
158	0.4	224,353	5.6	0.25	6.98	0.00	8.50	6.98	105.33	47,879	100%
160	0.4	223,567	5.6	0.25	6.69	0.00	8.49	6.69	105.27	47,852	100%
162	0.4	222,811	5.5	0.25	6.42	0.00	8.48	6.42	105.22	47,826	100%
164	0.3	222,083	5.5	0.25	6.16	0.00	8.46	6.16	105.16	47,801	100%
166	0.3	221,383	5.5	0.25	5.92	0.00	8.45	5.92	105.11	47,777	100%
168	0.3	220,709	5.5	0.25	5.68	0.00	8.44	5.68	105.06	47,754	100%
170	0.3	220,061	5.5	0.25	5.46	0.00	8.43	5.46	105.01	47,732	100%
172	0.2	219,435	5.5	0.25	5.25	0.00	8.42	5.25	104.96	47,710	100%
174	0.2	218,833	5.5	0.25	5.05	0.00	8.41	5.05	104.92	47,689	100%
176	0.2	218,252	5.4	0.25	4.86	0.00	8.40	4.86	104.87	47,669	100%
178	0.2	217,692	5.4	0.25	4.68	0.00	8.39	4.68	104.83	47,650	100%
180	0.2	217,152	5.4	0.25	4.50	0.00	8.38	4.50	104.79	47,631	100%
182	0.1	216,631	5.4	0.25	4.34	0.00	8.37	4.34	104.75	47,612	100%
184	0.1	216,128	5.4	0.25	4.18	0.00	8.36	4.18	104.71	47,595	100%
186	0.1	215,642	5.4	0.25	4.03	0.00	8.35	4.03	104.67	47,578	100%
188	0.1	215,173	5.4	0.25	3.89	0.00	8.34	3.89	104.63	47,561	100%
190	0.1	214,720	5.4	0.25	3.75	0.00	8.33	3.75	104.60	47,545	100%
192	0.1	214,281	5.4	0.25	3.62	0.00	8.32	3.62	104.57	47,530	100%
194	0.1	213,858	5.4	0.25	3.50	0.00	8.32	3.50	104.53	47,515	100%
196	0.1	213,448	5.3	0.25	3.38	0.00	8.31	3.38	104.50	47,501	100%
198	0.1	213,052	5.3	0.25	3.27	0.00	8.30	3.27	104.47	47,486	100%
200	0.1	212,668	5.3	0.25	3.16	0.00	8.30	3.16	104.44	47,473	100%
202	0.1	212,297	5.3	0.25	3.06	0.00	8.29	3.06	104.41	47,460	100%
204	0.1	211,938	5.3	0.25	2.96	0.00	8.28	2.96	104.38	47,447	100%
206	0.1	211,590	5.3	0.25	2.86	0.00	8.28	2.86	104.36	47,434	100%



Sediment Basin #6 Colon Mine Phase 1 Hydrograph
25-Yr Storm
FLOW (cfs)
STAGE
TIME (min)
OUTFLOW
INFLOW [cfs]
STAGE [ft]
0
50
100
150
200
250
300
350
400
450
500
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
0
20
40
60
80
100
120
140
160
180

Project: Charah Colon Mine		Computed: PAW	Date: 3/4/15
Subject: Permit Application		Checked: MDP	Date: 3/6/15
Task: Sediment Basin #8		Sheet: 1	Of: 4

Objective Design the temporary sediment basin to contain the 25-year storm.

References

1. NC Erosion and Sediment Control Planning and Design Manual.
2. "Elements of Urban Stormwater Design" by H. Rooney Malcom, P.E.
3. NOAA Atlas 14, Volume 2, Version 3
4. VA Erosion and Sediment Control Handbook

Given

Phase	1	1	
Storm Event (yrs) =	10	25	
Total Drainage Area A (ac) =	11.8	11.8	
Disturbed Area (ac) =	11.8	11.8	
Curve Number CN =	86	86	Hydrographs
Rainfall Depth P (in) =	5.28	6.28	(24-hr rainfall) Ref 3
Peak Flow Q_p (cfs) =	71.25	88.20	Hydrographs

Design Criteria

Required sediment storage	1,800	cf / acre of drainage
Required sediment storage	21,240	cf
Required Surface Area	435	sf/cfs of the 10-yr storm peak flow (based on the largest Phase in cfs)
Required Surface Area (SF)	38,367	of the 10-yr storm peak flow (based on the largest Phase)

Determine Shape of Basin:

Measure the area of the Basin using AutoCADD.
Calculate Volume of the Basin using Truncated Pyramid Method.
Shape factor used in hydrographs basin depth may be gretaer than indicated below

Elevation (ft)	Depth (ft)	Area (sf)	Volume (cf)	Cumulative Vol (cf)	Cumulative Vol (cy)
273	0	5,639	-	-	-
274	1	18,291	11,362	11,362	421
275	2	28,277	23,103	34,465	1,276
276	3	38,333	33,178	67,643	2,505
277	4	47,710	42,936	110,579	4,096
278	5	59,010	53,260	163,839	6,068
279	6	69,292	64,082	227,922	8,442

Design Sediment Depth (ft) = 3
Sediment Storage (cf) = 67,643 *Required Sediment Storage Achieved*

Design Surface Area Depth (ft) = 3
Surface Area (sf) = 38,333 *Increase Surface Area*

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Sediment Basin #8	Sheet: 2	Of: 4

Select Skimmer

A. R. Jarrett Method

$D = [Q / (2{,}310 * (H^{0.5})]^{0.5}$

D =Diameter of Orifice (inches)

Q = Dewater Rate (cf/day)

H = Head on orifice, varies based on skimmer size (ft)

Skimmer Sizes (Inches)	Head (ft)
1.5	0.125
2	0.167
2.5	0.167
3	0.250
4	0.333
5	0.333
6	0.417
8	0.500

Volume to Dewater (cf) =	67,643		
Number of Skimmers	1		
Days to Drain =	5	*assumed*	
Q each (cf/day) =	13,529		0.16 cfs
Selected Skimmer Size (inches) =	4		
Head on Skimmer (feet) =	0.333		
Diameter of Orifice (inches) =	3.2		

Route the flow through the Basin

Riser is not perforated, but skimmer is attached.

$S = (1000/CN) - 10$

Runoff Depth Q* (inches) = $(P-0.2S)^2/(P+0.8S)$ Ref 2, III-4

T_P (min) = $60.5(Q^*)A/Q_P/1.39$

Phase	1	1
Storm Event (yrs) =	10	25
S =	1.63	1.63
Runoff Depth Q* (inches) =	3.73	4.68
Time to Peak T_p (min) =	26.88	27.23

Determine Pond Storage Elevation (Z_{Water}):

Pick one point near max expected water surface and the other at the mid depth.

Z_1 (ft) = 3 S_1 (cf)= 67,643

Z_2 (ft) = 5 S_2 (cf) = 163,839

b = $\ln(S_2/S_1)/\ln(Z_2/Z_1)$ = 1.7 Ref 2, III-8

$K_S = S_2/Z_2^b$ = 10,091

Project: Charah Colon Mine		Computed: PAW	Date: 3/4/15
Subject: Permit Application		Checked: MDP	Date: 3/6/15
Task: Sediment Basin #8		Sheet: 3	Of: 4

Determine Settling Velocity

Conversion Factor = 3.281 ft/sec per m/sec

Gravitational Acceleration, g (m/s^2) = 9.81

Specific Gravity of soil (s_s)= 2.6

Kinematic Viscosity of water (v) = 1.14E-06 n^2 / sec @ 20° C — Ref 2, IV-11

Diameter of the Design Particle d_{15} = 40.00E-06 m

Design Particle Settling Velocity = $(g / 18) * [(s_s - 1) / \upsilon] d^2$ = 4.02E-03 ft/sec

Route the Storm through the Basin using the Hydrograph Model

Set Height of Emergency Spillway at (ft) = 5.30

Set Top of Dam at (ft) = 6.00

See Hydrograph

Anti-Seep Collar:

Anti-Seep Collar Size = 2 * Barrel Dia

Anti-Seep Collar Size (ft) = 2

Use Anti-Seep Collar Size (ft) = 2 x 2

Minimum Concrete Base for Riser:

Diameter of Riser (in) = 18 — From Hydrograph

Avg Density of Concrete (lbs/cf) = 87.6

Density of Water (lbs/cf) = 62.4

Riser Displacement (cf) = 7.95 — Pi * $(D_R/24)^2$ * Total Ht of Riser

Convert cf to cy = 27^{-1}

Min Concrete Needed (cy) = 0.21

Width & Length (ft) = 2.5

Thickness (ft) = 0.9

Anti-Vortex Device:

Diameter of Riser (in) = 18 — From Hydrograph

Cylinder Diameter (in) = 27 — Ref 4, III-104, Table 3.14-D

Cylinder Thickness (gage) = 16

Cylinder Height (in) = 8

Project: Charah Colon Mine		Computed: PAW	Date: 3/4/15
Subject: Permit Application		Checked: MDP	Date: 3/6/15
Task: Sediment Basin #8		Sheet: 4	Of: 4

Determine Tailwater conditions to size outlet apron

Use Normal Depth Procedure (Manning's Eqn.) Ref 2, II-7

$A*R^{2/3} = Q*n/1.49\ s^{0.5}$ Area (A)= bd+z(d^2) $Z_{av} = A*R^{2/3}$

$Z_{req} = Q*n/1.49s^{0.5}$ R=Area/(b+2d((z^2)+1)^.5)

n =	0.069	6-inch diameter Rip Rap, Lined Channel
Vp (ft/sec) =	9	Permissible Velocity for lining
Side Slope (z) =	5	enter X for X:1
s (ft/ft) =	0.02	Outlet Slope (estimated)
Bottom Width (ft) =	6	6 * Barrel Diameter
Q_B (cfs) =	2.6	Peak Flow out of the barrel 10-yr Hydrograph

Q (cfs)	Z_{req}	Flow Depth d (ft)	A (sf)	R (ft)	Z_{av}	V (ft/sec)
2.6	0.86	0.29	2.2	0.24	0.86	1.2

Flow Depth = Tailwater, d (ft) = 0.29   0.5* Barrel Diameter (ft) = 0.50   Ref 1, 8.06.3

Minimum Tailwater Conditions: d<0.5*Diameter of Outlet Pipe

Maximum Tailwater Conditions: d>0.5*Diameter of Outlet Pipe

Since the Tailwater is less than half of the diameter of the outlet, use Minimum Tailwater conditions.

Barrel Diameter (ft)	Entrance (ft)	Length (ft)	Outlet Width (ft)	Median Rip Rap Size d_{50}	Selected Rip Rap Size (in)
1	3	8	9	0.3	Class A

Conclusion

The temporary basin can contain the 25-yr storm.

Project:	Charah Colon Mine	Computed: PAW	Date: 3/4/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Riser Pipe Perforations/Skimmer Flow	Sheet: 1	Of: 2

Diameter of Riser (in) =	18	
Circumference of Riser (in) =	56.5	
Height of Riser from bottom of barrel (in) =	54	From Hydrograph
Vertical spacing between holes (in) =	0	center to center
Water Stage increment (ft)	0.05	

Orifice Equation

$Q = C_d * A * (2 * g * h)^{0.5}$ Ref 1, p III-11

Q = cfs, discharge

C_d = 0.6 coefficient of discharge

A = sf, cross sectional area

g = 32.2 ft/sec^2, gravity

h = ft, driving head measured from the center of the pipe

	Perforations					Skimmer	
Row	1	2	3	4	5	1	# of skimmers
Holes per row	0	0	0	0	0		
Hole Diameter (in)	0.75	0.75	0.75	0.75	0.75		
Spacing edge to edge (in)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		
Inlet Area (sf)	0.000	0.000	0.000	0.000	0.000		
Hole Stage (in)	0.50	0.50	0.50	0.50	0.50		
Hole Stage (ft)	0.04	0.04	0.04	0.04	0.04		

Water Stage (ft)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Total Flow (cfs)
0.00	0.00	0.00	0.00			0.00	0.00
0.04	0.00	0.00	0.00			0.00	0.00
0.09	0.00	0.00	0.00			0.00	0.00
0.14	0.00	0.00	0.00			0.00	0.00
0.19	0.00	0.00	0.00			0.00	0.00
0.24	0.00	0.00	0.00			0.00	0.00
0.29	0.00	0.00	0.00			0.00	0.00
0.34	0.00	0.00	0.00			0.16	0.16
0.39	0.00	0.00	0.00			0.16	0.16
0.44	0.00	0.00	0.00			0.16	0.16
0.49	0.00	0.00	0.00			0.16	0.16
0.54	0.00	0.00	0.00			0.16	0.16
0.59	0.00	0.00	0.00			0.16	0.16
0.64	0.00	0.00	0.00			0.16	0.16
0.69	0.00	0.00	0.00			0.16	0.16
0.74	0.00	0.00	0.00			0.16	0.16
0.79	0.00	0.00	0.00			0.16	0.16
0.84	0.00	0.00	0.00			0.16	0.16
0.89	0.00	0.00	0.00			0.16	0.16
0.94	0.00	0.00	0.00			0.16	0.16
0.99	0.00	0.00	0.00			0.16	0.16
1.04	0.00	0.00	0.00			0.16	0.16
1.09	0.00	0.00	0.00			0.16	0.16
1.14	0.00	0.00	0.00			0.16	0.16
1.19	0.00	0.00	0.00			0.16	0.16
1.24	0.00	0.00	0.00			0.16	0.16
1.29	0.00	0.00	0.00			0.16	0.16
1.34	0.00	0.00	0.00			0.16	0.16
1.39	0.00	0.00	0.00			0.16	0.16
1.44	0.00	0.00	0.00			0.16	0.16
1.49	0.00	0.00	0.00			0.16	0.16
1.54	0.00	0.00	0.00			0.16	0.16
1.59	0.00	0.00	0.00			0.16	0.16

1.64	0.00	0.00	0.00	0.16	0.16
1.69	0.00	0.00	0.00	0.16	0.16
1.74	0.00	0.00	0.00	0.16	0.16
1.79	0.00	0.00	0.00	0.16	0.16
1.84	0.00	0.00	0.00	0.16	0.16
1.89	0.00	0.00	0.00	0.16	0.16
1.94	0.00	0.00	0.00	0.16	0.16
1.99	0.00	0.00	0.00	0.16	0.16
2.04	0.00	0.00	0.00	0.16	0.16
2.09	0.00	0.00	0.00	0.16	0.16
2.14	0.00	0.00	0.00	0.16	0.16
2.19	0.00	0.00	0.00	0.16	0.16
2.24	0.00	0.00	0.00	0.16	0.16
2.29	0.00	0.00	0.00	0.16	0.16
2.34	0.00	0.00	0.00	0.16	0.16
2.39	0.00	0.00	0.00	0.16	0.16
2.44	0.00	0.00	0.00	0.16	0.16
2.49	0.00	0.00	0.00	0.16	0.16
2.54	0.00	0.00	0.00	0.16	0.16
2.59	0.00	0.00	0.00	0.16	0.16
2.64	0.00	0.00	0.00	0.16	0.16
2.69	0.00	0.00	0.00	0.16	0.16
2.74	0.00	0.00	0.00	0.16	0.16
2.79	0.00	0.00	0.00	0.16	0.16
2.84	0.00	0.00	0.00	0.16	0.16
2.89	0.00	0.00	0.00	0.16	0.16
2.94	0.00	0.00	0.00	0.16	0.16
2.99	0.00	0.00	0.00	0.16	0.16
3.04	0.00	0.00	0.00	0.16	0.16
3.09	0.00	0.00	0.00	0.16	0.16
3.14	0.00	0.00	0.00	0.16	0.16
3.19	0.00	0.00	0.00	0.16	0.16
3.24	0.00	0.00	0.00	0.16	0.16
3.29	0.00	0.00	0.00	0.16	0.16
3.34	0.00	0.00	0.00	0.16	0.16
3.39	0.00	0.00	0.00	0.16	0.16
3.44	0.00	0.00	0.00	0.16	0.16
3.49	0.00	0.00	0.00	0.16	0.16
3.54	0.00	0.00	0.00	0.16	0.16
3.59	0.00	0.00	0.00	0.16	0.16
3.64	0.00	0.00	0.00	0.16	0.16
3.69	0.00	0.00	0.00	0.16	0.16
3.74	0.00	0.00	0.00	0.16	0.16
3.79	0.00	0.00	0.00	0.16	0.16
3.84	0.00	0.00	0.00	0.16	0.16
3.89	0.00	0.00	0.00	0.16	0.16
3.94	0.00	0.00	0.00	0.16	0.16
3.99	0.00	0.00	0.00	0.16	0.16

Sediment Basin # 8 Colon

Phase 1

10 - year Storm Event

Qp = 71.25 cfs
Tp = 26.88 minutes
dT = Max of 2 minutes
or 1.0% of increment to peak

b = 1.7
K_s = 10,091

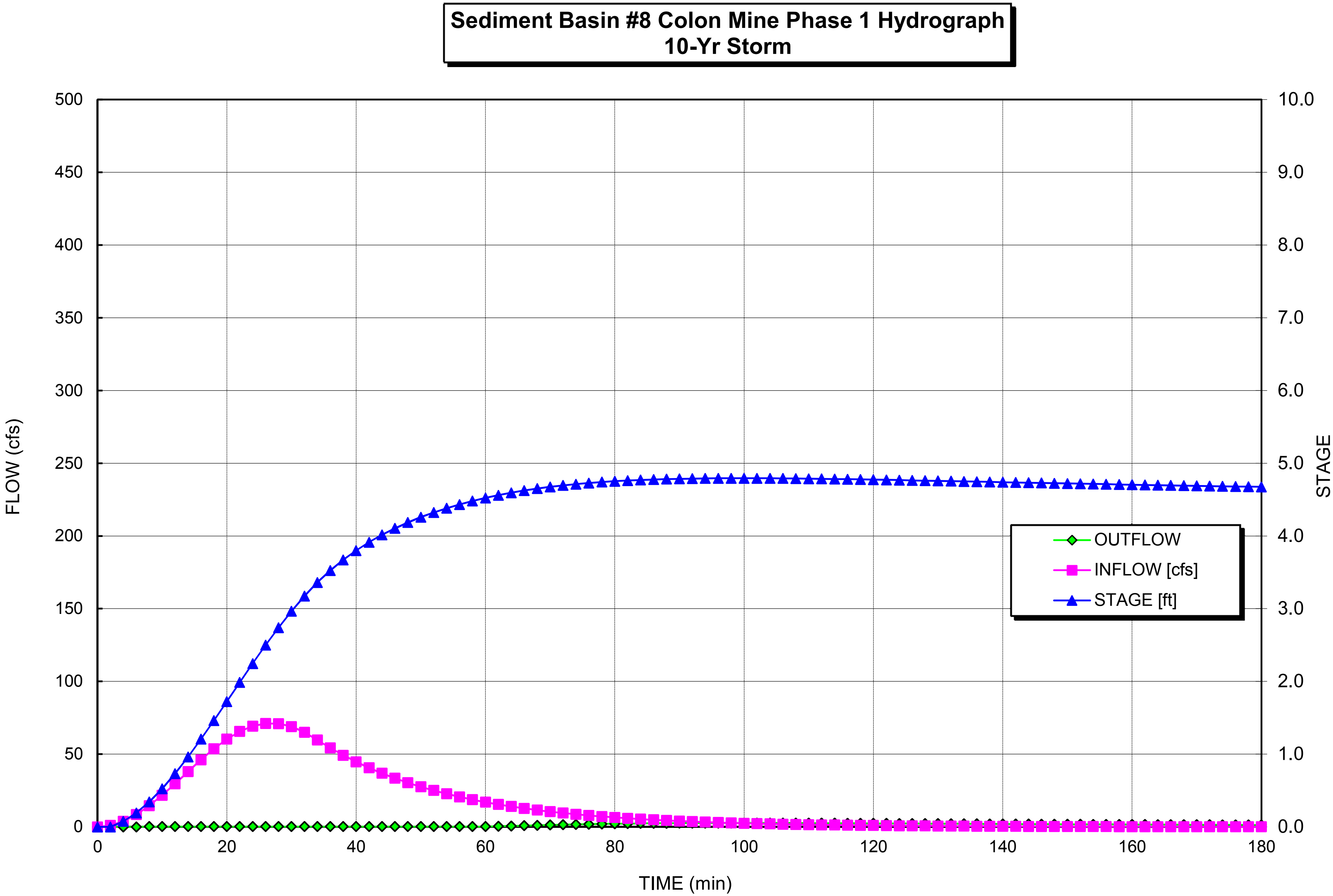
Number of Riser/Barrel Assemblies 1
Diameter of Barrel = 12 (in)
Height of Riser above barrel = 3.5 (ft)
Height of Riser from bottom of barrel= 4.5 (ft) elevation 277.50
Emergency Spillway = 5.3 (ft) elevation 278.30
Total Height of Dam = 6.0 (ft) elevation 279.00
Length of Emergency Spillway = 10 (ft)
Diameter of Riser = 18 (in)
Permanent Pond Stage = 0 (ft) elevation 273.0

4.0E-03 Settling Velocity of design particle (fps)
2 Effective number of cells (2 is construction site #)
100% Minimum Settling Efficiency
4.8 ft Maximum Stage 277.79 msl elevation
2.6 cfs Peak outflow
2.6 cfs Peak Riser/Barrel outflow
0.0 cfs Peak Weir flow

Notes:
1. Length of emergency spillway is the bottom width of the emergency spillway.
2. Settling efficiency neglects permanent pond volume

TIME (min)	INFLOW [cfs]	STORAGE [cu ft]	STAGE [ft]	Skimmer Flow [cfs]	RISER CAPACITY [cfs]	WEIR FLOW [cfs]	BARREL CAPACITY [cfs]	TOTAL OUTFLOW [cfs]	Bound Discharge [cfs]	Estimated Surface Area (sf)	Settling Efficiency [%]
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
2	1.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
4	3.8	116	0.1	0.00	0.00	0.00	0.00	0.00	5.83	2,650	N/A
6	8.4	575	0.2	0.00	0.00	0.00	0.00	0.00	11.46	5,208	N/A
8	14.5	1,584	0.3	0.16	0.16	0.00	0.16	0.16	17.58	7,991	100%
10	21.7	3,301	0.5	0.16	0.16	0.00	0.16	0.16	23.98	10,899	100%
12	29.7	5,884	0.7	0.16	0.16	0.00	0.16	0.16	30.61	13,914	100%
14	38.0	9,424	1.0	0.16	0.16	0.00	0.16	0.16	37.35	16,978	100%
16	46.1	13,960	1.2	0.16	0.16	0.00	0.16	0.16	44.10	20,045	100%
18	53.7	19,476	1.5	0.16	0.16	0.00	0.16	0.16	50.76	23,073	100%
20	60.3	25,904	1.7	0.16	0.16	0.00	0.16	0.16	57.26	26,028	100%
22	65.6	33,126	2.0	0.16	0.16	0.00	0.16	0.16	63.53	28,879	100%
24	69.2	40,980	2.2	0.16	0.16	0.00	0.16	0.16	69.51	31,595	100%
26	71.1	49,271	2.5	0.16	0.16	0.00	0.16	0.16	75.14	34,154	100%
28	70.9	57,780	2.7	0.16	0.16	0.00	0.16	0.16	80.37	36,532	100%
30	68.9	66,274	3.0	0.16	0.16	0.00	0.16	0.16	85.17	38,712	100%
32	65.1	74,525	3.2	0.16	0.16	0.00	0.16	0.16	89.50	40,680	100%
34	59.7	82,313	3.4	0.16	0.16	0.00	0.16	0.16	93.33	42,425	100%
36	54.2	89,462	3.5	0.16	0.16	0.00	0.16	0.16	96.68	43,944	100%
38	49.2	95,950	3.7	0.16	0.16	0.00	0.16	0.16	99.58	45,264	100%
40	44.7	101,837	3.8	0.16	0.16	0.00	0.16	0.16	102.12	46,417	100%
42	40.6	107,181	3.9	0.16	0.16	0.00	0.16	0.16	104.35	47,431	100%
44	36.8	112,029	4.0	0.16	0.16	0.00	0.16	0.16	106.32	48,326	100%
46	33.4	116,430	4.1	0.16	0.16	0.00	0.16	0.16	108.06	49,119	100%
48	30.3	120,422	4.2	0.16	0.16	0.00	0.16	0.16	109.61	49,824	100%
50	27.5	124,045	4.3	0.16	0.16	0.00	0.16	0.16	110.99	50,452	100%
52	25.0	127,333	4.3	0.16	0.16	0.00	0.16	0.16	112.23	51,013	100%
54	22.7	130,315	4.4	0.16	0.16	0.00	0.16	0.16	113.33	51,514	100%
56	20.6	133,021	4.4	0.16	0.16	0.00	0.16	0.16	114.32	51,964	100%
58	18.7	135,475	4.5	0.16	0.16	0.00	0.16	0.16	115.21	52,367	100%
60	17.0	137,702	4.5	0.16	0.21	0.00	7.57	0.21	116.00	52,729	100%
62	15.4	139,715	4.6	0.16	0.39	0.00	7.61	0.39	116.72	53,053	100%
64	14.0	141,519	4.6	0.16	0.61	0.00	7.64	0.61	117.35	53,341	100%
66	12.7	143,125	4.6	0.16	0.84	0.00	7.67	0.84	117.91	53,597	100%
68	11.5	144,549	4.7	0.16	1.07	0.00	7.69	1.07	118.41	53,821	100%
70	10.5	145,805	4.7	0.16	1.29	0.00	7.71	1.29	118.84	54,018	100%
72	9.5	146,907	4.7	0.16	1.49	0.00	7.73	1.49	119.22	54,190	100%
74	8.6	147,869	4.7	0.16	1.68	0.00	7.75	1.68	119.55	54,340	100%
76	7.8	148,703	4.7	0.16	1.85	0.00	7.76	1.85	119.83	54,469	100%
78	7.1	149,422	4.7	0.16	2.00	0.00	7.78	2.00	120.08	54,580	100%
80	6.5	150,036	4.8	0.16	2.13	0.00	7.79	2.13	120.29	54,675	100%
82	5.9	150,555	4.8	0.16	2.24	0.00	7.79	2.24	120.46	54,755	100%

84	5.3	150,990	4.8	0.16	2.33	0.00	7.80	2.33	120.61	54,822	100%
86	4.8	151,348	4.8	0.16	2.41	0.00	7.81	2.41	120.73	54,877	100%
88	4.4	151,638	4.8	0.16	2.48	0.00	7.81	2.48	120.83	54,921	100%
90	4.0	151,867	4.8	0.16	2.53	0.00	7.82	2.53	120.90	54,956	100%
92	3.6	152,041	4.8	0.16	2.57	0.00	7.82	2.57	120.96	54,983	100%
94	3.3	152,166	4.8	0.16	2.60	0.00	7.82	2.60	121.00	55,002	100%
96	3.0	152,248	4.8	0.16	2.62	0.00	7.82	2.62	121.03	55,014	100%
98	2.7	152,292	4.8	0.16	2.63	0.00	7.82	2.63	121.05	55,021	100%
100	2.5	152,301	4.8	0.16	2.63	0.00	7.82	2.63	121.05	55,022	100%
102	2.2	152,280	4.8	0.16	2.62	0.00	7.82	2.62	121.04	55,019	100%
104	2.0	152,232	4.8	0.16	2.61	0.00	7.82	2.61	121.03	55,012	100%
106	1.8	152,161	4.8	0.16	2.60	0.00	7.82	2.60	121.00	55,001	100%
108	1.7	152,070	4.8	0.16	2.58	0.00	7.82	2.58	120.97	54,987	100%
110	1.5	151,961	4.8	0.16	2.55	0.00	7.82	2.55	120.93	54,970	100%
112	1.4	151,836	4.8	0.16	2.52	0.00	7.82	2.52	120.89	54,951	100%
114	1.2	151,698	4.8	0.16	2.49	0.00	7.81	2.49	120.85	54,930	100%
116	1.1	151,549	4.8	0.16	2.46	0.00	7.81	2.46	120.80	54,907	100%
118	1.0	151,389	4.8	0.16	2.42	0.00	7.81	2.42	120.74	54,883	100%
120	0.9	151,222	4.8	0.16	2.39	0.00	7.81	2.39	120.69	54,857	100%
122	0.8	151,048	4.8	0.16	2.35	0.00	7.80	2.35	120.63	54,831	100%
124	0.8	150,868	4.8	0.16	2.31	0.00	7.80	2.31	120.57	54,803	100%
126	0.7	150,683	4.8	0.16	2.27	0.00	7.80	2.27	120.50	54,775	100%
128	0.6	150,495	4.8	0.16	2.23	0.00	7.79	2.23	120.44	54,746	100%
130	0.6	150,304	4.8	0.16	2.18	0.00	7.79	2.18	120.38	54,716	100%
132	0.5	150,111	4.8	0.16	2.14	0.00	7.79	2.14	120.31	54,687	100%
134	0.5	149,916	4.8	0.16	2.10	0.00	7.78	2.10	120.24	54,657	100%
136	0.4	149,721	4.7	0.16	2.06	0.00	7.78	2.06	120.18	54,627	100%
138	0.4	149,525	4.7	0.16	2.02	0.00	7.78	2.02	120.11	54,596	100%
140	0.4	149,330	4.7	0.16	1.98	0.00	7.77	1.98	120.05	54,566	100%
142	0.3	149,135	4.7	0.16	1.94	0.00	7.77	1.94	119.98	54,536	100%
144	0.3	148,942	4.7	0.16	1.90	0.00	7.77	1.90	119.91	54,506	100%
146	0.3	148,749	4.7	0.16	1.86	0.00	7.76	1.86	119.85	54,477	100%
148	0.2	148,558	4.7	0.16	1.82	0.00	7.76	1.82	119.78	54,447	100%
150	0.2	148,369	4.7	0.16	1.78	0.00	7.76	1.78	119.72	54,418	100%
152	0.2	148,182	4.7	0.16	1.74	0.00	7.75	1.74	119.65	54,389	100%
154	0.2	147,996	4.7	0.16	1.71	0.00	7.75	1.71	119.59	54,360	100%
156	0.2	147,813	4.7	0.16	1.67	0.00	7.75	1.67	119.53	54,331	100%
158	0.1	147,633	4.7	0.16	1.63	0.00	7.75	1.63	119.47	54,303	100%
160	0.1	147,455	4.7	0.16	1.60	0.00	7.74	1.60	119.41	54,276	100%
162	0.1	147,279	4.7	0.16	1.56	0.00	7.74	1.56	119.35	54,248	100%
164	0.1	147,106	4.7	0.16	1.53	0.00	7.74	1.53	119.29	54,221	100%
166	0.1	146,935	4.7	0.16	1.50	0.00	7.73	1.50	119.23	54,195	100%
168	0.1	146,768	4.7	0.16	1.47	0.00	7.73	1.47	119.17	54,169	100%
170	0.1	146,603	4.7	0.16	1.44	0.00	7.73	1.44	119.11	54,143	100%
172	0.1	146,440	4.7	0.16	1.41	0.00	7.73	1.41	119.06	54,118	100%
174	0.1	146,281	4.7	0.16	1.38	0.00	7.72	1.38	119.00	54,093	100%
176	0.1	146,124	4.7	0.16	1.35	0.00	7.72	1.35	118.95	54,068	100%
178	0.1	145,970	4.7	0.16	1.32	0.00	7.72	1.32	118.90	54,044	100%
180	0.1	145,818	4.7	0.16	1.29	0.00	7.71	1.29	118.84	54,020	100%
182	0.0	145,669	4.7	0.16	1.26	0.00	7.71	1.26	118.79	53,997	100%
184	0.0	145,523	4.7	0.16	1.24	0.00	7.71	1.24	118.74	53,974	100%
186	0.0	145,380	4.7	0.16	1.21	0.00	7.71	1.21	118.69	53,952	100%
188	0.0	145,239	4.7	0.16	1.19	0.00	7.70	1.19	118.64	53,930	100%
190	0.0	145,100	4.7	0.16	1.16	0.00	7.70	1.16	118.60	53,908	100%
192	0.0	144,964	4.7	0.16	1.14	0.00	7.70	1.14	118.55	53,886	100%
194	0.0	144,831	4.7	0.16	1.12	0.00	7.70	1.12	118.50	53,865	100%
196	0.0	144,700	4.7	0.16	1.10	0.00	7.70	1.10	118.46	53,845	100%
198	0.0	144,571	4.7	0.16	1.07	0.00	7.69	1.07	118.41	53,825	100%
200	0.0	144,445	4.6	0.16	1.05	0.00	7.69	1.05	118.37	53,805	100%
202	0.0	144,321	4.6	0.16	1.03	0.00	7.69	1.03	118.33	53,785	100%
204	0.0	144,199	4.6	0.16	1.01	0.00	7.69	1.01	118.29	53,766	100%
206	0.0	144,080	4.6	0.16	0.99	0.00	7.68	0.99	118.24	53,747	100%


Sediment Basin #8 Colon Mine Phase 1 Hydrograph
10-Yr Storm
FLOW (cfs)
STAGE
TIME (min)
0
50
100
150
200
250
300
350
400
450
500
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
0
20
40
60
80
100
120
140
160
180
OUTFLOW
INFLOW [cfs]
STAGE [ft]

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Computed By: PAW Date: 3/5/15

Checked By: MDP Date: 3/6/15

Sheet: _1__of _2__

Sediment Basin # 8 Colon

Phase 1

25 - year Storm Event

Qp = 88.20 cfs
Tp = 27.23 minutes
dT = Max of 2 minutes
or 1.0% of increment to peak

b = 1.7
K_s = 10,091

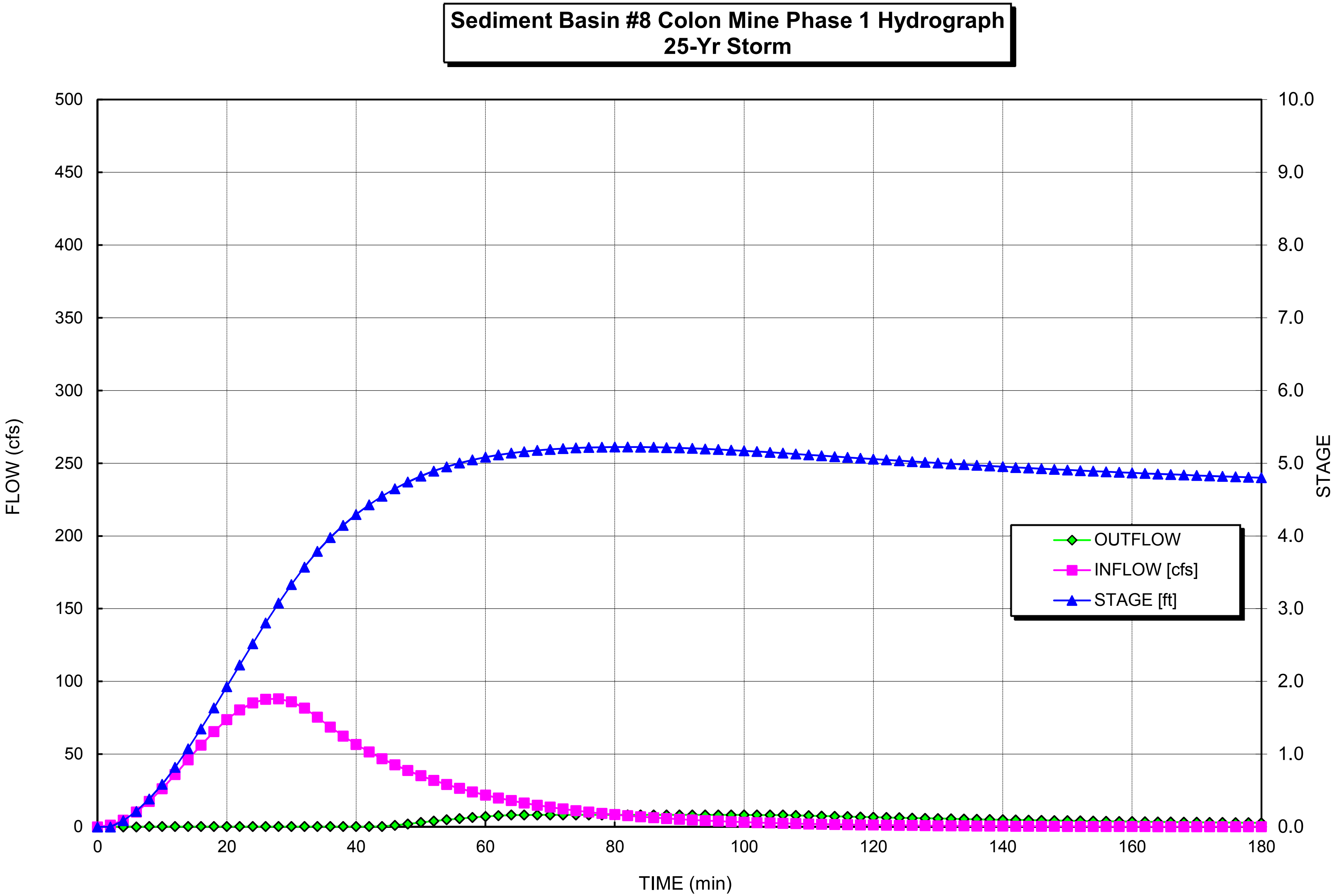
Number of Riser/Barrel Assemblies	1		
Diameter of Barrel =	12	(in)	
Height of Riser above barrel =	3.5	(ft)	
Height of Riser from bottom of barrel=	4.5	(ft) elevation	277.50
Emergency Spillway =	5.3	(ft) elevation	278.30
Total Height of Dam =	6.0	(ft) elevation	279.00
Length of Emergency Spillway =	10	(ft)	
Diameter of Riser =	18	(in)	
Permanent Pond Stage =	0	(ft) elevation	273.0

4.0E-03	Settling Velocity of design particle (fps)		
2	Effective number of cells (2 is construction site #)		
100%	Minimum Settling Efficiency		
5.2	ft Maximum Stage	278.22	msl elevation
8.2	cfs Peak outflow		
8.2	cfs Peak Riser/Barrel outflow		
0.0	cfs Peak Weir flow		

Notes:
1. Length of emergency spillway is the bottom width of the emergency spillway.
2. Settling efficiency neglects permanent pond volume

TIME (min)	INFLOW [cfs]	STORAGE [cu ft]	STAGE [ft]	Skimmer Flow [cfs]	RISER CAPACITY [cfs]	WEIR FLOW [cfs]	BARREL CAPACITY [cfs]	TOTAL OUTFLOW [cfs]	Bound Discharge [cfs]	Estimated Surface Area (sf)	Settling Efficiency [%]
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
2	1.2	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
4	4.6	140	0.1	0.00	0.00	0.00	0.00	0.00	6.31	2,869	N/A
6	10.2	694	0.2	0.00	0.00	0.00	0.00	0.00	12.40	5,638	N/A
8	17.5	1,912	0.4	0.16	0.16	0.00	0.16	0.16	19.04	8,653	100%
10	26.2	3,992	0.6	0.16	0.16	0.00	0.16	0.16	25.98	11,810	100%
12	35.9	7,122	0.8	0.16	0.16	0.00	0.16	0.16	33.18	15,083	100%
14	46.1	11,415	1.1	0.16	0.16	0.00	0.16	0.16	40.50	18,410	100%
16	56.1	16,923	1.3	0.16	0.16	0.00	0.16	0.16	47.84	21,743	100%
18	65.5	23,635	1.6	0.16	0.16	0.00	0.16	0.16	55.09	25,039	100%
20	73.7	31,473	1.9	0.16	0.16	0.00	0.16	0.16	62.17	28,261	100%
22	80.4	40,302	2.2	0.16	0.16	0.00	0.16	0.16	69.02	31,373	100%
24	85.2	49,933	2.5	0.16	0.16	0.00	0.16	0.16	75.56	34,347	100%
26	87.8	60,135	2.8	0.16	0.16	0.00	0.16	0.16	81.74	37,154	100%
28	88.0	70,647	3.1	0.16	0.16	0.00	0.16	0.16	87.50	39,771	100%
30	86.0	81,191	3.3	0.16	0.16	0.00	0.16	0.16	92.79	42,179	100%
32	81.7	91,488	3.6	0.16	0.16	0.00	0.16	0.16	97.60	44,362	100%
34	75.4	101,272	3.8	0.16	0.16	0.00	0.16	0.16	101.88	46,308	100%
36	68.6	110,303	4.0	0.16	0.16	0.00	0.16	0.16	105.62	48,010	100%
38	62.4	118,519	4.1	0.16	0.16	0.00	0.16	0.16	108.88	49,490	100%
40	56.7	125,986	4.3	0.16	0.16	0.00	0.16	0.16	111.73	50,784	100%
42	51.5	132,771	4.4	0.16	0.16	0.00	0.16	0.16	114.23	51,923	100%
44	46.8	138,937	4.5	0.16	0.31	0.00	7.59	0.31	116.44	52,928	100%
46	42.6	144,520	4.7	0.16	1.07	0.00	7.69	1.07	118.40	53,817	100%
48	38.7	149,502	4.7	0.16	2.01	0.00	7.78	2.01	120.10	54,593	100%
50	35.2	153,904	4.8	0.16	3.01	0.00	7.85	3.01	121.59	55,266	100%
52	32.0	157,764	4.9	0.16	3.97	0.00	7.91	3.97	122.87	55,848	100%
54	29.1	161,124	5.0	0.16	4.88	0.00	7.97	4.88	123.96	56,347	100%
56	26.4	164,025	5.0	0.16	5.71	0.00	8.01	5.71	124.90	56,774	100%
58	24.0	166,509	5.0	0.16	6.45	0.00	8.05	6.45	125.70	57,136	100%
60	21.8	168,617	5.1	0.16	7.09	0.00	8.08	7.09	126.37	57,440	100%
62	19.8	170,384	5.1	0.16	7.65	0.00	8.11	7.65	126.93	57,694	100%
64	18.0	171,847	5.1	0.16	8.11	0.00	8.13	8.11	127.39	57,903	100%
66	16.4	173,037	5.2	0.16	8.50	0.00	8.15	8.15	127.76	58,072	100%
68	14.9	174,025	5.2	0.16	8.82	0.00	8.17	8.17	128.07	58,212	100%
70	13.5	174,832	5.2	0.16	9.09	0.00	8.18	8.18	128.32	58,326	100%
72	12.3	175,476	5.2	0.16	9.30	0.00	8.19	8.19	128.52	58,416	100%
74	11.2	175,970	5.2	0.16	9.47	0.00	8.19	8.19	128.67	58,486	100%
76	10.2	176,328	5.2	0.16	9.59	0.00	8.20	8.20	128.78	58,536	100%
78	9.2	176,564	5.2	0.16	9.67	0.00	8.20	8.20	128.85	58,569	100%
80	8.4	176,688	5.2	0.16	9.71	0.00	8.21	8.21	128.89	58,586	100%
82	7.6	176,712	5.2	0.16	9.72	0.00	8.21	8.21	128.90	58,590	100%

84	6.9	176,643	5.2	0.16	9.70	0.00	8.20	8.20	128.88	58,580	100%
86	6.3	176,491	5.2	0.16	9.65	0.00	8.20	8.20	128.83	58,559	100%
88	5.7	176,263	5.2	0.16	9.57	0.00	8.20	8.20	128.76	58,527	100%
90	5.2	175,967	5.2	0.16	9.47	0.00	8.19	8.19	128.67	58,485	100%
92	4.7	175,609	5.2	0.16	9.35	0.00	8.19	8.19	128.56	58,435	100%
94	4.3	175,195	5.2	0.16	9.21	0.00	8.18	8.18	128.43	58,377	100%
96	3.9	174,729	5.2	0.16	9.06	0.00	8.18	8.18	128.28	58,311	100%
98	3.6	174,218	5.2	0.16	8.89	0.00	8.17	8.17	128.13	58,239	100%
100	3.2	173,664	5.2	0.16	8.70	0.00	8.16	8.16	127.95	58,161	100%
102	2.9	173,073	5.2	0.16	8.51	0.00	8.15	8.15	127.77	58,077	100%
104	2.7	172,447	5.2	0.16	8.31	0.00	8.14	8.14	127.57	57,988	100%
106	2.4	171,791	5.1	0.16	8.09	0.00	8.13	8.09	127.37	57,895	100%
108	2.2	171,110	5.1	0.16	7.88	0.00	8.12	7.88	127.15	57,798	100%
110	2.0	170,430	5.1	0.16	7.66	0.00	8.11	7.66	126.94	57,700	100%
112	1.8	169,751	5.1	0.16	7.45	0.00	8.10	7.45	126.73	57,603	100%
114	1.7	169,077	5.1	0.16	7.23	0.00	8.09	7.23	126.51	57,506	100%
116	1.5	168,407	5.1	0.16	7.03	0.00	8.08	7.03	126.30	57,410	100%
118	1.4	167,745	5.1	0.16	6.82	0.00	8.07	6.82	126.09	57,315	100%
120	1.2	167,090	5.1	0.16	6.62	0.00	8.06	6.62	125.88	57,220	100%
122	1.1	166,445	5.0	0.16	6.43	0.00	8.05	6.43	125.68	57,126	100%
124	1.0	165,810	5.0	0.16	6.24	0.00	8.04	6.24	125.48	57,034	100%
126	0.9	165,185	5.0	0.16	6.05	0.00	8.03	6.05	125.28	56,943	100%
128	0.8	164,571	5.0	0.16	5.87	0.00	8.02	5.87	125.08	56,854	100%
130	0.8	163,968	5.0	0.16	5.69	0.00	8.01	5.69	124.88	56,766	100%
132	0.7	163,378	5.0	0.16	5.52	0.00	8.00	5.52	124.69	56,679	100%
134	0.6	162,800	5.0	0.16	5.35	0.00	7.99	5.35	124.51	56,594	100%
136	0.6	162,234	5.0	0.16	5.19	0.00	7.98	5.19	124.32	56,511	100%
138	0.5	161,680	5.0	0.16	5.04	0.00	7.98	5.04	124.15	56,430	100%
140	0.5	161,139	5.0	0.16	4.89	0.00	7.97	4.89	123.97	56,350	100%
142	0.4	160,610	4.9	0.16	4.74	0.00	7.96	4.74	123.80	56,271	100%
144	0.4	160,093	4.9	0.16	4.60	0.00	7.95	4.60	123.63	56,195	100%
146	0.4	159,589	4.9	0.16	4.46	0.00	7.94	4.46	123.46	56,120	100%
148	0.3	159,097	4.9	0.16	4.33	0.00	7.93	4.33	123.30	56,047	100%
150	0.3	158,617	4.9	0.16	4.20	0.00	7.93	4.20	123.15	55,975	100%
152	0.3	158,148	4.9	0.16	4.08	0.00	7.92	4.08	122.99	55,905	100%
154	0.2	157,692	4.9	0.16	3.96	0.00	7.91	3.96	122.84	55,837	100%
156	0.2	157,247	4.9	0.16	3.84	0.00	7.90	3.84	122.70	55,770	100%
158	0.2	156,813	4.9	0.16	3.73	0.00	7.90	3.73	122.55	55,705	100%
160	0.2	156,389	4.9	0.16	3.62	0.00	7.89	3.62	122.41	55,642	100%
162	0.2	155,977	4.9	0.16	3.52	0.00	7.88	3.52	122.28	55,580	100%
164	0.2	155,575	4.9	0.16	3.42	0.00	7.88	3.42	122.14	55,519	100%
166	0.1	155,184	4.8	0.16	3.32	0.00	7.87	3.32	122.01	55,460	100%
168	0.1	154,802	4.8	0.16	3.22	0.00	7.86	3.22	121.89	55,403	100%
170	0.1	154,431	4.8	0.16	3.13	0.00	7.86	3.13	121.76	55,346	100%
172	0.1	154,068	4.8	0.16	3.05	0.00	7.85	3.05	121.64	55,291	100%
174	0.1	153,715	4.8	0.16	2.96	0.00	7.85	2.96	121.52	55,238	100%
176	0.1	153,371	4.8	0.16	2.88	0.00	7.84	2.88	121.41	55,186	100%
178	0.1	153,036	4.8	0.16	2.80	0.00	7.84	2.80	121.30	55,135	100%
180	0.1	152,709	4.8	0.16	2.72	0.00	7.83	2.72	121.19	55,085	100%
182	0.1	152,391	4.8	0.16	2.65	0.00	7.83	2.65	121.08	55,036	100%
184	0.1	152,081	4.8	0.16	2.58	0.00	7.82	2.58	120.98	54,989	100%
186	0.1	151,778	4.8	0.16	2.51	0.00	7.81	2.51	120.87	54,943	100%
188	0.0	151,483	4.8	0.16	2.44	0.00	7.81	2.44	120.77	54,897	100%
190	0.0	151,196	4.8	0.16	2.38	0.00	7.81	2.38	120.68	54,853	100%
192	0.0	150,916	4.8	0.16	2.32	0.00	7.80	2.32	120.58	54,810	100%
194	0.0	150,642	4.8	0.16	2.26	0.00	7.80	2.26	120.49	54,768	100%
196	0.0	150,376	4.8	0.16	2.20	0.00	7.79	2.20	120.40	54,727	100%
198	0.0	150,116	4.8	0.16	2.14	0.00	7.79	2.14	120.31	54,687	100%
200	0.0	149,862	4.7	0.16	2.09	0.00	7.78	2.09	120.23	54,648	100%
202	0.0	149,614	4.7	0.16	2.04	0.00	7.78	2.04	120.14	54,610	100%
204	0.0	149,373	4.7	0.16	1.99	0.00	7.77	1.99	120.06	54,573	100%
206	0.0	149,137	4.7	0.16	1.94	0.00	7.77	1.94	119.98	54,537	100%


Sediment Basin #8 Colon Mine Phase 1 Hydrograph
25-Yr Storm
FLOW (cfs)
STAGE
TIME (min)
0
50
100
150
200
250
300
350
400
450
500
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
0
20
40
60
80
100
120
140
160
180
OUTFLOW
INFLOW [cfs]
STAGE [ft]

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Project: Charah Colon Mine		Computed: PAW	Date: 3/5/15
Subject: Permit Application		Checked: MDP	Date: 3/6/15
Task: Sediment Basin #9		Sheet: 1	Of: 4

Objective Design the sediment basin to contain the 25-year storm and pass the 100-year storm without over topping the berm.

References

1. NC Erosion and Sediment Control Planning and Design Manual.
2. "Elements of Urban Stormwater Design" by H. Rooney Malcom, P.E.
3. NOAA Atlas 14, Volume 2, Version 3
4. VA Erosion and Sediment Control Handbook

Given

Phase	1	2	2	2		
Storm Event (yrs) =	10	10	25	100		
Total Drainage Area A (ac) =	62.8	85.9	85.9	85.9		
Disturbed Area (ac) =	46.7	65.9	65.9	65.9		
Curve Number CN =	72	72	72	72	Hydrographs	
Rainfall Depth P (in) =	5.28	5.28	6.28	7.88	(24-hr rainfall)	Ref 3
Peak Flow Q_p (cfs) =	145.70	199.50	268.73	384.06	Hydrographs	

Design Criteria

Required sediment storage	1,800	cf / acre of drainage
Required sediment storage	154,620	cf (based on largest Phase)
Required Surface Area	435	sf/cfs of the 10-yr storm peak flow (based on the largest Phase in cfs)
Required Surface Area (SF)	86,783	of the 10-yr storm peak flow (based on the largest Phase)

Determine Shape of Basin:
Measure the area of the Basin using AutoCADD.
Calculate Volume of the Basin using Truncated Pyramid Method.
Shape factor used in hydrographs basin depth may be gretaer than indicated below

Elevation (ft)	Depth (ft)	Area (sf)	Volume (cf)	Cumulative Vol (cf)	Cumulative Vol (cy)
262	0	88,670	0	0	0
263	1	92,409	90,533	90,533	3,353
264	2	96,226	94,311	184,844	6,846
265	3	100,091	98,152	282,996	10,481
266	4	103,992	102,035	385,032	14,260
267	5	107,938	105,959	490,990	18,185
268	6	111,933	109,929	600,920	22,256

Design Sediment Depth (ft) = 3
Sediment Storage (cf) = 282,996 *Required Sediment Storage Achieved*

Design Surface Area Depth (ft) = 3
Surface Area (sf) = 100,091 *Required Surface Area Achieved*

Project: Charah Colon Mine		Computed: PAW	Date: 3/5/15
Subject: Permit Application		Checked: MDP	Date: 3/6/15
Task: Sediment Basin #9		Sheet: 2	Of: 4

Select Skimmer

A. R. Jarrett Method

$D = [Q / (2{,}310 * (H^{0.5})]^{0.5}$

D =Diameter of Orifice (inches)

Q = Dewater Rate (cf/day)

H = Head on orifice, varies based on skimmer size (ft)

Skimmer Sizes (Inches)	Head (ft)
1.5	0.125
2	0.167
2.5	0.167
3	0.250
4	0.333
5	0.333
6	0.417
8	0.500

Volume to Dewater (cf) =	282,996		
Number of Skimmers	2		
Days to Drain =	5	*assumed*	
Q each (cf/day) =	28,300		0.33 cfs

Selected Skimmer Size (inches) =	5
Head on Skimmer (feet) =	0.333
Diameter of Orifice (inches) =	4.6

Route the flow through the Basin

Riser is not perforated, but skimmer is attached.

$S = (1000/CN) - 10$

Runoff Depth Q* (inches) = $(P-0.2S)^2/(P+0.8S)$ Ref 2, III-4

T_P (min) = $60.5(Q^*)A/Q_P/1.39$

Phase	1	2	2	2
Storm Event (yrs) =	10	10	25	100
S =	3.89	3.89	3.89	3.89
Runoff Depth Q* (inches) =	2.42	2.42	3.22	4.59
Time to Peak T_p (min) =	45.32	45.27	44.85	44.68

Determine Pond Storage Elevation (Z_{Water}):

Pick one point near max expected water surface and the other at the mid depth.

Z_1 (ft) = 3 S_1 (cf)= 282,996

Z_2 (ft) = 6 S_2 (cf) = 600,920

$b = \ln(S_2/S_1)/\ln(Z_2/Z_1) =$ 1.1 Ref 2, III-8

$K_S = S_2/Z_2^{\,b} =$ 85,791

Project:	Charah Colon Mine	Computed: PAW	Date: 3/5/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Sediment Basin #9	Sheet: 3	Of: 4

Determine Settling Velocity

Conversion Factor = 3.281 ft/sec per m/sec

Gravitational Acceleration, g (m/s^2) = 9.81

Specific Gravity of soil (s_s)= 2.6

Kinematic Viscosity of water (υ) = 1.14E-06 n^2 / sec @ 20° C — Ref 2, IV-11

Diameter of the Design Particle d_{15} = 40.00E-06 m

Design Particle Settling Velocity = $(g / 18) * [(s_s - 1) / \upsilon] d^2 =$ 4.02E-03 ft/sec

Route the Storm through the Basin using the Hydrograph Model

Set Height of Emergency Spillway at (ft) = 7.50

Set Top of Dam at (ft) = 8.50

See Hydrograph

Emergency Spillway

Q_E (cfs) = 100-Yr Storm

Q_E (cfs) = 55.2

Cross Section = Trapezoid

Channel Side Slope (z) = 5 (enter X for X:1)

n = 0.03 Grass Lined

Vp (ft/sec) = 5.0 Permissible Velocity for lining — Ref 2, II-7

Allowable Shear Stress (psf) = 2.0 Allowable Shear Stress for lining

Bottom Width, b (ft) = 50

Calculate Required Depth of Spillway:

Normal-Depth Procedure

$AR^{2/3}=Qn/1.49s^{0.5}$ — Q=VA

$Z_{req}=Qn/1.49s^{0.5}$ — Area (A)= bd+z(d^2)

$Z_{av}=AR^{2/3}$ — R=Area/(b+2d((z^2)+1)^.5)

Avg Shear Stress(T) = K_b*d*s*unit weight of water

Channel Slope ft/ft	Depth, d (ft)	A (sf)	Z_{req}	R	Z_{avail}	V (ft/sec)	T (psf)
0.01	0.40	20.94	11.12	0.39	11.12	2.6	0.3
0.02	0.33	16.91	7.86	0.32	7.86	3.3	0.4

Construct the channel to be : 50 ft, Bottom Width (measured at top of lining)

1.0 ft, depth (measured at top of lining)

1% slope

Anti-Seep Collar:

Anti-Seep Collar Size = 2 * Barrel Dia

Anti-Seep Collar Size (ft) = 7

Use Anti-Seep Collar Size (ft) = 7 x 7

Project: Charah Colon Mine		Computed: PAW	Date: 3/5/15
Subject: Permit Application		Checked: MDP	Date: 3/6/15
Task: Sediment Basin #9		Sheet: 4	Of: 4

Minimum Concrete Base for Riser:

Diameter of Riser (in) = 72 From Hydrograph
Avg Density of Concrete (lbs/cf) = 87.6
Density of Water (lbs/cf) = 62.4
Riser Displacement (cf) = 189.44 $Pi * (D_R/24)^2$ * Total Ht of Riser
Convert cf to cy = 27^{-1}
Min Concrete Needed (cy) = 5.00
Width & Length (ft) = 7
Thickness (ft) = 2.8

Anti-Vortex Device:

Diameter of Riser (in) = 72 From Hydrograph
Cylinder Diameter (in) = 102 Ref 4, III-104, Table 3.14-D
Cylinder Thickness (gage) = 14
Cylinder Height (in) = 36

Determine Tailwater conditions to size outlet apron

Use Normal Depth Procedure (Manning's Eqn.) Ref 2, II-7

$A*R^{2/3} = Q*n/1.49\ s^{0.5}$ Area (A)= bd+z(d^2) $Z_{av} = A*R^{2/3}$

$Z_{req} = Q*n/1.49s^{0.5}$ R=Area/(b+2d((z^2)+1)^.5)

n = 0.069 6-inch diameter Rip Rap, Lined Channel
Vp (ft/sec) = 9 Permissible Velocity for lining
Side Slope (z) = 5 enter X for X:1
s (ft/ft) = 0.02 Outlet Slope (estimated)
Bottom Width (ft) = 10.5 6 * Barrel Diameter
Q_B (cfs) = 85.1 Peak Flow out of the barrel 25-yr Hydrograph

Q (cfs)	Z_{req}	Flow Depth d (ft)	A (sf)	R (ft)	Z_{av}	V (ft/sec)
85.1	27.88	1.50	27.0	1.05	27.88	3.1

Flow Depth = Tailwater, d (ft) = 1.50 0.5* Barrel Diameter (ft) = 1.75 Ref 1, 8.06.3
Minimum Tailwater Conditions: d<0.5*Diameter of Outlet Pipe
Maximum Tailwater Conditions: d>0.5*Diameter of Outlet Pipe
Since the Tailwater is less than half of the diameter of the outlet, use Minimum Tailwater conditions.

Barrel Diameter (ft)	Entrance (ft)	Length (ft)	Outlet Width (ft)	Median Rip Rap Size d_{50}	Selected Rip Rap Size (in)
3.5	10.5	22	26	0.7	Class B

Conclusion

The basin can contain the 25-yr storm and pass the 100-yr storm without overtopping the berm.

Project:	Charah Colon Mine	Computed: PAW	Date: 3/5/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Riser Pipe Perforations/Skimmer Flow	Sheet 1	Of 2

Diameter of Riser (in) =	72	
Circumference of Riser (in) =	226.2	
Height of Riser from bottom of barrel (in) =	80	From Hydrograph
Vertical spacing between holes (in) =	0	center to center
Water Stage increment (ft)	0.05	

Orifice Equation

$Q = C_d * A * (2 * g * h)^{0.5}$ Ref 1, p III-11

Q = cfs, discharge

C_d = 0.6 coefficient of discharge

A = sf, cross sectional area

g = 32.2 ft/sec^2, gravity

h = ft, driving head measured from the center of the pipe

	Perforations					Skimmer	
Row	1	2	3	4	5	2	# of skimmers
Holes per row	0	0	0	0	0		
Hole Diameter (in)	0.75	0.75	0.75	0.75	0.75		
Spacing edge to edge (in)							
Inlet Area (sf)	0.000	0.000	0.000	0.000	0.000		
Hole Stage (in)	0.50	0.50	0.50	0.50	0.50		
Hole Stage (ft)	0.04	0.04	0.04	0.04	0.04		

Water Stage (ft)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Total Flow (cfs)
0.00	0.00	0.00	0.00			0.00	0.00
0.04	0.00	0.00	0.00			0.00	0.00
0.09	0.00	0.00	0.00			0.00	0.00
0.14	0.00	0.00	0.00			0.00	0.00
0.19	0.00	0.00	0.00			0.00	0.00
0.24	0.00	0.00	0.00			0.00	0.00
0.29	0.00	0.00	0.00			0.00	0.00
0.34	0.00	0.00	0.00			0.66	0.66
0.39	0.00	0.00	0.00			0.66	0.66
0.44	0.00	0.00	0.00			0.66	0.66
0.49	0.00	0.00	0.00			0.66	0.66
0.54	0.00	0.00	0.00			0.66	0.66
0.59	0.00	0.00	0.00			0.66	0.66
0.64	0.00	0.00	0.00			0.66	0.66
0.69	0.00	0.00	0.00			0.66	0.66
0.74	0.00	0.00	0.00			0.66	0.66
0.79	0.00	0.00	0.00			0.66	0.66
0.84	0.00	0.00	0.00			0.66	0.66
0.89	0.00	0.00	0.00			0.66	0.66
0.94	0.00	0.00	0.00			0.66	0.66
0.99	0.00	0.00	0.00			0.66	0.66
1.04	0.00	0.00	0.00			0.66	0.66
1.09	0.00	0.00	0.00			0.66	0.66
1.14	0.00	0.00	0.00			0.66	0.66
1.19	0.00	0.00	0.00			0.66	0.66
1.24	0.00	0.00	0.00			0.66	0.66
1.29	0.00	0.00	0.00			0.66	0.66
1.34	0.00	0.00	0.00			0.66	0.66
1.39	0.00	0.00	0.00			0.66	0.66
1.44	0.00	0.00	0.00			0.66	0.66
1.49	0.00	0.00	0.00			0.66	0.66
1.54	0.00	0.00	0.00			0.66	0.66
1.59	0.00	0.00	0.00			0.66	0.66

Project:	Charah Colon Mine	Computed: PAW	Date: 3/5/15
Subject:	Permit Application	Checked: MDP	Date: 3/6/15
Task:	Riser Pipe Perforations/Skimmer Flow	Sheet 2	Of 2

1.64	0.00	0.00	0.00	0.66	0.66
1.69	0.00	0.00	0.00	0.66	0.66
1.74	0.00	0.00	0.00	0.66	0.66
1.79	0.00	0.00	0.00	0.66	0.66
1.84	0.00	0.00	0.00	0.66	0.66
1.89	0.00	0.00	0.00	0.66	0.66
1.94	0.00	0.00	0.00	0.66	0.66
1.99	0.00	0.00	0.00	0.66	0.66
2.04	0.00	0.00	0.00	0.66	0.66
2.09	0.00	0.00	0.00	0.66	0.66
2.14	0.00	0.00	0.00	0.66	0.66
2.19	0.00	0.00	0.00	0.66	0.66
2.24	0.00	0.00	0.00	0.66	0.66
2.29	0.00	0.00	0.00	0.66	0.66
2.34	0.00	0.00	0.00	0.66	0.66
2.39	0.00	0.00	0.00	0.66	0.66
2.44	0.00	0.00	0.00	0.66	0.66
2.49	0.00	0.00	0.00	0.66	0.66
2.54	0.00	0.00	0.00	0.66	0.66
2.59	0.00	0.00	0.00	0.66	0.66
2.64	0.00	0.00	0.00	0.66	0.66
2.69	0.00	0.00	0.00	0.66	0.66
2.74	0.00	0.00	0.00	0.66	0.66
2.79	0.00	0.00	0.00	0.66	0.66
2.84	0.00	0.00	0.00	0.66	0.66
2.89	0.00	0.00	0.00	0.66	0.66
2.94	0.00	0.00	0.00	0.66	0.66
2.99	0.00	0.00	0.00	0.66	0.66
3.04	0.00	0.00	0.00	0.66	0.66
3.09	0.00	0.00	0.00	0.66	0.66
3.14	0.00	0.00	0.00	0.66	0.66
3.19	0.00	0.00	0.00	0.66	0.66
3.24	0.00	0.00	0.00	0.66	0.66
3.29	0.00	0.00	0.00	0.66	0.66
3.34	0.00	0.00	0.00	0.66	0.66
3.39	0.00	0.00	0.00	0.66	0.66
3.44	0.00	0.00	0.00	0.66	0.66
3.49	0.00	0.00	0.00	0.66	0.66
3.54	0.00	0.00	0.00	0.66	0.66
3.59	0.00	0.00	0.00	0.66	0.66
3.64	0.00	0.00	0.00	0.66	0.66
3.69	0.00	0.00	0.00	0.66	0.66
3.74	0.00	0.00	0.00	0.66	0.66
3.79	0.00	0.00	0.00	0.66	0.66
3.84	0.00	0.00	0.00	0.66	0.66
3.89	0.00	0.00	0.00	0.66	0.66
3.94	0.00	0.00	0.00	0.66	0.66
3.99	0.00	0.00	0.00	0.66	0.66

Computed By: PAW Date:3/5/15

Checked By: MDP Date: 3/6/15

Sheet: _1___of __2__

Qp = 145.70 cfs

Tp = 45.32 minutes

dT = Max of 2 minutes

or 1.0% of increment to peak

Sediment Basin # 9 Colon

Phase 1

10 - year Storm Event

b = 1.1

K_s = 85,791

Number of Riser/Barrel Assemblies 2

Diameter of Barrel = 42 (in)

Height of Riser above barrel = 3.2 (ft)

Height of Riser from bottom of barrel= 6.7 (ft) elevation 268.70

Emergency Spillway = 7.5 (ft) elevation 269.50

Total Height of Dam = 8.5 (ft) elevation 270.50

Length of Emergency Spillway = 50 (ft)

Diameter of Riser = 72 (in)

Permanent Pond Stage = 0 (ft) elevation 262.0

4.0E-03 Settling Velocity of design particle (fps)

2 Effective number of cells (2 is construction site #)

100% Minimum Settling Efficiency

5.4 ft Maximum Stage 267.39 msl elevation

1.3 cfs Peak outflow

1.3 cfs Peak Riser/Barrel outflow

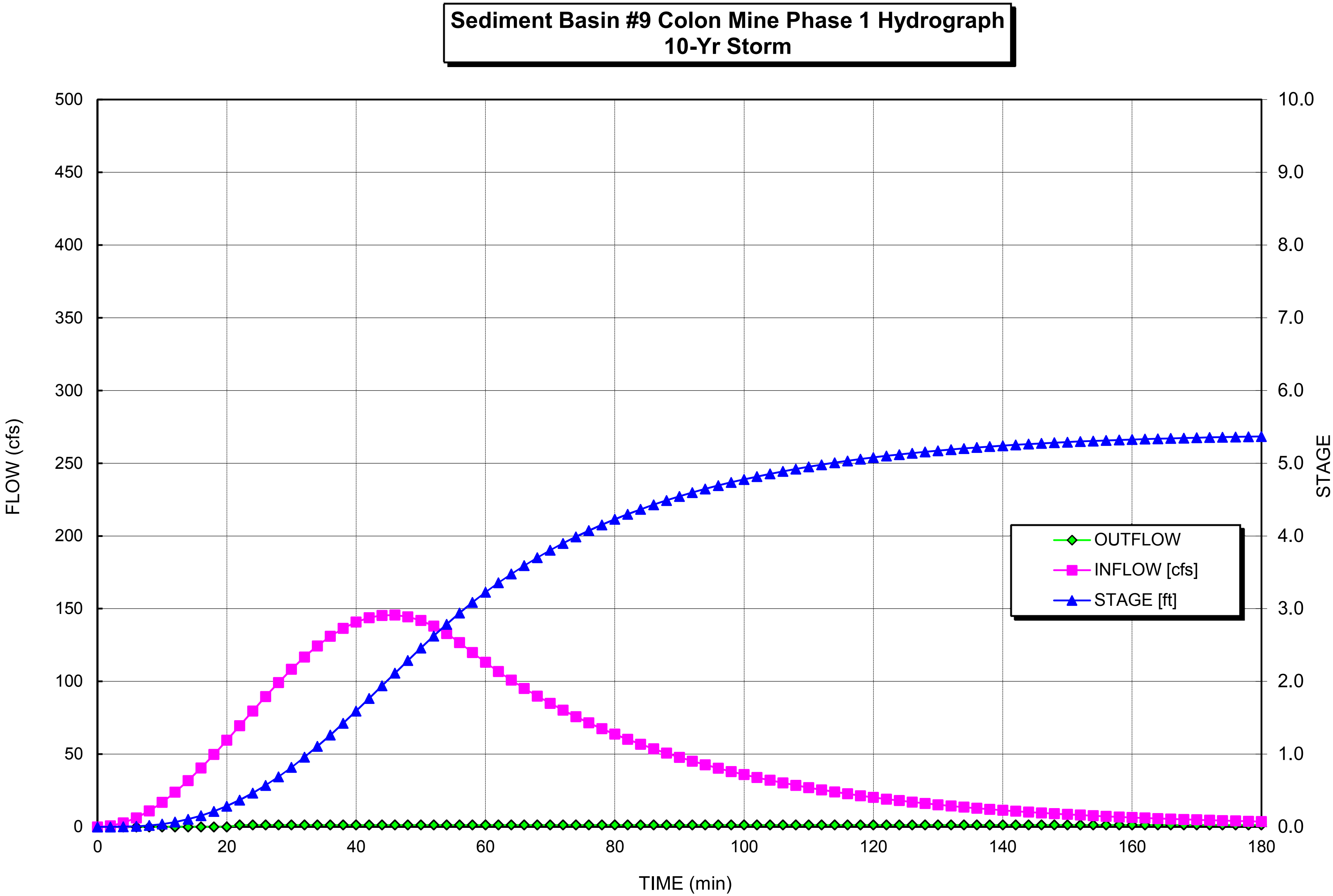
0.0 cfs Peak Weir flow

Notes:

1. Length of emergency spillway is the bottom width of the emergency spillway.
2. Settling efficiency neglects permanent pond volume

TIME (min)	INFLOW [cfs]	STORAGE [cu ft]	STAGE [ft]	Skimmer Flow [cfs]	RISER CAPACITY [cfs]	WEIR FLOW [cfs]	BARREL CAPACITY [cfs]	TOTAL OUTFLOW [cfs]	Bound Discharge [cfs]	Estimated Surface Area (sf)	Settling Efficiency [%]
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
2	0.7	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
4	2.8	84	0.0	0.00	0.00	0.00	0.00	0.00	118.17	53,715	N/A
6	6.2	418	0.0	0.00	0.00	0.00	0.00	0.00	134.27	61,030	N/A
8	10.9	1,163	0.0	0.00	0.00	0.00	0.00	0.00	145.65	66,206	N/A
10	16.8	2,473	0.0	0.00	0.00	0.00	0.00	0.00	154.66	70,300	N/A
12	23.8	4,491	0.1	0.00	0.00	0.00	0.00	0.00	162.17	73,715	N/A
14	31.7	7,345	0.1	0.00	0.00	0.00	0.00	0.00	168.64	76,656	N/A
16	40.4	11,149	0.2	0.00	0.00	0.00	0.00	0.00	174.33	79,242	N/A
18	49.7	15,998	0.2	0.00	0.00	0.00	0.00	0.00	179.41	81,550	N/A
20	59.5	21,965	0.3	0.00	0.00	0.00	0.00	0.00	183.99	83,632	N/A
22	69.5	29,104	0.4	0.66	0.66	0.00	0.66	1.31	188.16	85,525	100%
24	79.6	37,290	0.5	0.66	0.66	0.00	0.66	1.31	191.90	87,227	100%
26	89.6	46,686	0.6	0.66	0.66	0.00	0.66	1.31	195.36	88,800	100%
28	99.2	57,277	0.7	0.66	0.66	0.00	0.66	1.31	198.56	90,256	100%
30	108.3	69,025	0.8	0.66	0.66	0.00	0.66	1.31	201.53	91,605	100%
32	116.8	81,869	1.0	0.66	0.66	0.00	0.66	1.31	204.28	92,856	100%
34	124.4	95,727	1.1	0.66	0.66	0.00	0.66	1.31	206.84	94,018	100%
36	131.0	110,498	1.3	0.66	0.66	0.00	0.66	1.31	209.21	95,097	100%
38	136.5	126,064	1.4	0.66	0.66	0.00	0.66	1.31	211.42	96,099	100%
40	140.8	142,289	1.6	0.66	0.66	0.00	0.66	1.31	213.46	97,029	100%
42	143.8	159,029	1.8	0.66	0.66	0.00	0.66	1.31	215.36	97,891	100%
44	145.4	176,125	1.9	0.66	0.66	0.00	0.66	1.31	217.12	98,689	100%
46	145.6	193,415	2.1	0.66	0.66	0.00	0.66	1.31	218.74	99,426	100%
48	144.4	210,732	2.3	0.66	0.66	0.00	0.66	1.31	220.23	100,107	100%
50	141.9	227,909	2.5	0.66	0.66	0.00	0.66	1.31	221.61	100,732	100%
52	138.0	244,779	2.6	0.66	0.66	0.00	0.66	1.31	222.87	101,306	100%
54	132.9	261,185	2.8	0.66	0.66	0.00	0.66	1.31	224.03	101,830	100%
56	126.6	276,976	2.9	0.66	0.66	0.00	0.66	1.31	225.07	102,306	100%
58	119.8	292,013	3.1	0.66	0.66	0.00	0.66	1.31	226.02	102,737	100%
60	113.1	306,229	3.2	0.66	0.66	0.00	0.66	1.31	226.88	103,126	100%
62	106.8	319,644	3.4	0.66	0.66	0.00	0.66	1.31	227.65	103,479	100%
64	100.8	332,302	3.5	0.66	0.66	0.00	0.66	1.31	228.36	103,799	100%
66	95.2	344,246	3.6	0.66	0.66	0.00	0.66	1.31	229.00	104,091	100%
68	89.9	355,514	3.7	0.66	0.66	0.00	0.66	1.31	229.59	104,357	100%
70	84.9	366,146	3.8	0.66	0.66	0.00	0.66	1.31	230.13	104,602	100%
72	80.2	376,176	3.9	0.66	0.66	0.00	0.66	1.31	230.62	104,827	100%
74	75.7	385,638	4.0	0.66	0.66	0.00	0.66	1.31	231.08	105,035	100%
76	71.5	394,564	4.1	0.66	0.66	0.00	0.66	1.31	231.50	105,226	100%
78	67.5	402,984	4.2	0.66	0.66	0.00	0.66	1.31	231.89	105,403	100%
80	63.7	410,925	4.2	0.66	0.66	0.00	0.66	1.31	232.25	105,566	100%
82	60.2	418,414	4.3	0.66	0.66	0.00	0.66	1.31	232.58	105,718	100%

84	56.8	425,478	4.4	0.66	0.66	0.00	0.66	1.31	232.89	105,859	100%
86	53.6	432,138	4.4	0.66	0.66	0.00	0.66	1.31	233.18	105,990	100%
88	50.7	438,419	4.5	0.66	0.66	0.00	0.66	1.31	233.45	106,112	100%
90	47.8	444,340	4.5	0.66	0.66	0.00	0.66	1.31	233.69	106,225	100%
92	45.2	449,923	4.6	0.66	0.66	0.00	0.66	1.31	233.93	106,330	100%
94	42.6	455,185	4.6	0.66	0.66	0.00	0.66	1.31	234.14	106,429	100%
96	40.3	460,146	4.7	0.66	0.66	0.00	0.66	1.31	234.34	106,520	100%
98	38.0	464,821	4.7	0.66	0.66	0.00	0.66	1.31	234.53	106,606	100%
100	35.9	469,226	4.8	0.66	0.66	0.00	0.66	1.31	234.71	106,686	100%
102	33.9	473,378	4.8	0.66	0.66	0.00	0.66	1.31	234.87	106,761	100%
104	32.0	477,289	4.9	0.66	0.66	0.00	0.66	1.31	235.03	106,831	100%
106	30.2	480,973	4.9	0.66	0.66	0.00	0.66	1.31	235.17	106,896	100%
108	28.5	484,443	4.9	0.66	0.66	0.00	0.66	1.31	235.31	106,957	100%
110	26.9	487,710	5.0	0.66	0.66	0.00	0.66	1.31	235.43	107,014	100%
112	25.4	490,787	5.0	0.66	0.66	0.00	0.66	1.31	235.55	107,068	100%
114	24.0	493,684	5.0	0.66	0.66	0.00	0.66	1.31	235.66	107,118	100%
116	22.7	496,410	5.0	0.66	0.66	0.00	0.66	1.31	235.76	107,165	100%
118	21.4	498,975	5.1	0.66	0.66	0.00	0.66	1.31	235.86	107,209	100%
120	20.2	501,389	5.1	0.66	0.66	0.00	0.66	1.31	235.95	107,250	100%
122	19.1	503,659	5.1	0.66	0.66	0.00	0.66	1.31	236.03	107,289	100%
124	18.0	505,794	5.1	0.66	0.66	0.00	0.66	1.31	236.11	107,325	100%
126	17.0	507,801	5.1	0.66	0.66	0.00	0.66	1.31	236.19	107,358	100%
128	16.1	509,688	5.2	0.66	0.66	0.00	0.66	1.31	236.26	107,390	100%
130	15.2	511,460	5.2	0.66	0.66	0.00	0.66	1.31	236.32	107,420	100%
132	14.3	513,125	5.2	0.66	0.66	0.00	0.66	1.31	236.38	107,448	100%
134	13.5	514,688	5.2	0.66	0.66	0.00	0.66	1.31	236.44	107,474	100%
136	12.8	516,156	5.2	0.66	0.66	0.00	0.66	1.31	236.50	107,498	100%
138	12.1	517,532	5.2	0.66	0.66	0.00	0.66	1.31	236.55	107,521	100%
140	11.4	518,824	5.2	0.66	0.66	0.00	0.66	1.31	236.59	107,542	100%
142	10.8	520,034	5.3	0.66	0.66	0.00	0.66	1.31	236.64	107,562	100%
144	10.2	521,168	5.3	0.66	0.66	0.00	0.66	1.31	236.68	107,580	100%
146	9.6	522,231	5.3	0.66	0.66	0.00	0.66	1.31	236.72	107,598	100%
148	9.1	523,225	5.3	0.66	0.66	0.00	0.66	1.31	236.75	107,614	100%
150	8.6	524,155	5.3	0.66	0.66	0.00	0.66	1.31	236.78	107,629	100%
152	8.1	525,024	5.3	0.66	0.66	0.00	0.66	1.31	236.82	107,644	100%
154	7.6	525,836	5.3	0.66	0.66	0.00	0.66	1.31	236.84	107,657	100%
156	7.2	526,595	5.3	0.66	0.66	0.00	0.66	1.31	236.87	107,669	100%
158	6.8	527,302	5.3	0.66	0.66	0.00	0.66	1.31	236.90	107,681	100%
160	6.4	527,960	5.3	0.66	0.66	0.00	0.66	1.31	236.92	107,691	100%
162	6.1	528,574	5.3	0.66	0.66	0.00	0.66	1.31	236.94	107,701	100%
164	5.7	529,144	5.3	0.66	0.66	0.00	0.66	1.31	236.96	107,711	100%
166	5.4	529,674	5.3	0.66	0.66	0.00	0.66	1.31	236.98	107,719	100%
168	5.1	530,166	5.3	0.66	0.66	0.00	0.66	1.31	237.00	107,727	100%
170	4.8	530,621	5.4	0.66	0.66	0.00	0.66	1.31	237.02	107,734	100%
172	4.6	531,042	5.4	0.66	0.66	0.00	0.66	1.31	237.03	107,741	100%
174	4.3	531,431	5.4	0.66	0.66	0.00	0.66	1.31	237.04	107,747	100%
176	4.1	531,790	5.4	0.66	0.66	0.00	0.66	1.31	237.06	107,753	100%
178	3.8	532,119	5.4	0.66	0.66	0.00	0.66	1.31	237.07	107,759	100%
180	3.6	532,422	5.4	0.66	0.66	0.00	0.66	1.31	237.08	107,763	100%
182	3.4	532,699	5.4	0.66	0.66	0.00	0.66	1.31	237.09	107,768	100%
184	3.2	532,952	5.4	0.66	0.66	0.00	0.66	1.31	237.10	107,772	100%
186	3.0	533,182	5.4	0.66	0.66	0.00	0.66	1.31	237.11	107,776	100%
188	2.9	533,390	5.4	0.66	0.66	0.00	0.66	1.31	237.11	107,779	100%
190	2.7	533,578	5.4	0.66	0.66	0.00	0.66	1.31	237.12	107,782	100%
192	2.6	533,747	5.4	0.66	0.66	0.00	0.66	1.31	237.13	107,785	100%
194	2.4	533,897	5.4	0.66	0.66	0.00	0.66	1.31	237.13	107,787	100%
196	2.3	534,030	5.4	0.66	0.66	0.00	0.66	1.31	237.14	107,789	100%
198	2.2	534,148	5.4	0.66	0.66	0.00	0.66	1.31	237.14	107,791	100%
200	2.0	534,249	5.4	0.66	0.66	0.00	0.66	1.31	237.14	107,793	100%
202	1.9	534,337	5.4	0.66	0.66	0.00	0.66	1.31	237.15	107,794	100%
204	1.8	534,411	5.4	0.66	0.66	0.00	0.66	1.31	237.15	107,795	100%
206	1.7	534,471	5.4	0.66	0.66	0.00	0.66	1.31	237.15	107,796	100%


Sediment Basin #9 Colon Mine Phase 1 Hydrograph
10-Yr Storm
FLOW (cfs)
STAGE
TIME (min)
OUTFLOW
INFLOW [cfs]
STAGE [ft]
0
50
100
150
200
250
300
350
400
450
500
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
0
20
40
60
80
100
120
140
160
180

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Computed By: PAW Date: 12/31/14

Checked By: EAW Date: 1/2/15

Sheet: _1___of _2_

Sediment Basin # 9 Colon

Phase 2

10 - year Storm Event

Qp =	199.50	cfs
Tp =	45.27	minutes
dT = Max of	**2**	minutes
or	**1.0%**	of increment to peak

b = 1.1
Ks = 85,791

Number of Riser/Barrel Assemblies	2		
Diameter of Barrel =	42	(in)	
Height of Riser above barrel =	3.2	(ft)	
Height of Riser from bottom of barrel=	6.7	(ft) elevation	268.70
Emergency Spillway =	7.5	(ft) elevation	269.50
Total Height of Dam =	8.5	(ft) elevation	270.50
Length of Emergency Spillway =	50	(ft)	
Diameter of Riser =	72	(in)	
Permanent Pond Stage =	0	(ft) elevation	262.0

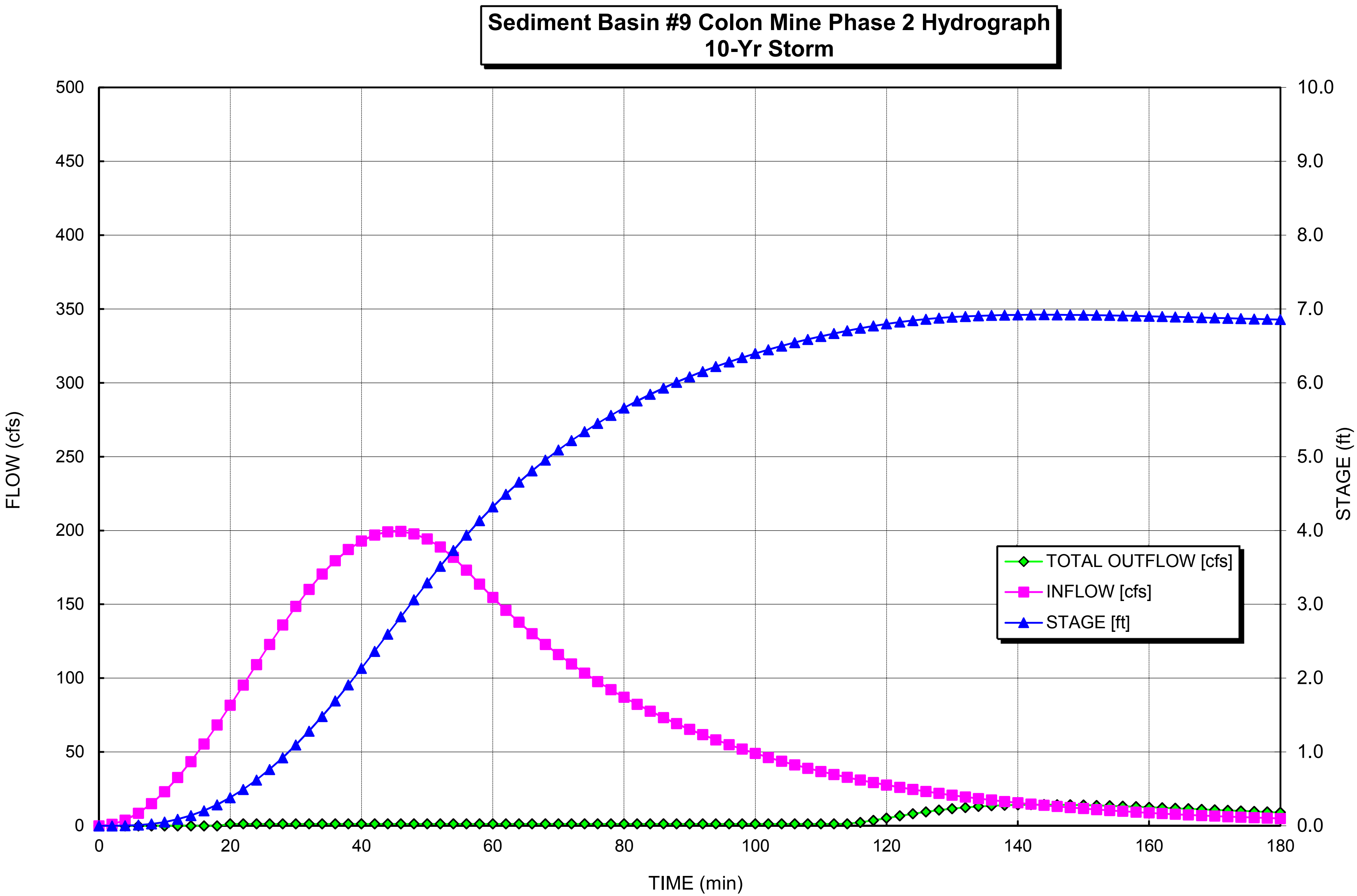
4.0E-03 Settling Velocity of design particle (fps)
2 Effective number of cells (2 is construction site #)

100%	Minimum Settling Efficiency		
6.9	ft Maximum Stage	268.92	msl elevation
14.3	cfs Peak outflow		
14.3	cfs Peak Riser/Barrel outflow		
0.0	cfs peak weir flow		

Notes:
1. Length of emergency spillway is the bottom width of the emergency spillway.
2. Settling efficiency neglects permanent pond volume

TIME (min)	INFLOW [cfs]	STORAGE [cu ft]	STAGE [ft]	Skimmer Flow [cfs]	RISER CAPACITY [cfs]	WEIR FLOW [cfs]	BARREL CAPACITY [cfs]	TOTAL OUTFLOW [cfs]	Bound Discharge [cfs]	Estimated Surface Area (sf)	Settling Efficiency [%]
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
2	1.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
4	3.8	115	0.0	0.00	0.00	0.00	0.00	0.00	121.18	55,083	N/A
6	8.5	573	0.0	0.00	0.00	0.00	0.00	0.00	137.69	62,584	N/A
8	15.0	1,596	0.0	0.00	0.00	0.00	0.00	0.00	149.36	67,893	N/A
10	23.1	3,394	0.1	0.00	0.00	0.00	0.00	0.00	158.60	72,091	N/A
12	32.6	6,162	0.1	0.00	0.00	0.00	0.00	0.00	166.30	75,592	N/A
14	43.5	10,078	0.1	0.00	0.00	0.00	0.00	0.00	172.94	78,608	N/A
16	55.4	15,296	0.2	0.00	0.00	0.00	0.00	0.00	178.77	81,260	N/A
18	68.2	21,947	0.3	0.00	0.00	0.00	0.00	0.00	183.98	83,627	N/A
20	81.6	30,132	0.4	0.66	0.66	0.00	0.66	1.31	188.68	85,761	100%
22	95.4	39,768	0.5	0.66	0.66	0.00	0.66	1.31	192.88	87,675	100%
24	109.2	51,053	0.6	0.66	0.66	0.00	0.66	1.31	196.75	89,434	100%
26	122.8	63,997	0.8	0.66	0.66	0.00	0.66	1.31	200.32	91,055	100%
28	136.0	78,579	0.9	0.66	0.66	0.00	0.66	1.31	203.62	92,554	100%
30	148.5	94,745	1.1	0.66	0.66	0.00	0.66	1.31	206.67	93,941	100%
32	160.1	112,413	1.3	0.66	0.66	0.00	0.66	1.31	209.50	95,227	100%
34	170.5	131,468	1.5	0.66	0.66	0.00	0.66	1.31	212.12	96,420	100%
36	179.6	151,772	1.7	0.66	0.66	0.00	0.66	1.31	214.56	97,528	100%
38	187.1	173,161	1.9	0.66	0.66	0.00	0.66	1.31	216.82	98,556	100%
40	192.9	195,452	2.1	0.66	0.66	0.00	0.66	1.31	218.92	99,509	100%
42	196.9	218,443	2.4	0.66	0.66	0.00	0.66	1.31	220.86	100,393	100%
44	199.1	241,919	2.6	0.66	0.66	0.00	0.66	1.31	222.66	101,211	100%
46	199.4	265,655	2.8	0.66	0.66	0.00	0.66	1.31	224.33	101,967	100%
48	197.7	289,422	3.1	0.66	0.66	0.00	0.66	1.31	225.86	102,665	100%
50	194.2	312,991	3.3	0.66	0.66	0.00	0.66	1.31	227.27	103,306	100%
52	188.8	336,135	3.5	0.66	0.66	0.00	0.66	1.31	228.57	103,893	100%
54	181.8	358,637	3.7	0.66	0.66	0.00	0.66	1.31	229.75	104,430	100%
56	173.1	380,290	3.9	0.66	0.66	0.00	0.66	1.31	230.82	104,918	100%
58	163.7	400,906	4.1	0.66	0.66	0.00	0.66	1.31	231.79	105,359	100%
60	154.6	420,396	4.3	0.66	0.66	0.00	0.66	1.31	232.67	105,758	100%
62	146.0	438,789	4.5	0.66	0.66	0.00	0.66	1.31	233.46	106,119	100%
64	137.8	456,147	4.7	0.66	0.66	0.00	0.66	1.31	234.18	106,447	100%
66	130.1	472,527	4.8	0.66	0.66	0.00	0.66	1.31	234.84	106,746	100%
68	122.9	487,984	5.0	0.66	0.66	0.00	0.66	1.31	235.44	107,019	100%
70	116.0	502,570	5.1	0.66	0.66	0.00	0.66	1.31	235.99	107,270	100%
72	109.5	516,332	5.2	0.66	0.66	0.00	0.66	1.31	236.50	107,501	100%
74	103.4	529,318	5.3	0.66	0.66	0.00	0.66	1.31	236.97	107,713	100%
76	97.6	541,571	5.5	0.66	0.66	0.00	0.66	1.31	237.40	107,910	100%
78	92.2	553,131	5.6	0.66	0.66	0.00	0.66	1.31	237.80	108,091	100%
80	87.0	564,036	5.7	0.66	0.66	0.00	0.66	1.31	238.17	108,259	100%
82	82.2	574,325	5.8	0.66	0.66	0.00	0.66	1.31	238.51	108,415	100%
84	77.6	584,030	5.8	0.66	0.66	0.00	0.66	1.31	238.83	108,559	100%

86	73.3	593,185	5.9	0.66	0.66	0.00	0.66	1.31	239.13	108,693	100%
88	69.2	601,820	6.0	0.66	0.66	0.00	0.66	1.31	239.40	108,818	100%
90	65.3	609,964	6.1	0.66	0.66	0.00	0.66	1.31	239.66	108,935	100%
92	61.7	617,645	6.2	0.66	0.66	0.00	0.66	1.31	239.90	109,043	100%
94	58.2	624,889	6.2	0.66	0.66	0.00	0.66	1.31	240.12	109,144	100%
96	55.0	631,720	6.3	0.66	0.66	0.00	0.66	1.31	240.33	109,239	100%
98	51.9	638,160	6.3	0.66	0.66	0.00	0.66	1.31	240.52	109,327	100%
100	49.0	644,232	6.4	0.66	0.66	0.00	0.66	1.31	240.70	109,409	100%
102	46.3	649,957	6.4	0.66	0.66	0.00	0.66	1.31	240.87	109,486	100%
104	43.7	655,353	6.5	0.66	0.66	0.00	0.66	1.31	241.03	109,558	100%
106	41.3	660,440	6.5	0.66	0.66	0.00	0.66	1.31	241.18	109,626	100%
108	39.0	665,233	6.6	0.66	0.66	0.00	0.66	1.31	241.32	109,689	100%
110	36.8	669,751	6.6	0.66	0.66	0.00	0.66	1.31	241.45	109,748	100%
112	34.7	674,007	6.7	0.66	0.66	0.00	0.66	1.31	241.57	109,803	100%
114	32.8	678,017	6.7	0.66	0.68	0.00	102.96	1.36	241.68	109,855	100%
116	31.0	681,789	6.7	0.66	1.14	0.00	103.31	2.28	241.79	109,903	100%
118	29.2	685,230	6.8	0.66	1.83	0.00	103.64	3.65	241.88	109,947	100%
120	27.6	688,300	6.8	0.66	2.58	0.00	103.92	5.17	241.97	109,987	100%
122	26.1	690,992	6.8	0.66	3.34	0.00	104.18	6.69	242.05	110,021	100%
124	24.6	693,317	6.8	0.66	4.06	0.00	104.39	8.13	242.11	110,050	100%
126	23.2	695,294	6.9	0.66	4.72	0.00	104.58	9.44	242.16	110,075	100%
128	21.9	696,949	6.9	0.66	5.30	0.00	104.73	10.60	242.21	110,096	100%
130	20.7	698,310	6.9	0.66	5.79	0.00	104.86	11.58	242.25	110,113	100%
132	19.6	699,405	6.9	0.66	6.20	0.00	104.96	12.40	242.28	110,127	100%
134	18.5	700,264	6.9	0.66	6.53	0.00	105.04	13.06	242.30	110,137	100%
136	17.4	700,912	6.9	0.66	6.78	0.00	105.10	13.56	242.32	110,145	100%
138	16.5	701,377	6.9	0.66	6.96	0.00	105.14	13.93	242.33	110,151	100%
140	15.5	701,681	6.9	0.66	7.08	0.00	105.17	14.17	242.34	110,155	100%
142	14.7	701,846	6.9	0.66	7.15	0.00	105.18	14.30	242.35	110,157	100%
144	13.9	701,891	6.9	0.66	7.17	0.00	105.19	14.34	242.35	110,158	100%
146	13.1	701,833	6.9	0.66	7.14	0.00	105.18	14.29	242.35	110,157	100%
148	12.4	701,688	6.9	0.66	7.09	0.00	105.17	14.17	242.34	110,155	100%
150	11.7	701,469	6.9	0.66	7.00	0.00	105.15	14.00	242.34	110,152	100%
152	11.0	701,189	6.9	0.66	6.89	0.00	105.12	13.78	242.33	110,149	100%
154	10.4	700,857	6.9	0.66	6.76	0.00	105.09	13.52	242.32	110,145	100%
156	9.8	700,482	6.9	0.66	6.61	0.00	105.06	13.23	242.31	110,140	100%
158	9.3	700,073	6.9	0.66	6.46	0.00	105.02	12.91	242.30	110,135	100%
160	8.8	699,636	6.9	0.66	6.29	0.00	104.98	12.58	242.28	110,129	100%
162	8.3	699,177	6.9	0.66	6.11	0.00	104.94	12.23	242.27	110,124	100%
164	7.8	698,701	6.9	0.66	5.94	0.00	104.89	11.87	242.26	110,118	100%
166	7.4	698,212	6.9	0.66	5.76	0.00	104.85	11.51	242.25	110,112	100%
168	7.0	697,715	6.9	0.66	5.57	0.00	104.80	11.15	242.23	110,105	100%
170	6.6	697,212	6.9	0.66	5.39	0.00	104.76	10.78	242.22	110,099	100%
172	6.2	696,706	6.9	0.66	5.21	0.00	104.71	10.42	242.20	110,093	100%
174	5.9	696,199	6.9	0.66	5.03	0.00	104.66	10.07	242.19	110,086	100%
176	5.5	695,694	6.9	0.66	4.86	0.00	104.61	9.71	242.18	110,080	100%
178	5.2	695,191	6.9	0.66	4.68	0.00	104.57	9.37	242.16	110,074	100%
180	4.9	694,693	6.9	0.66	4.52	0.00	104.52	9.03	242.15	110,067	100%
182	4.7	694,201	6.9	0.66	4.35	0.00	104.48	8.70	242.13	110,061	100%
184	4.4	693,715	6.8	0.66	4.19	0.00	104.43	8.39	242.12	110,055	100%
186	4.1	693,236	6.8	0.66	4.04	0.00	104.39	8.07	242.11	110,049	100%
188	3.9	692,764	6.8	0.66	3.89	0.00	104.34	7.77	242.09	110,043	100%
190	3.7	692,301	6.8	0.66	3.74	0.00	104.30	7.48	242.08	110,037	100%
192	3.5	691,847	6.8	0.66	3.60	0.00	104.26	7.20	242.07	110,031	100%
194	3.3	691,402	6.8	0.66	3.47	0.00	104.21	6.93	242.06	110,026	100%
196	3.1	690,965	6.8	0.66	3.34	0.00	104.17	6.67	242.04	110,020	100%
198	2.9	690,538	6.8	0.66	3.21	0.00	104.13	6.42	242.03	110,015	100%
200	2.8	690,121	6.8	0.66	3.09	0.00	104.10	6.18	242.02	110,010	100%
202	2.6	689,713	6.8	0.66	2.97	0.00	104.06	5.94	242.01	110,004	100%
204	2.5	689,314	6.8	0.66	2.86	0.00	104.02	5.72	242.00	109,999	100%



Sediment Basin #9 Colon Mine Phase 2 Hydrograph
10-Yr Storm
FLOW (cfs)
STAGE (ft)
TIME (min)
0
50
100
150
200
250
300
350
400
450
500
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
0
20
40
60
80
100
120
140
160
180
TOTAL OUTFLOW [cfs]
INFLOW [cfs]
STAGE [ft]

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Sediment Basin # 9 Colon

Phase 2

25 - year Storm Event

Qp =	268.73	cfs
Tp =	44.85	minutes
dT = Max of	**2**	minutes
or	**1.0%**	of increment to peak

b = 1.1
Ks = 85,791

Number of Riser/Barrel Assemblies	2		
Diameter of Barrel =	42	(in)	
Height of Riser above barrel =	3.2	(ft)	
Height of Riser from bottom of barrel=	6.7	(ft) elevatior	268.70
Emergency Spillway =	7.5	(ft) elevatior	269.50
Total Height of Dam =	8.5	(ft) elevatior	270.50
Length of Emergency Spillway =	50	(ft)	
Diameter of Riser =	72	(in)	
Permanent Pond Stage =	0	(ft) elevatior	262.0

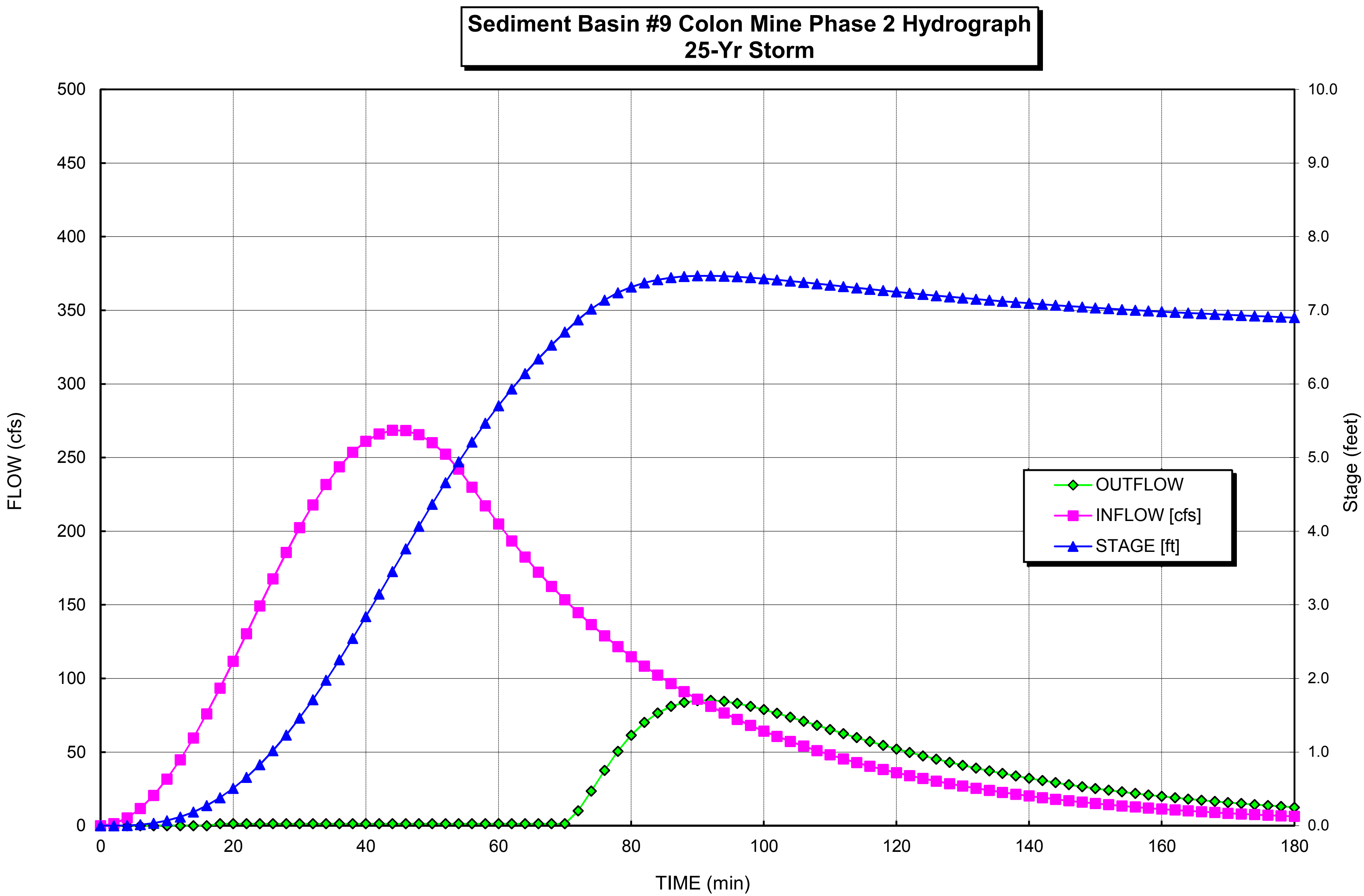
4.0E-03 Settling Velocity of design particle (fps)
2 Effective number of cells (2 is construction site #)

92%	Minimum Settling Efficiency		
7.5	ft Maximum Stage	269.5	msl elevation
85.1	cfs Peak outflow		
85.1	cfs Peak Riser/Barrel outflow		
0.0	cfs peak weir flow		

Notes:
1. Length of emergency spillway is the bottom width of the emergency spillway.
2. Settling efficiency neglects permanent pond volume

TIME (min)	INFLOW [cfs]	STORAGE [cu ft]	STAGE [ft]	Skimmer Flow [cfs]	RISER CAPACITY [cfs]	WEIR FLOW [cfs]	BARREL CAPACITY [cfs]	TOTAL OUTFLOW [cfs]	Bound Discharge [cfs]	Estimated Surface Area (sf)	Settling Efficiency [%]
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
2	1.3	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
4	5.2	158	0.0	0.00	0.00	0.00	0.00	0.00	124.27	56,487	N/A
6	11.7	787	0.0	0.00	0.00	0.00	0.00	0.00	141.19	64,179	N/A
8	20.5	2,190	0.0	0.00	0.00	0.00	0.00	0.00	153.17	69,622	N/A
10	31.6	4,656	0.1	0.00	0.00	0.00	0.00	0.00	162.64	73,926	N/A
12	44.7	8,452	0.1	0.00	0.00	0.00	0.00	0.00	170.54	77,516	N/A
14	59.6	13,820	0.2	0.00	0.00	0.00	0.00	0.00	177.34	80,607	N/A
16	75.9	20,971	0.3	0.00	0.00	0.00	0.00	0.00	183.31	83,325	N/A
18	93.4	30,080	0.4	0.66	0.66	0.00	0.66	1.31	188.65	85,750	100%
20	111.6	41,128	0.5	0.66	0.66	0.00	0.66	1.31	193.40	87,909	100%
22	130.4	54,368	0.7	0.66	0.66	0.00	0.66	1.31	197.74	89,882	100%
24	149.2	69,854	0.8	0.66	0.66	0.00	0.66	1.31	201.72	91,692	100%
26	167.7	87,595	1.0	0.66	0.66	0.00	0.66	1.31	205.38	93,357	100%
28	185.5	107,556	1.2	0.66	0.66	0.00	0.66	1.31	208.77	94,893	100%
30	202.4	129,659	1.5	0.66	0.66	0.00	0.66	1.31	211.89	96,314	100%
32	217.9	153,785	1.7	0.66	0.66	0.00	0.66	1.31	214.79	97,630	100%
34	231.7	179,772	2.0	0.66	0.66	0.00	0.66	1.31	217.47	98,850	100%
36	243.7	207,424	2.3	0.66	0.66	0.00	0.66	1.31	219.96	99,981	100%
38	253.6	236,514	2.5	0.66	0.66	0.00	0.66	1.31	222.27	101,030	100%
40	261.0	266,783	2.8	0.66	0.66	0.00	0.66	1.31	224.40	102,002	100%
42	266.1	297,951	3.1	0.66	0.66	0.00	0.66	1.31	226.38	102,902	100%
44	268.5	329,721	3.5	0.66	0.66	0.00	0.66	1.31	228.22	103,734	100%
46	268.3	361,783	3.8	0.66	0.66	0.00	0.66	1.31	229.91	104,503	100%
48	265.5	393,821	4.1	0.66	0.66	0.00	0.66	1.31	231.46	105,210	100%
50	260.1	425,521	4.4	0.66	0.66	0.00	0.66	1.31	232.89	105,860	100%
52	252.2	456,574	4.7	0.66	0.66	0.00	0.66	1.31	234.20	106,454	100%
54	242.1	486,685	4.9	0.66	0.66	0.00	0.66	1.31	235.39	106,996	100%
56	229.8	515,577	5.2	0.66	0.66	0.00	0.66	1.31	236.47	107,488	100%
58	217.1	542,996	5.5	0.66	0.66	0.00	0.66	1.31	237.45	107,932	100%
60	204.9	568,894	5.7	0.66	0.66	0.00	0.66	1.31	238.33	108,333	100%
62	193.4	593,324	5.9	0.66	0.66	0.00	0.66	1.31	239.13	108,696	100%
64	182.5	616,370	6.1	0.66	0.66	0.00	0.66	1.31	239.86	109,025	100%
66	172.2	638,109	6.3	0.66	0.66	0.00	0.66	1.31	240.52	109,326	100%
68	162.5	658,614	6.5	0.66	0.66	0.00	0.66	1.31	241.12	109,602	100%
70	153.3	677,956	6.7	0.66	0.67	0.00	102.95	1.35	241.68	109,854	100%
72	144.7	696,195	6.9	0.66	5.03	0.00	104.66	10.06	242.19	110,086	100%
74	136.6	712,352	7.0	0.66	11.76	0.00	106.15	23.52	242.63	110,287	99%
76	128.9	725,917	7.1	0.66	18.81	0.00	107.38	37.61	243.00	110,453	98%
78	121.6	736,867	7.2	0.66	25.27	0.00	108.36	50.54	243.29	110,584	97%
80	114.8	745,394	7.3	0.66	30.74	0.00	109.12	61.47	243.51	110,686	95%
82	108.3	751,788	7.4	0.66	35.06	0.00	109.69	70.13	243.67	110,761	94%
84	102.2	756,368	7.4	0.66	38.28	0.00	110.09	76.56	243.79	110,814	93%

86	96.4	759,445	7.4	0.66	40.49	0.00	110.36	80.98	243.87	110,850	93%
88	91.0	761,300	7.5	0.66	41.84	0.00	110.52	83.69	243.92	110,872	93%
90	85.9	762,179	7.5	0.66	42.49	0.00	110.60	84.98	243.94	110,882	92%
92	81.0	762,287	7.5	0.66	42.57	0.00	110.61	85.14	243.94	110,883	92%
94	76.5	761,796	7.5	0.66	42.21	0.00	110.56	84.41	243.93	110,877	92%
96	72.2	760,844	7.5	0.66	41.51	0.00	110.48	83.02	243.91	110,866	93%
98	68.1	759,543	7.4	0.66	40.56	0.00	110.37	81.12	243.87	110,851	93%
100	64.3	757,981	7.4	0.66	39.43	0.00	110.23	78.86	243.83	110,833	93%
102	60.7	756,230	7.4	0.66	38.18	0.00	110.08	76.36	243.79	110,813	93%
104	57.2	754,345	7.4	0.66	36.85	0.00	109.91	73.69	243.74	110,791	94%
106	54.0	752,370	7.4	0.66	35.47	0.00	109.74	70.93	243.69	110,768	94%
108	51.0	750,340	7.4	0.66	34.07	0.00	109.56	68.13	243.64	110,744	94%
110	48.1	748,280	7.3	0.66	32.67	0.00	109.38	65.33	243.58	110,720	95%
112	45.4	746,212	7.3	0.66	31.28	0.00	109.19	62.56	243.53	110,695	95%
114	42.8	744,152	7.3	0.66	29.92	0.00	109.01	59.84	243.48	110,671	95%
116	40.4	742,112	7.3	0.66	28.59	0.00	108.83	57.18	243.42	110,647	96%
118	38.1	740,101	7.3	0.66	27.30	0.00	108.65	54.60	243.37	110,623	96%
120	36.0	738,126	7.3	0.66	26.06	0.00	108.47	52.11	243.32	110,599	96%
122	34.0	736,192	7.2	0.66	24.86	0.00	108.30	49.71	243.27	110,576	97%
124	32.1	734,303	7.2	0.66	23.70	0.00	108.13	47.40	243.22	110,554	97%
126	30.3	732,462	7.2	0.66	22.59	0.00	107.97	45.19	243.17	110,532	97%
128	28.5	730,669	7.2	0.66	21.53	0.00	107.81	43.07	243.12	110,510	97%
130	26.9	728,927	7.2	0.66	20.52	0.00	107.65	41.04	243.08	110,489	98%
132	25.4	727,235	7.2	0.66	19.55	0.00	107.50	39.10	243.03	110,469	98%
134	24.0	725,594	7.1	0.66	18.63	0.00	107.35	37.25	242.99	110,449	98%
136	22.6	724,002	7.1	0.66	17.74	0.00	107.21	35.49	242.95	110,430	98%
138	21.4	722,460	7.1	0.66	16.90	0.00	107.07	33.81	242.90	110,411	98%
140	20.2	720,967	7.1	0.66	16.10	0.00	106.93	32.21	242.86	110,393	98%
142	19.0	719,521	7.1	0.66	15.34	0.00	106.80	30.69	242.83	110,375	99%
144	18.0	718,122	7.1	0.66	14.62	0.00	106.67	29.24	242.79	110,358	99%
146	16.9	716,768	7.1	0.66	13.93	0.00	106.55	27.86	242.75	110,342	99%
148	16.0	715,458	7.0	0.66	13.27	0.00	106.43	26.54	242.72	110,326	99%
150	15.1	714,192	7.0	0.66	12.65	0.00	106.32	25.29	242.68	110,310	99%
152	14.2	712,967	7.0	0.66	12.05	0.00	106.20	24.11	242.65	110,295	99%
154	13.4	711,783	7.0	0.66	11.49	0.00	106.10	22.98	242.62	110,280	99%
156	12.7	710,637	7.0	0.66	10.95	0.00	105.99	21.91	242.59	110,266	99%
158	12.0	709,530	7.0	0.66	10.44	0.00	105.89	20.89	242.56	110,253	99%
160	11.3	708,460	7.0	0.66	9.96	0.00	105.79	19.92	242.53	110,239	99%
162	10.7	707,425	7.0	0.66	9.50	0.00	105.70	18.99	242.50	110,226	99%
164	10.1	706,424	7.0	0.66	9.06	0.00	105.61	18.12	242.47	110,214	99%
166	9.5	705,457	7.0	0.66	8.64	0.00	105.52	17.28	242.44	110,202	99%
168	9.0	704,522	6.9	0.66	8.25	0.00	105.43	16.49	242.42	110,190	100%
170	8.5	703,617	6.9	0.66	7.87	0.00	105.35	15.74	242.39	110,179	100%
172	8.0	702,743	6.9	0.66	7.51	0.00	105.27	15.02	242.37	110,168	100%
174	7.5	701,897	6.9	0.66	7.17	0.00	105.19	14.34	242.35	110,158	100%
176	7.1	701,079	6.9	0.66	6.85	0.00	105.11	13.69	242.32	110,148	100%
178	6.7	700,288	6.9	0.66	6.54	0.00	105.04	13.08	242.30	110,138	100%
180	6.3	699,523	6.9	0.66	6.25	0.00	104.97	12.49	242.28	110,128	100%
182	6.0	698,783	6.9	0.66	5.97	0.00	104.90	11.93	242.26	110,119	100%
184	5.6	698,067	6.9	0.66	5.70	0.00	104.83	11.40	242.24	110,110	100%
186	5.3	697,375	6.9	0.66	5.45	0.00	104.77	10.90	242.22	110,101	100%
188	5.0	696,704	6.9	0.66	5.21	0.00	104.71	10.42	242.20	110,093	100%
190	4.7	696,056	6.9	0.66	4.98	0.00	104.65	9.96	242.19	110,085	100%
192	4.5	695,428	6.9	0.66	4.77	0.00	104.59	9.53	242.17	110,077	100%
194	4.2	694,820	6.9	0.66	4.56	0.00	104.53	9.12	242.15	110,069	100%
196	4.0	694,232	6.9	0.66	4.36	0.00	104.48	8.72	242.14	110,062	100%
198	3.8	693,662	6.8	0.66	4.18	0.00	104.43	8.35	242.12	110,054	100%
200	3.5	693,110	6.8	0.66	4.00	0.00	104.37	7.99	242.10	110,047	100%
202	3.3	692,576	6.8	0.66	3.83	0.00	104.32	7.66	242.09	110,041	100%
204	3.2	692,058	6.8	0.66	3.67	0.00	104.28	7.33	242.08	110,034	100%
206	3.0	691,557	6.8	0.66	3.51	0.00	104.23	7.03	242.06	110,028	100%


Sediment Basin #9 Colon Mine Phase 2 Hydrograph
25-Yr Storm
FLOW (cfs)
Stage (feet)
TIME (min)
0
50
100
150
200
250
300
350
400
450
500
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
0
20
40
60
80
100
120
140
160
180
OUTFLOW
INFLOW [cfs]
STAGE [ft]

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Sediment Basin # 9 Colon

Phase 2

100 - year Storm Event

Qp = 384.1 cfs
Tp = 44.7 minutes
dT = Max of 2 minutes
or 1.0% of increment to peak

b = 1.1
Ks = 85,791

Number of Riser/Barrel Assemblies	2			
Diameter of Barrel =	42	(in)		
Height of Riser above barrel =	3.2	(ft)		
Height of Riser from bottom of barrel=	6.7	(ft)	elevation	268.70
Emergency Spillway =	7.5	(ft)	elevation	269.50
Total Height of Dam =	8.5	(ft)	elevation	270.50
Length of Emergency Spillway =	50	(ft)		
Diameter of Riser =	72	(in)		
Permanent Pond Stage =	0	(ft)	elevation	262.0

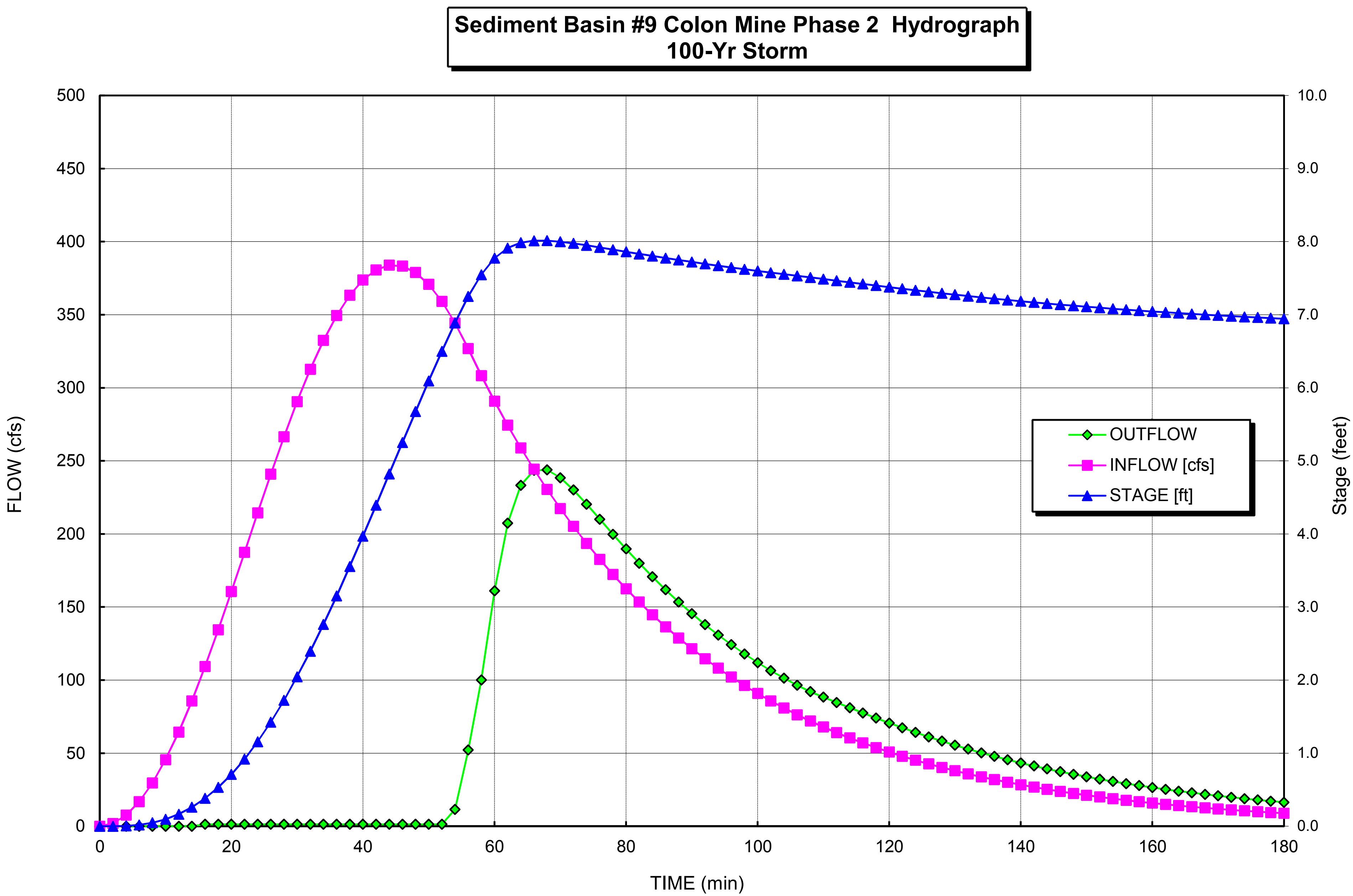
4.0E-03 Settling Velocity of design particle (fps)
2 Effective number of cells (2 is construction site #)

73%	Minimum Settling Efficiency	
8.0	ft Maximum Stage	270.0 msl elevation
243.8	cfs Peak outflow	
188.6	cfs Peak Riser/Barrel outflow	
55.2	cfs peak weir flow	

Notes:
1. Length of emergency spillway is the bottom width of the emergency spillway.
2. Settling efficiency neglects permanent pond volume

TIME (min)	INFLOW [cfs]	STORAGE [cu ft]	STAGE [ft]	Skimmer Flow [cfs]	RISER CAPACITY [cfs]	WEIR FLOW [cfs]	BARREL CAPACITY [cfs]	TOTAL OUTFLOW [cfs]	Bound Discharge [cfs]	Estimated Surface Area (sf)	Settling Efficiency [%]
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
2	1.9	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	-	N/A
4	7.5	228	0.0	0.00	0.00	0.00	0.00	0.00	127.93	58,150	N/A
6	16.8	1,133	0.0	0.00	0.00	0.00	0.00	0.00	145.35	66,068	N/A
8	29.6	3,154	0.0	0.00	0.00	0.00	0.00	0.00	157.68	71,672	N/A
10	45.6	6,705	0.1	0.00	0.00	0.00	0.00	0.00	167.42	76,102	N/A
12	64.4	12,171	0.2	0.00	0.00	0.00	0.00	0.00	175.55	79,797	N/A
14	85.8	19,900	0.3	0.00	0.00	0.00	0.00	0.00	182.55	82,978	N/A
16	109.2	30,193	0.4	0.66	0.66	0.00	0.66	1.31	188.71	85,775	100%
18	134.4	43,145	0.5	0.66	0.66	0.00	0.66	1.31	194.14	88,245	100%
20	160.6	59,110	0.7	0.66	0.66	0.00	0.66	1.31	199.06	90,482	100%
22	187.5	78,225	0.9	0.66	0.66	0.00	0.66	1.31	203.55	92,521	100%
24	214.4	100,563	1.2	0.66	0.66	0.00	0.66	1.31	207.65	94,387	100%
26	240.9	126,135	1.4	0.66	0.66	0.00	0.66	1.31	211.43	96,103	100%
28	266.5	154,890	1.7	0.66	0.66	0.00	0.66	1.31	214.91	97,686	100%
30	290.6	186,710	2.0	0.66	0.66	0.00	0.66	1.31	218.12	99,148	100%
32	312.7	221,419	2.4	0.66	0.66	0.00	0.66	1.31	221.10	100,501	100%
34	332.4	258,784	2.8	0.66	0.66	0.00	0.66	1.31	223.86	101,755	100%
36	349.4	298,519	3.2	0.66	0.66	0.00	0.66	1.31	226.42	102,918	100%
38	363.3	340,291	3.6	0.66	0.66	0.00	0.66	1.31	228.79	103,995	100%
40	373.8	383,728	4.0	0.66	0.66	0.00	0.66	1.31	230.98	104,993	100%
42	380.7	428,423	4.4	0.66	0.66	0.00	0.66	1.31	233.02	105,917	100%
44	383.8	473,946	4.8	0.66	0.66	0.00	0.66	1.31	234.90	106,771	100%
46	383.2	519,850	5.3	0.66	0.66	0.00	0.66	1.31	236.63	107,559	100%
48	378.8	565,680	5.7	0.66	0.66	0.00	0.66	1.31	238.22	108,284	100%
50	370.8	610,984	6.1	0.66	0.66	0.00	0.66	1.31	239.69	108,949	100%
52	359.2	655,318	6.5	0.66	0.66	0.00	0.66	1.31	241.03	109,558	100%
54	344.2	698,260	6.9	0.66	5.77	0.00	104.85	11.55	242.25	110,112	100%
56	326.7	738,184	7.3	0.66	26.09	0.00	108.48	52.19	243.32	110,600	96%
58	308.3	771,132	7.5	0.66	49.26	1.59	111.37	100.11	244.17	110,985	90%
60	290.8	796,112	7.8	0.66	69.80	21.41	113.51	161.02	244.79	111,267	82%
62	274.4	811,692	7.9	0.66	83.76	39.82	114.82	207.33	245.16	111,438	77%
64	258.9	819,740	8.0	0.66	91.29	50.70	115.49	233.27	245.36	111,526	74%
66	244.3	822,814	8.0	0.66	94.22	55.08	115.75	243.52	245.43	111,559	73%
68	230.4	822,903	8.0	0.66	94.30	55.21	115.76	243.81	245.43	111,560	73%
70	217.4	821,299	8.0	0.66	92.77	52.91	115.62	238.44	245.39	111,543	73%
72	205.1	818,776	8.0	0.66	90.37	49.35	115.41	230.10	245.33	111,515	74%
74	193.5	815,779	7.9	0.66	87.56	45.23	115.16	220.35	245.26	111,483	75%
76	182.6	812,561	7.9	0.66	84.56	40.95	114.90	210.07	245.18	111,448	77%
78	172.3	809,263	7.9	0.66	81.53	36.71	114.62	199.76	245.11	111,412	78%
80	162.5	805,963	7.9	0.66	78.53	32.62	114.34	189.68	245.03	111,375	79%
82	153.3	802,705	7.8	0.66	75.61	28.74	114.07	179.95	244.95	111,340	80%
84	144.7	799,511	7.8	0.66	72.78	25.10	113.80	170.65	244.87	111,304	81%

86	136.5	796,393	7.8	0.66	70.05	21.71	113.54	161.80	244.79	111,270	82%
88	128.8	793,356	7.7	0.66	67.42	18.56	113.28	153.41	244.72	111,236	83%
90	121.5	790,399	7.7	0.66	64.90	15.66	113.03	145.46	244.65	111,203	84%
92	114.6	787,523	7.7	0.66	62.48	13.00	112.78	137.95	244.58	111,171	85%
94	108.1	784,724	7.7	0.66	60.14	10.58	112.54	130.87	244.51	111,139	86%
96	102.0	781,997	7.6	0.66	57.90	8.38	112.31	124.19	244.44	111,108	87%
98	96.3	779,338	7.6	0.66	55.74	6.41	112.08	117.90	244.37	111,078	88%
100	90.8	776,741	7.6	0.66	53.66	4.66	111.86	111.99	244.31	111,049	89%
102	85.7	774,201	7.6	0.66	51.65	3.14	111.64	106.45	244.24	111,020	90%
104	80.8	771,710	7.6	0.66	49.71	1.86	111.42	101.27	244.18	110,992	90%
106	76.3	769,259	7.5	0.66	47.81	0.84	111.21	96.46	244.12	110,963	91%
108	72.0	766,835	7.5	0.66	45.97	0.14	111.00	92.08	244.06	110,936	91%
110	67.9	764,421	7.5	0.66	44.15	0.00	110.79	88.31	244.00	110,908	92%
112	64.1	761,972	7.5	0.66	42.34	0.00	110.58	84.67	243.93	110,879	92%
114	60.4	759,497	7.4	0.66	40.53	0.00	110.36	81.05	243.87	110,851	93%
116	57.0	757,022	7.4	0.66	38.74	0.00	110.15	77.49	243.81	110,822	93%
118	53.8	754,565	7.4	0.66	37.00	0.00	109.93	74.00	243.75	110,793	94%
120	50.8	752,140	7.4	0.66	35.31	0.00	109.72	70.61	243.68	110,765	94%
122	47.9	749,756	7.4	0.66	33.67	0.00	109.51	67.34	243.62	110,737	95%
124	45.2	747,422	7.3	0.66	32.09	0.00	109.30	64.18	243.56	110,710	95%
126	42.6	745,142	7.3	0.66	30.57	0.00	109.10	61.14	243.50	110,683	95%
128	40.2	742,919	7.3	0.66	29.11	0.00	108.90	58.23	243.44	110,656	96%
130	37.9	740,757	7.3	0.66	27.72	0.00	108.71	55.44	243.39	110,631	96%
132	35.8	738,657	7.3	0.66	26.39	0.00	108.52	52.78	243.33	110,606	96%
134	33.8	736,619	7.2	0.66	25.12	0.00	108.34	50.24	243.28	110,582	97%
136	31.9	734,643	7.2	0.66	23.91	0.00	108.16	47.81	243.23	110,558	97%
138	30.1	732,728	7.2	0.66	22.75	0.00	107.99	45.51	243.18	110,535	97%
140	28.4	730,875	7.2	0.66	21.65	0.00	107.83	43.31	243.13	110,513	97%
142	26.8	729,081	7.2	0.66	20.61	0.00	107.66	41.22	243.08	110,491	98%
144	25.2	727,346	7.2	0.66	19.61	0.00	107.51	39.23	243.03	110,470	98%
146	23.8	725,668	7.1	0.66	18.67	0.00	107.36	37.34	242.99	110,450	98%
148	22.5	724,045	7.1	0.66	17.77	0.00	107.21	35.54	242.95	110,430	98%
150	21.2	722,477	7.1	0.66	16.91	0.00	107.07	33.83	242.90	110,411	98%
152	20.0	720,962	7.1	0.66	16.10	0.00	106.93	32.20	242.86	110,393	98%
154	18.9	719,498	7.1	0.66	15.33	0.00	106.80	30.66	242.82	110,375	99%
156	17.8	718,083	7.1	0.66	14.60	0.00	106.67	29.20	242.79	110,358	99%
158	16.8	716,716	7.1	0.66	13.90	0.00	106.55	27.80	242.75	110,341	99%
160	15.8	715,395	7.0	0.66	13.24	0.00	106.43	26.48	242.71	110,325	99%
162	15.0	714,119	7.0	0.66	12.61	0.00	106.31	25.22	242.68	110,309	99%
164	14.1	712,886	7.0	0.66	12.02	0.00	106.20	24.03	242.65	110,294	99%
166	13.3	711,695	7.0	0.66	11.45	0.00	106.09	22.90	242.61	110,279	99%
168	12.6	710,545	7.0	0.66	10.91	0.00	105.98	21.82	242.58	110,265	99%
170	11.8	709,433	7.0	0.66	10.40	0.00	105.88	20.80	242.55	110,251	99%
172	11.2	708,359	7.0	0.66	9.91	0.00	105.78	19.83	242.52	110,238	99%
174	10.5	707,321	7.0	0.66	9.45	0.00	105.69	18.90	242.50	110,225	99%
176	9.9	706,318	7.0	0.66	9.01	0.00	105.60	18.02	242.47	110,213	99%
178	9.4	705,349	7.0	0.66	8.60	0.00	105.51	17.19	242.44	110,201	99%
180	8.9	704,413	6.9	0.66	8.20	0.00	105.42	16.40	242.42	110,189	100%
182	8.4	703,507	6.9	0.66	7.82	0.00	105.34	15.65	242.39	110,178	100%
184	7.9	702,632	6.9	0.66	7.47	0.00	105.26	14.93	242.37	110,167	100%
186	7.4	701,786	6.9	0.66	7.13	0.00	105.18	14.25	242.34	110,156	100%
188	7.0	700,969	6.9	0.66	6.80	0.00	105.10	13.61	242.32	110,146	100%
190	6.6	700,178	6.9	0.66	6.50	0.00	105.03	12.99	242.30	110,136	100%
192	6.2	699,413	6.9	0.66	6.20	0.00	104.96	12.41	242.28	110,127	100%
194	5.9	698,674	6.9	0.66	5.93	0.00	104.89	11.85	242.26	110,117	100%
196	5.6	697,959	6.9	0.66	5.66	0.00	104.82	11.32	242.24	110,108	100%
198	5.2	697,267	6.9	0.66	5.41	0.00	104.76	10.82	242.22	110,100	100%
200	4.9	696,597	6.9	0.66	5.17	0.00	104.70	10.35	242.20	110,091	100%
202	4.7	695,950	6.9	0.66	4.95	0.00	104.64	9.89	242.18	110,083	100%
204	4.4	695,323	6.9	0.66	4.73	0.00	104.58	9.46	242.17	110,075	100%


Sediment Basin #9 Colon Mine Phase 2 Hydrograph
100-Yr Storm
FLOW (cfs)
Stage (feet)
TIME (min)
OUTFLOW
INFLOW [cfs]
STAGE [ft]
0
50
100
150
200
250
300
350
400
450
500
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
0
20
40
60
80
100
120
140
160
180

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DESIGN HYDROGEOLOGIC REPORT - ADDENDUM, REVISION ~~1~~ 2
COLON MINE RECLAMATION STRUCTURAL FILL SITE
1303 BRICKYARD ROAD
SANFORD, NORTH CAROLINA

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~~November 5, 2014~~ ~~January 4, 2015~~ **March 6, 2015**

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DESIGN HYDROGEOLOGIC REPORT - ADDENDUM, REVISION ~~1~~2
COLON MINE RECLAMATION STRUCTURAL FILL SITE
1303 BRICKYARD ROAD
SANFORD, NORTH CAROLINA

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COLON MINE RECLAMATION STRUCTURAL FILL SITE
1303 BRICKYARD ROAD
SANFORD, NORTH CAROLINA

1.0 INTRODUCTION

Buxton Environmental, Inc., respectfully submits the *Design Hydrogeologic Report – Addendum, Revision ~~1~~2* prepared for the proposed Colon Mine Reclamation Structural Fill Site (RSFS) located at 1303 Brickyard Road (address for the former adjacent off-site manufacturing facility for Cherokee Sanford Group, LLC and General Shale Brick, Inc.) in Sanford, North Carolina. The subject property presently consists of Parcel No.: 9655-70-1612 (408.22 acres), which was consolidated from 5 parcels during the recent purchased by Green Meadow LLC, according to the Lee County GIS website. The proposed Colon Mine RSFS consist of 118.7 acres, which is located on the northern ¼ of the entire parcel. The primary purpose of this investigation is to provide detailed and localized hydrogeologic information for the engineering design of the proposed Colon Mine RSFS for coal combustion residuals and for the effective design of a water quality monitoring system. The investigation was conducted in general accordance with North Carolina Department of Environment and Natural Resources, Division of Waste Management-Solid Waste Section (NCSWS) rules and guidelines; the General Assembly of North Carolina Session 2013-Senate Bill 729 (ratified) regarding coal combustion residuals; and the HDR Engineering, Inc. of the Carolinas (HDR) Hydrogeologic Investigation and Reporting Scope-of-Work, Task 3 dated July 2014 which was prepared for Charah, Inc. The Design Hydrogeologic Report investigation was conducted by Buxton Environmental, Inc. on behalf of HDR. Site location, site layout and proposed Colon Mine RSFS plan maps are provided in Figures 1, 2 and 3, respectively. Photographic documentation is provided in Appendix A.

The addendum, Revision 1, was prepared in response to comments presented in a December 19, 2014 *Permit Application – Completeness Review* letter from the NCSWS (Appendix A1); to update general ownership and site configuration information; to update hydrogeologic information at the site; and to document the findings of additional soil boring/piezometer installation activities conducted along the northeastern and eastern edge of the site. The addendum, Revision 2 changes were made in response to requested changes to the Water Quality Monitoring Plan by Ms. Elizabeth Werner with the NCSWS during a February 20, 2015 conversation with Buxton Environmental, Inc.

A summary of background information, and the methods and results of the Design Hydrogeologic Report – Addendum, Revision ~~1~~2 investigation is provided below.

12.0 VERTICAL SEPARATION AND FOUNDATION STANDARDS

The vertical separation and foundation standard as required by the General Assembly of North Carolina Session 2013 – Senate Bill 729 (ratified) regarding coal combustion residuals will be discussed in detail in the engineering design report being prepared by HDR. Vertical settlement calculations will be submitted by HDR.

The General Assembly of North Carolina Session 2013-Senate Bill 729 (ratified) regarding coal combustion residuals, requires that the bottom of ash (top of liner) be a minimum of 4 feet above the seasonal high groundwater table. The proposed bottom of ash (top of liner), which will be established by HDR, will meet or exceed these requirements. Buxton Environmental, Inc. recommends a minimum separation of 4.5 feet at the Colon Mine RSFS, based on seasonal high and long-term high groundwater evaluations.

The Seasonal High - Shallow & Intermediate Groundwater Potentiometric Map with Proposed Top of Liner Grades is provided in Figure 6. (Revised)

13.0 ~~PROPOSED~~ WATER QUALITY MONITORING PLAN

Water quality monitoring will be conducted at the proposed Colon Mine RSFS, in accordance with NCSWS rules and guidance documents, ~~and~~ General Assembly of North Carolina Session 2013-Senate Bill 729 (ratified) regarding coal combustion residuals, and requested changes to the Water Quality Monitoring Plan by Ms. Elizabeth Werner with the NCSWS during a February 20, 2015 conversation with Buxton Environmental, Inc. The water quality monitoring plan has been prepared to effectively provide early detection of any release of hazardous constituents, as to be protective of human health and the environment. Applicable NCSWS regulatory rules will be followed if a release of hazardous constituents is confirmed, however, required assessment and/or corrective measures have not been specifically outlined in this plan.

The monitoring activities will also be conducted in general accordance with NCSWS memorandums dated October 27, 2006, February 23, 2007 and October 16, 2007 concerning changes to laboratory detection limits and reporting requirements, and the *Solid Waste Section Guidelines for Groundwater, Soil and Surface Water Sampling* dated April 2008.

In developing the proposed water quality monitoring plan, we have considered structural fill configuration, waste stream, surrounding land use, site geologic and hydrogeologic characteristics (including but not limited to aquifer thickness, groundwater flow rate and direction, lithology, hydraulic conductivity, porosity and effective porosity). Supporting documentation concerning these considerations has been previously addressed in the report.

13.1 Groundwater Points of Compliance

Buxton Environmental, Inc. proposes to conduct shallow groundwater quality monitoring at nine (9) permanent shallow compliance monitor wells (MW-1 through MW-9) (Figure 7). The wells will include the eight (8) downgradient/sidegradient compliance wells and one (1) upgradient background well (MW-3) (topographic high saddle along power line on near southwest corner of the site). Piezometers PZ-1 (MW-1) and PZ-7 (MW-2), which were installed during the Design Hydrogeologic investigation, will be utilized as compliance wells. The monitor wells will be generally installed at the review boundary (125 feet off the fill boundary) (where room allows); or ½ the distance from the fill boundary to the property boundary where the fill boundary is less than 250 feet off the property boundary. The permanent compliance wells should be completed prior to issuance of the Permit to Operate.

13.2 Compliance Monitor Well Construction

The compliance monitor wells should be constructed in a manner in which shallow groundwater quality and hydrogeologic characteristics can be adequately monitored.

The monitor wells will be installed by advancing a soil boring into the upper portion of the shallow aquifer. The wells will be constructed with 10 foot sections of 2-inch diameter mill slotted PVC screen attached to an appropriate length of 2-inch diameter PVC casing. A sand pack will be placed in the annual space of the boring to approximately 2-feet above the well screen, an approximately 2-foot thick bentonite seal will be placed above the sand, and the remaining annual space will be filled to grade with bentonite grout. The wells will be completed at grade with a 3 x 3 foot x 6-inch thick concrete pad and lockable stand-up cover. Three well guard posts will be placed around each well to protect the well from vehicle damage. The proposed compliance monitor wells will be completed in accordance with North Carolina Well Construction Standards (15A NCAC 02C .0108). A typical compliance well construction diagram is provided in Appendix O.

Following the completion activities, each well will be developed to the fullest extent possible.

Following installation of new compliance wells, borings logs and Well Construction Records (Form GW-1b) should be submitted to the NCSWS in hard copy and electronic format (pdf). Boring logs and Well Construction Records for currently installed compliance wells PZ-1/MW-1 and PZ-7/MW-2 are provided in Appendix G.

13.3 Surface Water Sampling Locations

Surface water sampling is proposed to be conducted at two locations, including the intermittent tributary of Roberts Creek located to the immediate northeast of the site (SW-1) and the head waters of Roberts Creek to the southeast of the site (SW-2) (Figure 7). Off-site access agreements may be required.

13.4 Leachate Sampling Location

Buxton Environmental, Inc. understands that leachate from the Colon Mine RSFS will collect into three (3) sumps, which will then be pumped into an aboveground holding tank. One (1) composite leachate sample is proposed to be conducted from the aboveground holding tank, in order to determine site specific characteristics of the leachate.

13.5 ~~Initial~~ Background Groundwater and Surface Water Monitoring Activities, with Statistical Groundwater Evaluation

A minimum of ~~four~~eight (8) independent ~~initial~~ background groundwater monitoring events should be conducted at the nine (9) proposed compliance wells. Ms. Elizabeth Werner with the NCSWS indicated during the February 20, 2015 telephone conversation with Buxton Environmental, Inc. that only 1 initial independent background groundwater sampling event would be necessary, prior to placement of coal combustion residuals. A minimum of one ~~initial~~ background sampling event should be conducted at the two surface water sample locations. The initial background groundwater and surface water monitoring events should be conducted prior to issuance of the Permit to Operate.

At each compliance monitor well, groundwater level measurements will be made to within 0.01 of a foot with a depth to water electrode.

The purging and sampling of the wells will be conducted with low flow sampling techniques specified in the *Solid Waste Section Guidelines for Groundwater, Soil and Surface Water Sampling* dated April 2008. Field parameters including temperature, pH, specific conductance, temperature, dissolved oxygen and turbidity will be collected until field parameters have stabilized within specific tolerances for three consecutive readings.

The groundwater and surface water samples will be analyzed for Appendix III constituents (including additional Appendix I metals outlined in 40 CFR Part 258 and in general accordance with applicable NCSWS guidance and Senate Bill 729)Appendix I constituents (volatile organic compounds (VOC's) and metals (including mercury) outlined in 40 CFR Part 258 and in general accordance with applicable NCSWS guidance and Senate Bill 729. For quality control purposes, one trip blank and one equipment blank will be analyzed for Appendix III constituents (including additional Appendix I metals outlined in 40 CFR Part 258 and in general accordance with applicable NCSWS guidance and Senate Bill 729)Appendix I VOC's and metals (including mercury) during each event. The laboratory analyses will be conducted by a North Carolina certified laboratory in accordance with Level I (standard) QA/QC procedures. Sample collection, handling and storage will be conducted in general accordance with accepted protocol, including chain-of-custody documentation.

The eight (8) background monitoring events will be conducted over a 1 year period of time with an approximately 1.5 month spacing commencing immediately following issuance of the Permit to Construct. The initial independent background groundwater sampling event will be conducted prior to issuance of the Permit to Operate and placement of coal combustion residuals.

Statistical Groundwater Evaluation

A statistical evaluation of the background groundwater data will be conducted in accordance with NCSWS rules utilizing the basic method outlined below.

In order to determine the most appropriate statistical method to evaluate the groundwater data, a Shipiro-Wilk Test was first conducted to determine the normality (distribution) of the data. Based on the distribution (parametric or non-parametric) and percentage of detected target constituents at the site, the Kruskal-Wallis Test and/or the Wilcoxon Rank-Sum Test for Two Groups would likely be utilized to evaluate the background groundwater data. However, other approved statistical methods could be employed to more adequately analyze the data if needed, based on the groundwater analytical results.

The background groundwater and surface water sampling with statistical evaluation report will be submitted within 90 days of completion of the eighth (8th) and final background sampling event.

13.6 Semi-Annual Groundwater, Surface Water and Leachate Monitoring Activities, with Statistical Groundwater Evaluation

Semi-annual groundwater, surface water and leachate monitoring activities will be conducted at the site. These activities are anticipated to be conducted in April and October of each year during the active life and post-closure period of the proposed Colon Mine RSFS.

At each compliance monitor well, groundwater level measurements will be made to within 0.01 of a foot with a depth to water electrode.

The low flow purging and sampling of the wells should be conducted as specified in the *Solid Waste Section Guidelines for Groundwater, Soil and Surface Water Sampling* dated April 2008. Field parameters including temperature, pH, specific conductance, temperature, dissolved oxygen and turbidity will be collected until field parameters have stabilized within specific tolerances for three consecutive readings.

The groundwater, surface water and leachate samples will be analyzed for Appendix III constituents (including additional Appendix I metals outlined in 40 CFR Part 258 and in general accordance with applicable NCSWS guidance and Senate Bill 729)Appendix I constituents including VOC's and metals (including mercury) outlined in 40 CFR Part 258 and in general accordance with applicable NCSWS memos and the *Solid Waste Section Guidelines for Groundwater, Soil and Surface Water Sampling* dated April 2008, and Senate Bill 729. The leachate sample will also be analyzed for biologic oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), sulfate, nitrate and phosphate. For quality control purposes, one trip blank and one equipment blank will be analyzed for Appendix III constituents (including additional Appendix I metals outlined in 40 CFR Part 258 and in general accordance with applicable NCSWS guidance and Senate Bill 729) Appendix I VOC's and metals (including mercury) during each event. The laboratory analyses are proposed to be conducted by a North Carolina certified laboratory in accordance with Level I (standard) QA/QC procedures. Sample collection, handling and storage will be conducted in general accordance with accepted protocol, including chain-of-custody documentation.

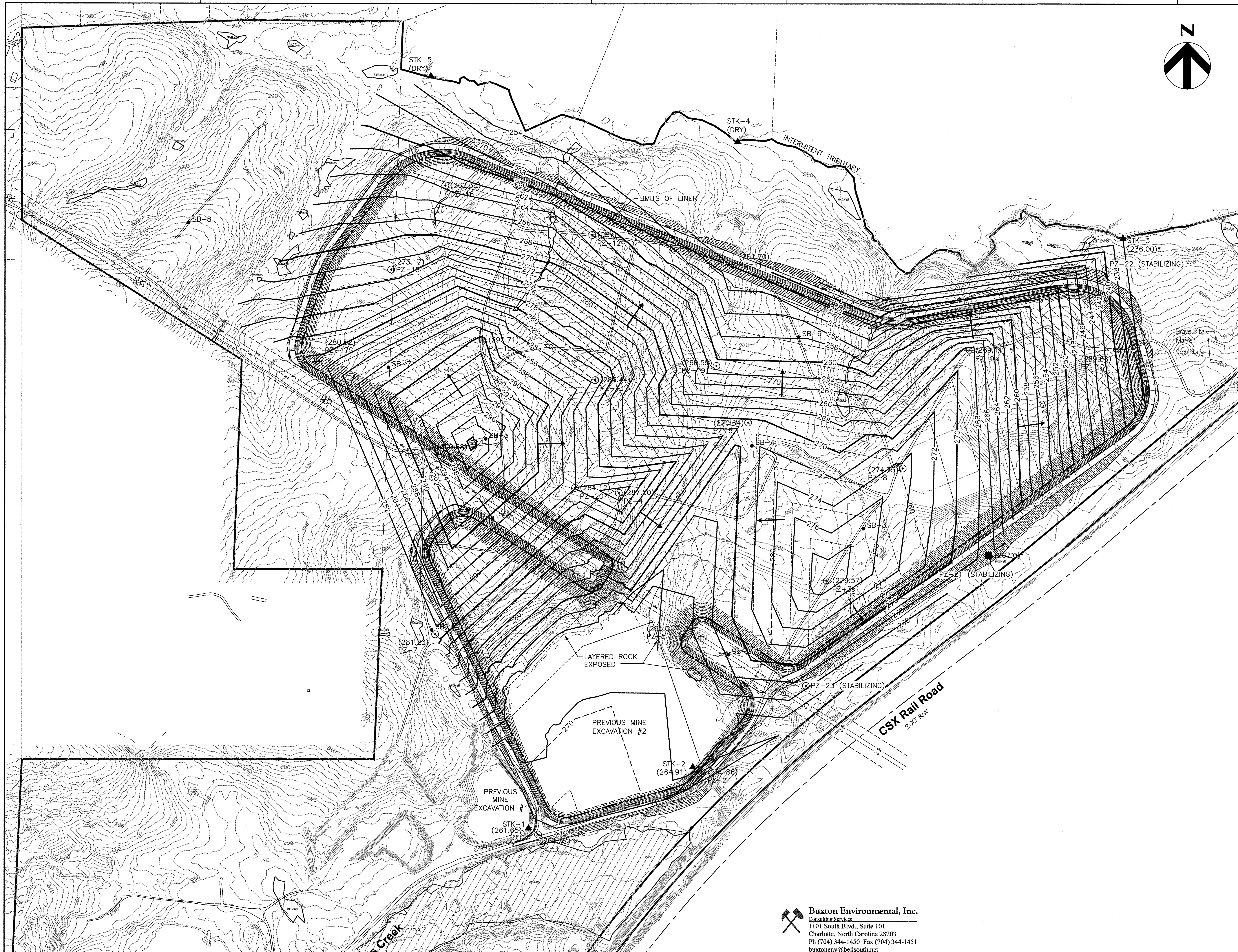
Statistical Evaluation of Historical Groundwater Quality Data

A statistical evaluation of historical groundwater quality data will be conducted in accordance with NCSWS rules utilizing the basic method outlined below.

Based on the distribution (parametric or non-parametric) and percentage of detected target constituents at the site, the Kruskal-Wallis Test and/or the Wilcoxon Rank-Sum Test for Two Groups would likely be utilized to evaluate the historical groundwater data. However, other approved statistical methods could be employed to more adequately analyze the data if needed, based on the groundwater analytical results.

Following receipt of the analytical data, a groundwater, surface water and leachate monitoring report with statistical evaluation of groundwater will be prepared in general accordance NCSWS guidelines. The report will include an executive summary, methods, results, conclusions and recommendations, tables of gauging and sample results, groundwater flow rates and groundwater flow direction map. The report will be prepared by a North Carolina Professional Geologist or Engineer.

A copy of the report should be submitted to the NCSWS within 120 days of the sampling date. The owner or operator shall notify the NCSWS of any exceedance of NCSWS, Groundwater Protection Standards (NCGPS's) within 14 days of this finding. An Assessment Monitoring Program will be required to be implemented within 90 days following an exceedance of the NCGPS, unless a successful alternate source demonstration can be made justifying an alternate cause of the exceedance.



NOTES:

1. SURVEY BASE MAP PREPARED BY LAWRENCE SURVEYING OF MONROE DATED AUGUST 21, 2014.
2. GROUNDWATER POTENTIOMETRIC CONTOURS GENERATED UTILIZING AUTOCAD DRAFTING AND INTERPOLATION SOFTWARE BY HDR ENGINEERING, INC. WITH OVERSIGHT BY ROSS KLINGMAN, P.G. WITH BUXTON ENGINEERING, INC.
3. THE GROUNDWATER POTENTIOMETRIC CONTOURS WERE GENERATED UTILIZING WATER LEVEL ELEVATIONS COLLECTED ON 8-21-14 (INTERPETED SEASONAL HIGH WATER LEVEL @ SHALLOW AND INTERMEDIATE PIEZOMETERS AND SURFACE WATER LOCATIONS. GROUNDWATER ELEVATIONS AT PZ-19 AND PZ-20 WERE OBTAINED ON 9-13-14 AND PZ-18 ON OCTOBER 31, 2014. INFERRED GROUNDWATER LEVELS OF -5' BELOW GRADE WERE UTILIZED ALONG DRAINAGE DITCHES ON NORTH AND WEST SIDE OF SITE AND WETLAND AREA ON SOUTHEAST PROPERTY BOUNDARY; AND GROUNDWATER LEVEL INFERRED TO BE 236.00 FEET AT STK-3 DITCH (SEE SECTION 9.4 IN TEXT FOR INFERENCES AND JUSTIFICATIONS).
4. TOP OF LINER ELEVATIONS ESTABLISHED BY HDR.

LEGEND

- ⊙ SINGLE SHALLOW OR INTERMEDIATE PIEZOMETER
- NESTED SHALLOW AND INTERMEDIATE PIEZOMETER PAIR
- NESTED INTERMEDIATE AND DEEP PIEZOMETER PAIR (WITH ROCK CORE)
- • GEOTECHNICAL SOIL BORING (GEOTRACK) (APPROX. LOCATIONS FOR B-2, B-4 & B-5)
- ▲ SURFACE WATER STAKE
- ■ INFERRED WETLAND GROUNDWATER ELEVATIONS
- (277.26') TOP OF WATER ELEVATION
- 270 MAJOR GROUNDWATER POTENTIOMETRIC CONTOUR
- 268 MINOR GROUNDWATER POTENTIOMETRIC CONTOUR
- 270 MAJOR INFERRED GROUNDWATER POTENTIOMETRIC CONTOUR
- 268 MINOR INFERRED GROUNDWATER POTENTIOMETRIC CONTOUR
- 260 TOP OF LINER MAJOR CONTOUR
- 258 TOP OF LINER MINOR CONTOUR
- 250 EXISTING TOPOGRAPHY CONTOUR
- ← GROUNDWATER FLOW DIRECTION
- * INFERRED WATER LEVEL ELEVATION

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N.C.B.E.L.S. License Number F-0116

ISSUE	DATE	DESCRIPTION
C	03/2015	RAISED FLOOR GRADES 6"
B	12/31/14	REVISED PER NCDENR COMMENTS
A	11/2014	ISSUED FOR APPROVAL

PROJECT MANAGER	M.D. PLUMMER, P.E.
DESIGNED BY	R. KLINGMAN, P.G.
DRAWN BY	J. GAUL
CHECKED BY	
PROJECT NUMBER	453925-235691-018

NORTH CAROLINA LICENSED GEOLOGIST SEAL 1266 CHARLES ROSS KLINGMAN

Charah®

COLON MINE SITE STRUCTURAL FILL
SANFORD, NC

SHALLOW AND INTERMEDIATE GROUNDWATER POTENTIOMETRIC MAP WITH PROPOSED TOP OF LINER GRADES

0 1" 2"

FILENAME 00G-05A.dwg
SCALE 1"=200'

SHEET
FIGURE 6

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SECTION 01060
SPECIAL CONDITIONS

PART 1 - GENERAL

1.1 CONDITIONS SPECIFIC TO THIS PROJECT

A. CQC/CQA Duties: ~~In general, the CQC Consultant will perform all testing related to earthwork and soil liner work and provide documentation to the CQA Consultant. The CQA Consultant will conduct the destructive geosynthetic testing and provide geosynthetic documentation as per these documents. CQC and CQA documentation will be used by the CQA Consultant to prepare and submit final certification to NCDENR~~The CQA Consultant may conduct all required testing and certify the project. If utilized, the CQC Consultant will provide all documentation to the CQA Consultant for review and inclusion in the certification to NCDENR. Refer to the CQA Plan.

B. The CONTRACTOR is responsible for construction/maintenance of any additional access/haul roads as approved by the OWNER.

C. The CONTRACTOR is responsible for maintaining the Erosion and Sediment Control measures.

D. CONTRACTOR is to obtain all soil material from on-site. Stockpiling of soil material shall be within the limits of disturbance as shown on the Drawings.

E. Limits of Disturbance:
   1. As defined on the Drawings.

F. Site Access:
   1. The only access to the site available to the CONTRACTOR is entering through the existing entrance on Colon Road.

G. Hours of Construction shall be as agreed by the OWNER. Construction may occur on Legal Holidays with permission from the OWNER. The OWNER may allow the CONTRACTOR to extend the Hours of Construction provided there are not complaints from the community and the OWNER approves of the extension. If the OWNER receives any complaints, then the OWNER may revoke the extended hours of construction.

1.2 PROJECT MEETINGS

A. A preconstruction conference shall be held at the site with the ENGINEER, CONTRACTOR's Project Manager and Project Superintendent and CONTRACTOR's Subcontractor Representatives. The purpose is to review sequence of work and communication procedures.

B. Pre-Installation Conferences:
   1. Coordinate and schedule with Resident Project Representative and ENGINEER for each material, product or system specified. Conferences to be held prior to initiating installation, but not more than two (2) weeks before scheduled initiation of installation.
      a. Conferences may be combined if installation schedule of multiple components occurs within the same two (2) week interval.
      b. Review manufacturers recommendations and Contract Documents Specifications.
   2. CONTRACTOR's Superintendent and individual who will actually act as foreman of the installation crew (installer), if other than the Superintendent, shall attend.

C. Construction Meetings:
   1. The ENGINEER will conduct construction meetings involving:
      a. CONTRACTOR's project manager.
      b. CONTRACTOR's project superintendent.
      c. OWNER's designated representative(s).

d. ENGINEER's designated representative(s).
e. CONTRACTOR's subcontractors as appropriate to the work in progress.
f. OWNER's Construction Quality Control Consultant.
2. Frequency of meetings to be as agreed upon at the Pre-Construction Meeting.
3. The ENGINEER will take meeting minutes and submit copies of meeting minutes to participants and designated recipients identified at the Preconstruction Conference. Corrections, additions or deletions to the minutes shall be noted and addressed at the following meeting.
4. The CONTRACTOR shall have available at each meeting up-to-date record drawings

1.3 DATA AND MEASUREMENTS

A. The data given in the Specifications and shown on the Drawings is believed to be accurate but the accuracy is not guaranteed. The Contractor must take all levels, locations, measurements, and verify all dimensions of the job site prior to construction and must adapt his work into the exact construction. Larger scale Drawings take precedence over smaller scale Drawings, and approved shop drawings take precedence over all others.

B. All survey's shall be sealed by a North Carolina registered land surveyor and submitted to the Engineer. The Contractor shall provide the Engineer with an electronic version of the sealed survey in AutoCAD readable format. Provide unique layers for 1 FT contours, index contours, text, water, vegetation, buildings, roads, etc. Utilize North Carolina grid coordinate system and locate all features in x, y, and z dimensions.

C. Initial survey shall include the following:
1. Topography of the cell area
2. Topography of the stockpile areas.
3. Topography within limits of construction including:
a. Topography of all sediment basins.
b. Location of existing channels.
c. Location of structures.
d. Inverts of pipe, size, and pipe location.

D. Final as-built survey shall include the following, for example:
1. Topography of the entire area within limits of construction.
2. Limits of liner placement.
3. Topography of the stockpile areas and all other disturbed areas.
4. Location of roads.
5. Location of channels.
6. Topography of all sediment basins and associated outlet structures.
7. Culverts (invert, size, locations).
8. Location of utility poles on the property.
9. Other areas or items that were a part of the Work as directed by the Engineer.
10. Locations of leachate pipes, valves, sumps, and subcell divider berms.

E. During construction, the contractor shall submit to the Engineer for review preliminary surveys that depict thickness verification of the soil layers.

F. Thickness verification may be done with a table or by electronic comparison of drawing files. The method shall be agreed to by the CQA and ENGINEER prior to construction. If the table method is selected, the same point on each soil layer must be used. The thickness is to be measured perpendicular to the slope. Refer to the soil specifications for frequency of points.

G. Contractor shall preserve and protect all reference points and pay for replacement of any destroyed referenced points.

H. Additional requirements are set forth in Section 9.0 of the CQA Plan.

1.4 SPECIAL CONSIDERATIONS

A. CONTRACTOR shall be responsible for negotiations of any waivers or alternate arrangements required to enable transportation of materials to the site.

B. Maintain conditions of access road to site such that access is not hindered as the result of construction related deterioration.

C. Safety:
   1. The CONTRACTOR alone shall be solely and completely responsible for conditions of the job site in connection with his work, including safety of all personas and property, preparatory to and during performance of the work. This requirement shall apply continuously and not be limited to normal working hours.
   2. The Construction Documents and the construction hereby contemplated, are to be governed, at all times, by applicable provisions of local and state laws and regulations, and federal laws, including, but not limited to, the latest amendments of the following: Department of Labor, Bureau of Labor Standards Safety and Health Regulations for Construction, and Williams and Steiger Occupational Safety and Health Act of 1970, including rules and regulations pursuant thereto, applicable to the Work and performance of the Contract. (OSHA).
   3. The duty of the ENGINEER to conduct construction review of the CONTRACTOR's performance is not intended to include review of the adequacy of the CONTRACTOR's safety measures in, on, or near the construction site.
   4. All explosives shall be stored in a secure manner and all storage places shall be marked clearly "DANGEROUS EXPLOSIVES," and shall be in the care of competent watchmen at all times.

D. Inspections by Federal and State Agencies: Authorized representative and agents of the state and federal government shall be permitted to inspect all work, materials, records of personnel, invoices of materials, and other relevant data and records.

E. Water:
   1. CONTRACTOR is responsible for all water necessary for the completion of the Work. Water used on the project shall be fresh and of drinkable quality. The CONTRACTOR shall make arrangements to obtain fresh water for his drinking.
   2. Water for other uses such as dust control and moisture control of fill may be obtained from storm water basins as approved by the CQC and CQA Consultants. The CONTRACTOR shall obtain any required permits.
   3. CONTRACTOR is responsible for coordinating use of, and all costs associated with use of, water from local sources.

F. The CONTRACTOR shall provide sanitary facilities during construction.

G. Order of Construction: The CONTRACTOR will schedule construction operations to allow the other contractors access to the site.

1.5 HISTORICAL AND ARCHAEOLOGICAL

A. If during the course of construction, evidence of deposits of historical or archeological interest is found, the CONTRACTOR shall cease operations affecting the find and shall notify OWNER. No further disturbance of the deposits shall ensue until the CONTRACTOR has been notified by OWNER that CONTRACTOR may proceed. OWNER will issue a notice to proceed after appropriate authorities have surveyed the find and made a determination to OWNER. Compensation to the CONTRACTOR, if any, for lost time or changes in construction resulting from the find, shall be determined in accordance with changed or extra work provisions of the Contract Documents. The site has been previously investigated and has no known history of historical or archaeological finds.

PART 2 - PRODUCTS

2.1 INTERFACE FRICTION TESTS

A. Laboratory friction tests shall be conducted, on behalf of the OWNER by the CQA Consultant, with representative samples of the materials selected by the CONTRACTOR for use in the Work. The CQA Consultant must approve the testing laboratory used for these tests. The CONTRACTOR is responsible for shipping materials to the testing laboratory. The initial set of testing and subsequent conformance tests (if any) shall be paid for by the CQA Consultant. If any interface doesn't meet the requirements, or if the CONTRACTOR changes geosynthetic materials, then the additional cost to qualify those materials shall be borne by the CONTRACTOR.

B. Base Liner

1. Testing will include the interfaces between the following adjacent materials with a minimum peak friction angle of 26 degrees is required for each interface.

MATERIAL	SPECIFICATION SECTION
Ash	----
Drainage Composite	02777
60 Mil HDPE (textured)	02775
Geosynthetic Clay Liner (GCL)	~~02776~~02800
Soil liner	02276

C. Cap System

1. The CONTRACTOR may select one of the following cap systems. Testing will include the interfaces between the following adjacent materials with a minimum peak friction angle of 26 degrees is required for each interface.

a. Option 1

MATERIAL	SPECIFICATION SECTION
Drainage Soil	N/A
40 Mil (textured HDPE or textured LLDPE)	02775 or 02774
Ash	---

b. Option 2

MATERIAL	SPECIFICATION SECTION
Unclassified Soil	N/A
Drainage Composite	02777
40 Mil (textured HDPE or textured LLDPE)	02775 or 02774
Ash	----

D. Testing shall be performed in accordance with ASTM D6243. The liner system materials shall be tested at normal stressed of 2,000, 4,000, and 6,250 psf. The cap system materials shall be tested at normal stressed of 500, 1,000, and 1,500 psf. Displacement rates shall be in accordance with ASTM D6243 Procedure A for geosynthetic to geosynthetic interfaces and Procedure B for soil to geosynthetic interfaces. Soil components shall be compacted to the same moisture-density requirements specified for full-scale field placement and saturated prior to shear for 24 hours. All geosynthetic interfaces shall be tested in a wet condition. Geosynthetics shall be oriented such that the shear force is parallel to the downslope orientation of these components in the field. The testing laboratory shall confirm these criteria with the CQA firm prior to performing the tests.

~~D.~~E. ~~Test results must be satisfactory for material shop drawings to be approved.~~ Report results in accordance with ASTM D6243 provide complete test data, including plots of shear force versus horizontal displacement and a plot of peak shear stress versus normal stress for the tests conducted. Test results must be satisfactory for material shop drawings to be approved.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 02777
DRAINAGE COMPOSITE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bonded geotextile-geonet drainage composite.

B. Related sections include but are not necessarily limited to:
   1. Section 02774 – LLDPE Geomembrane.
   2. Section 02775 – HDPE Geomembrane.
   3. Section 02778 - Geotextiles.
   4. Construction Quality Assurance Plan.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D413, Rubber Property - Adhesion to Flexible Substrate.
      b. D792, Standard Test Methods for Density and Specific Gravity of Plastic by Displacement.
      c. D1238, Flow Rates of Thermoplastics by Extrusion Plastometer.
      d. D1505, Density of Plastics by the Density-Gradient Technique.
      e. D1603, Carbon Black in Olefin Plastics.
      f. D4716, Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
      g. D4873, Identification, Storage and Handling of Geosynthetic Rolls.
      h. D5199, Standard Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
      i. D5321, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
      j. D6364, Standard Test Method for Determining Short-Term Compression Behavior of Geosynthetics.
      k. D7005, Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites.
      ~~k.~~l. D7179, Standard Test Method for Determining Geonet Breaking Force.

B. Qualifications:
   1. Each manufacturing and fabricating firm shall demonstrate 5 years continuous experience, including a minimum of 5,000,000 SF of drainage composite production in the past 3 years.
   2. Installer shall attend pre-installation conference.

1.3 DEFINITIONS:

A. Manufacturer: Manufacturer producing drainage composites from geonet cores and geotextiles.

B. Installer: The Installers are the individuals actually performing the hands-on work in the field.

C. MARV: Minimum average roll value.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Manufacturer's documentation that raw materials and roll materials comply with required drainage composite physical properties.

2. Manufacturer and Installer quality control manuals.
3. Original test results for resins and roll material at frequency specified in respective quality control manuals. Include or bracket the rolls delivered for use in the Work.
4. Layout plan with proposed size, number, position and sequencing of drainage composite rolls and direction of all field seams.
5. Proposed details of anchor trench if different than included in Contract Documents.

B. Miscellaneous Submittals:
   1. Qualification documentation specified in Article 1.2.

1.5 DELIVERY, STORAGE AND HANDLING

A. Label, handle, and store drainage composites in accordance with ASTM D4873 and as specified herein.

B. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage. Do not remove the plastic wrapping until deployment.

C. Label each roll with the manufacturer's name, drainage composite type, lot number, roll number, and roll dimensions (length, width, gross weight).

D. Repair or replace, as directed by the Engineer, drainage composite or plastic wrapping damaged as a result of storage or handling.

E. Do not expose drainage composite to temperatures in excess of 71 DegC (160 DegF) or below 0 DegC (32 DegF) unless recommended by the Manufacturer.

F. Do not use hooks, tongs or other sharp instruments for handling the drainage composite.

G. Do not lift rolls by use of cables or chains in contact with the drainage composite.

H. Do not drag drainage composite along the ground or across textured geomembranes.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. GSE Environmental.
   2. Agru-America~~n~~, Inc.
   3. Engineer approved equal.

2.2 MATERIALS AND MANUFACTURE

A. Geonet Core:
   1. Use nonthermally degraded polyethylene polymer which is clean and free of any foreign contaminants.
   2. Manufactured geonet to conform to the property requirements listed in Table 1 and be free of defects including tears, nodules or other manufacturing defects which may affect its serviceability.

TABLE 1 - GEONET PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE
Polymer Density	ASTM D1505	>0.93 g/cc
Polymer Melt Index	ASTM D1238	<1.1 g/10 min.
Carbon Black Content	ASTM D1603	2-3 percent
Thickness	ASTM D5199	≥0.300 in.
Tensile Strength (MD)	ASTM D7179	75 lb/in
Compressive Strength	ASTM D6364	25,000 psf

B. Geotextile:

1. Cover geonet core on both sides with a geotextile complying with requirements specified in Section 02778: Geotextiles~~, Separator~~.

C. Drainage Composite:

1. Create a composite by heat bonding geotextiles to the geonet. The bond between the geotextile and the geonet shall exhibit a MARV ply adhesion of 1 LBS/IN when tested in accordance with ASTM D7005
2. Effective Transmissivity MARV of $3.3x10^{-3}$ square meters per second @ 100 hrs.

2.3 SOURCE QUALITY CONTROL

A. Transmissivity Testing:

1. Measure in place flow rate using water at 68 DegF with a normal compressive load of 6,250 psf, a hydraulic gradient of 0.02, and 100-hour loading.
2. Attach geotextiles to the geonet in the same configuration as will be used in the field.
3. Boundary conditions shall match the upper and lower interfaces to be used in the field.
4. Testing frequency: 1 test for every ~~50~~200,000 SF of installed product.
5. Report shall include:
   a. Graph of flow rate vs. hydraulic gradient.
   b. Calculate transmissivity under laminer flow conditions.
   c. Calculated effective transmissivity at hydraulic gradient of 0.3.

B. Interface Friction Tests.

1. Test materials using ASTM D 6243. Section 01060-Special Conditions, outlines the conditions under which this material shall be tested.
2. This material is part of a system. The system shall meet the requirements before the component material can be deemed acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to placement of the drainage composite, clean the substrate of all soil, rock, and other materials which could damage the composite.

B. The geocomponent drainage media shall be placed only on geomembrane that has been approved by the Geomembrane Installer and accepted by the Geotech Engineer.

3.2 INSTALLATION

A. Install geocomposite drain in accordance with manufacturer's written recommendations.

B. Deploy the drainage composite ensuring that the drainage composite and underlying materials are not damaged. Replace or repair faulty or damaged drainage composite as directed by Engineer.

C. Unroll drainage composite downslope keeping in slight tension to minimize wrinkles and folds.

D. Maintain free of dirt, mud, or any other foreign materials at all times during construction. Clean or replace rolls which are contaminated.

E. Place adequate ballast to prevent uplift by wind.

F. Overlap adjacent rolls a minimum of 6 IN. Overlap new drainage composite over existing as shown on the drawings.

G. Use manufacturer's fasteners to join adjacent rolls. Metallic fasteners will not be allowed. Space fasteners a maximum of 5 FT along downslope roll overlaps and a maximum of 1 FT along cross slope roll overlaps. Use fasteners of contrasting color from the drainage composite to facilitate visual inspection. Do not weld drainage composite to geomembranes.

H. Heat tack overlap of the upper geotextile to the upper geotextile of the adjacent rolls.

I. Repairs holes or tears in the drainage composite by placing a patch of drainage composite extending a minimum of 2 FT beyond the edges of the hole or tear. Use approved fasteners, spaced every 6 IN around the patch, to fasten the patch to the original roll.

J. Penetration details shall be as recommended by the Manufacturer and as approved by the Engineer.

3.3 FIELD QUALITY CONTROL

A. Provide as-constructed drawing showing roll number; layout; joint locations; and repair and patch locations.

B. Prior to installation of the drainage composite, provide the Engineer quality control certificates signed by the manufacturer's quality assurance manager for every 50,000 SF of geocomposite drainage media to be installed.

C. Refer to Section 02778 for exposure limits of the geotextile. If the exposure limits are exceeded, the drainage composite shall be replaced.

END OF SECTION

SECTION 02778
GEOTEXTILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Non-woven geotextile material.
   2. Woven geotextile material.

B. Related Sections:
   1. Section 02220 - Earthwork.
   2. Section 02777 - Drainage Geocomposite.
   3. Construction Quality Assurance Plan.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway Transportation Officials (AASHTO):
      a. M288, Standard Specification for Geotextile Specification for Highway Application.
   2. ASTM International (ASTM):
      a. D1987, Biological Clogging of Geotextile or Soil/Geotextile Filters.
      b. D3766, Standard Terminology Relating to Catalysts and Catalysis.
      c. D3776, Test Method for Mass Per Unit Area of Woven Fabric.
      d. D3786, Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Bursting Strength Tester Method.
      e. D4354, Sampling of Geosynthetics for Testing.
      f. D4355, Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
      g. D4491, Water Permeability of Geotextiles by Permittivity.
      h. D4533, Trapezoid Tearing Strength of Geotextiles.
      i. D4595, Tensile Properties of Geotextiles by the Wide-Width Strip Method.
      j. D4632, Grab Breaking Load and Elongation of Geotextiles.
      k. D4751, Determining Apparent Opening Size of A Geotextile.
      l. D4759, Determining the Specification Conformance of Geosynthetics.
      m. D4833, Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
      n. D4873, Identification, Storage, and Handling of Geosynthetic Rolls.
      o. D5261, Test Method for Measuring Mass Per Unit Area of Geotextiles.
      p. D6193, Standard Practice for Stitches and Seams.
      q. D6241, Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
      ~~q.~~ r. D7238, Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus.

B. Qualifications:
   1. Each manufacturing, fabricating firm shall demonstrate 5 years continuous experience, including a minimum of 10,000,000 SF of geotextile installation in the past 3 years.
   2. Installing firm shall demonstrate that the site Superintendent or Foreman has had responsible charge for installation of a minimum of 1,000,000 SF of geotextile.
   3. Installer shall attend pre-installation conference.

1.3 DEFINITIONS:

A. Manufacturer: Manufacturer producing geotextile sheets from resin and additives.

B. Installer: The Installers are the individuals actually performing the hands-on work in the field.

C. MARV: Minimum Average Roll Value

1.4 SUBMITTALS

A. Shop Drawings:
1. Manufacturer's documentation that raw materials and roll materials comply with required geotextile physical properties.
2. Manufacturer and Installer quality control manuals.
3. Original test results for resins, roll material and factory seam tests at frequency specified in respective quality control manuals. Results shall include or bracket the rolls delivered for use in the Work.
4. Proposed details of anchoring and overlapping if different than included in Contract Documents.

B. Miscellaneous Submittals:
1. For needle punched geotextiles, the Manufacturer shall certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers.
2. Qualification documentation specified in Article 1.2.

1.5 DELIVERY, STORAGE AND HANDLING

A. Label, handle, and store geotextiles in accordance with ASTM D4873 and as specified herein.

B. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage. Do not remove the plastic wrapping until deployment.

C. Label each roll with the manufacturer's name, geotextile type, lot number, roll number, and roll dimensions (length, width, gross weight).

D. Repair or replace geotextile or plastic wrapping damaged as a result of storage or handling, as directed.

E. Do not expose geotextile to temperatures in excess of 71 DegC (160 DegF) or less than 0 DegC (32 DegF) unless recommended by the manufacturer.

F. Do not use hooks, tongs or other sharp instruments for handling geotextile. Do not lift rolls lifted by use of cables or chains in contact with the geotextile. Do not drag geotextile along the ground.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. Agru America, Inc.
2. Carthage Mills.
3. GSE Environmental
~~3.~~4. TenCate Geosynthetics.
~~4. GSE Environmental~~

2.2 MATERIALS AND MANUFACTURE

A. Geotextile:
1. Geotextile fibers:
   a. Long-chain synthetic polymer composed of at least 85 percent by weight polyolefins, polyesters, or polyamides.

b. Filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure.
c. Do not add reclaimed or recycled fibers or polymer to the formulation.

2. Form geotextile into a network such that the filaments or yarns retain dimensional stability relative to each other, including the selvages.
3. The geotextile physical properties shall equal or exceed the minimum average roll values listed below. Values shown are for the weaker principal direction. Acceptance of geotextile shall be in accordance with ASTM D4759.

B. ~~Cushion Separator~~ Geotextile for Gecomposite: ~~Non-woven, needle punched; polyester or polypropylene; continuous filament or staple fibers; conforming to the following properties:~~
~~For base liner top of geocomposite only:~~

1. Top Geotextile: The geotextile intended as the filter shall be a hybrid geotextile consisting of a woven and non-woven needle punched composite geotextile with the two geotextiles bonded together mechanically. The two geotextiles shall form a monolithic filter product with the woven side bonded to the top of the geonet. The top geotextile shall conform to the following properties:

Property ======	Test Method ======	Minimum Average Roll Value ======
Composite mass per Unit Area, oz/yd^2	ASTM D5261	14
Grab Tensile Strength, lb	ASTM D4632	200
Puncture Strength, lb	ASTM D~~4833~~6241	~~100~~775
Trapezoidal Tear Strength, lb	ASTM D4533	85
Apparent Opening Size, US Sieve (mm)	ASTM D4751	170 (0.88)
Permittivity, (sec $^{-1}$)	ASTM D4491	0.3
Flow Rate, gpm/ft^2	ASTM D4491	20
UV Resistance, % Retained	ASTM D4355 (after 500 hours)	90

~~The geotextile intended as the filter shall be a hybrid geotextile consisting of a woven and non-woven needle punched composite geotextile with the two geotextiles bonded together mechanically. The two geotextiles shall form a monolithic filter product with the woven side bonded to the geonet.~~
~~2. For all other locations:~~

2. Bottom Geotextile: A nonwoven geotextile conforming to the following properties:

Property ======	Test Method ======	Minimum Average Roll Value ======
Mass per Unit Area, oz/yd^2	ASTM D5261	6
Grab Tensile Strength, lb	ASTM D4632	160
Grab Elongation	ASTM D4632	50%
Puncture Strength, lb	ASTM D6241	435
Trapezoidal Tear Strength, lb	ASTM D4533	65
Apparent Opening Size, US Sieve (mm)	ASTM D4751	70 (0.212)
Permittivity, (sec $^{-1}$)	ASTM D4491	1.5
Flow Rate, gpm/ft^2	ASTM D4491	110
UV Resistance, % Retained	ASTM D4355 (after 500 hours)	70

C. Separator Geotextile

Property ======	Test Method ======	Minimum Average Roll Value ======

Unit Weight	ASTM D5261	8 oz/sy
Grab Tensile Strength	ASTM D4632	210 lb
Elongation	ASTM D4632	50%
Puncture Strength	ASTM D4833	95 lb
Maximum Apparent Opening Size	ASTM D4751	#70 US Sieve
Permittivity	ASTM D4491	0.5 sec-1

D. Roadbed Geotextile ~~Fabric~~: The geotextile shall be composed of synthetic fibers formed into a woven fabric. Fibers used in the manufacture of the geotextile shall be polyolefins, polyesters or polyamides and conform to the following properties.

Property	Test Method	Minimum Average Roll Value
======	======	======
Grab Tensile	ASTM D4632	200 lbs
Grab Elongation	ASTM D4632	15 %
Puncture Strength	ASTM D4833	100 lbs
Trapezoidal Tear	ASTM D4533	75
UV Resistance	ASTM D4355 or D7238	90 %

~~C.~~E. Thread:
1. High-strength polyester, nylon, or other approved thread type.
2. Equivalent chemical compatibility and ultraviolet light stability as the geotextile.
3. Contrasting color with the geotextile.

~~D.~~F. ~~The geotextile shall be able to withstand direct exposure to ultraviolet radiation from the sun for up to 90 days without noticeable effect on index or performance properties~~ If the geotextile is exposed for greater than 75 days, additional index testing will be required to confirm that the material still meets the specification properties.

PART 3 - EXECUTION

3.1 PREPARATION

A. Construct the surface underlying the geotextiles smooth and free of ruts or protrusions which could damage the geotextiles.

3.2 INSTALLATION

A. Install geotextiles in accordance with manufacturer's written recommendations.

B. Hand place geotextile. No equipment will be permitted to traffic in direct contact with the geotextile.

C. Lay geotextile smooth so as to be free of tensile stresses, folds, and wrinkles.

D. Seam Construction:
1. Geotextile seams may be sewn or overlapped. Construct overlapped seams in accordance with manufacturer's recommendations or as shown on Drawings.
2. Sew seams continuously using an SSA flat seam with one row of a two-thread 401 chain stitch unless otherwise recommended by the manufacturer.
3. Minimum distance from the geotextile edge to the stitch line nearest to that edge: 2 IN unless otherwise recommended by the manufacturer.
4. Test seams at the frequency specified in Article 3.3.
5. Tie off thread at the end of each seam to prevent unraveling.
6. Construct seams on the top side of the geotextile to allow inspection.
7. Sew skipped stitches or discontinuities with an extra line of stitching with 18 IN of overlap.

8. Heat tack the geotextile overlaps as shown on the Drawings.
9. Overlap adjacent panels a minimum of 4 IN. Heat bond seam must develop a minimum of 60% of the tensile strength of the parent geotextile as measured in ASTM D4632.

E. Protect geotextiles from clogging, tears, and other damage during installation.

F. Geotextile Repair:
1. Place a patch of the same type of geotextile which extends a minimum of 12 inches beyond the edge of the damage or defect.
2. Fasten patches continuously using a sewn seam or other approved method.
3. Align machine direction of the patch with the machine direction of the geotextile being repaired.
4. Replace geotextile which cannot be repaired.

G. Use adequate ballast (e.g. sand bags) to prevent uplift by wind.

H. Do not use staples or pins to hold the geotextile in place.

I. Geotextile left uncovered for more than 90 days shall be replaced unless otherwise allowed by Engineer.

END OF SECTION

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SECTION 02800

GEOSYNTHETIC CLAY LINER (GCL)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Furnish all labor, material, and equipment to complete installation of the GCL in accordance with the Contract Drawings and these Specifications.
   2. Completely coordinate work with that of other trades.
   3. Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, complete, and compatible installation shall be furnished and installed as part of this work.
   4. Furnish CQC Consultant to monitor the work of GCL Installer and to perform CQA/CQC testing in accordance with provisions of the Contract Documents.

B. Related Sections include but are not necessarily limited to:
   1. Section 01060 – Special Conditions
   2. Section 02220 - Earthwork.
   3. Section 02775 - HDPE Geomembrane Liner System.

1.2 QUALITY STANDARDS

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D4632, Test Method for Grab Breaking Load and Elongation of Geotextiles.
      b. D4643, Determination of Water Content of Soil by Microwave Oven Method.
      c. D4833, Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
      d. D4873, Identification, Storage and Handling of Geosynthetic Rolls.
      e. D5261, Measuring Mass Per Unit Area of Geotextiles.
      f. D5321, Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
      g. D5887, Test Method for Measurement of Index Flux through Saturated GCL Specimens Using a Flexible Wall Permeameter.
      h. D5888, Guide for Storage and Handling of Geosynthetic Clay Liners.
      i. D5889, Quality Control of GCL.
      j. D5890, Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
      k. D5891, Fluid Loss of Clay Component of Geosynthetic Clay Liners.
      l. D5993, Test Method for Measuring Mass Per Unit Area of Geosynthetic Clay Liners.
      m. D6072, Practice for Obtaining Samples of GCL
      n. D6102, Guide for Installation of Geosynthetic Clay Liners.
      o. D6243, Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method.
      p. D6496, Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle Punched GCLs.
      q. D6766, Test Method for Evaluation of Hydraulic Properties of Geosynthetic Clay Liners Permeated with Potentially Incompatible Aqueous Solutions.
      r. D6768, Test Method for Tensile Strength of Geosynthetic Clay Liner.

2. Geosynthetic Research Institute (GRI):
    a. GCL-3, Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs).

B. Quality Assurance:
1. The OWNER's representative will conduct independent testing to support construction quality assurance program and to provide documentation of such to appropriate regulatory agencies. Facilitate and provide opportunities as OWNER's representative require.
2. Manufacture, store, place, seam, test and protect GCL as described in ASTM D4873, D5888 and D6102.

C. Qualifications:
1. Each manufacturing firm shall demonstrate 5 years continuous experience, including a minimum of 5,000,000 SF of the material for use in similar projects..

D. CQA Plan Implementation: Construction Quality Assurance documentation for the GCL installation will be performed for the Owner in accordance with the CQA Plan prepared for this project. The Owner, CQC Consultant, and GCL Installer, however, should familiarize themselves with the CQA Plan.

1.3 DEFINITIONS:

A. Manufacturer: Manufacturer produces geosynthetic clay liner panels from first quality geotextiles and sodium bentonite. The manufacturer is responsible for producing panels which comply with this Specification. These responsibilities include but are not limited to:
1. Acceptance of the geotextiles, bentonite, and additives from suppliers/manufacturers and testing of these materials to ensure compliance with the manufacturer's specifications and with this Specification.
2. Fabrication of the geotextiles and bentonite into GCL panels using mixing and extrusion equipment.
3. Testing of the GCL to ensure compliance with manufacturer's specification and this Specification.
4. Shipping of the GCL to fabricator/installer designated facilities.
5. Certification of the raw materials and finished GCL to comply with this Specification.
6. Certification of fabricator's and installer's training, experience, and methods for seaming and inspecting GCL installations in compliance with manufacturer's standards and with Quality Assurance requirements of this Specification (Article 1.2).

B. Installer: Installers of GCLs are responsible for storing, handling, fitting, seaming, and testing of GCL panels in the field. These responsibilities include but are not limited to:
1. Acceptance (in writing) of the GCL rolls from the transporter.
2. Acceptance (in writing) of the soil material which will serve as a base for the GCL. This acceptance shall precede installation of the GCL, and shall state that the installer has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of GCL liners. The written acceptance shall explicitly state any and all exceptions to acceptance.
3. Handling, seaming, testing, and repair of GCL liners in compliance with this Specification and with written procedure manuals prepared by the installer or the manufacturer.
4. Repair or replacement of defects in the GCL as required by the Inspector or the Owner.
5. Installer and manufacturer may be the same firm.

C. Inspector: Inspectors of GCL liner are responsible for observing field installation of the GCL and providing the manufacturer, installer, and Owner with verbal and written documentation of the compliance of the installation with this Specification and with written procedures manuals prepared by the manufacturer. Inspector's responsibilities include, but are not limited to:
1. Inspection of material, handling, and field installation of the GCL liner. Inspection of all seams, repair, and test results.
2. All exceptions to material or installation shall be documented to the Engineer in writing within 48 hours of discovery.

D. Engineer: The Engineer is responsible for design of the geosynthetic liner system.

E. Hydrated GCL is defined as material which has become soft as determined by squeezing the material with finger pressure, material which has exhibited swelling, or material which as a moisture content greater than 100 percent as determined by ASTM D2216.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product Data and Factory Test Results: Published product properties and specifications for the proposed GCL, as well as factory test results of materials certified by the GCL manufacturer, shall be submitted showing conformance with the requirements of these Specifications. In addition, the Contractor shall submit the manufacturer's certification stating that the material is similar to and of the same formulation as that for which test results are submitted, and by which actual usage has been demonstrated to be satisfactory for the intended application.
2. Samples: Samples of the GCL sheeting shall be provided to the CQA Consultant. Samples shall have a width of 4.5 IN, and a length of 5 IN.
3. Delivery, Storage, and Handling Instructions: The manufacturer's recommendations for delivery, storage, and handling shall be submitted to the CQA Consultant for review.
4. Delivery Date: The CQA Consultant shall be notified of the scheduled delivery date for the materials.
5. Installation Drawings, Procedures, and Schedules: Installation drawings, procedures, and a schedule for carrying out the work shall be provided by the Contractor to the CQA Consultant for review. Procedures addressed by the Contractor shall include but not be limited to material unloading, storage, installation, repair, and protection to be provided in the event of rain. A schedule showing the order of placement, location of panels, seams, and penetrations shall be submitted for the CQA Consultant's review. Proposed methods of seaming (overlapping) GCL panels. Submit drawings showing the panel layout, seams, and associated details including pipe penetrations. Following review, these drawings will be used for installation of the GCL. Any deviations from these drawings must be approved by the CQA Consultant.

B. Miscellaneous Submittals:

1. Test results:
   a. Bentonite, geotextile and GCL tests at frequency specified in respective quality control manuals. Results shall include or bracket the rolls delivered for use in the Work.
2. Qualification documentation specified in Article 1.2.
3. Submit written certifications that:
   a. The GCL delivered to site meets the requirements of this Specification.
   b. The GCL was received and accepted in undamaged condition from shipper.
   c. The subgrade has been properly prepared and acceptable for the placement of the GCL.
   d. The GCL was installed in accordance with this Specification and with approved shop drawings.
   e. The materials placed on top of the GCL were placed properly and carefully.
4. Warranties.
5. Record Drawing Information: Record drawings including but not limited to drawings showing the location of all seams, panels, repairs, patches, anchor trenches, pipe penetrations, and other appurtenances, including measurements and dimensions, shall be prepared by the Contractor and submitted to the Owner following completion of the project.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not place GCL rolls directly on the ground.

B. Store and protect GCL from dirt, water, ultraviolet light and other sources of damage.

C. Label, handle, and store GCL in accordance with ASTM D4873 and as specified herein.

1. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage.

2. Do not remove the plastic wrapping until deployment.

D. Label each roll with the manufacturers name, lot number, roll number, and roll dimensions (length, width, gross weight).

1. Repair or replace GCL or plastic wrapping damaged as a result of storage or handling, as directed.
2. Do not expose GCL to temperatures in excess of 71 Deg C (160 Deg F) or less than 0 Deg C (32 Deg F) unless recommended by the Manufacturer.

E. Do not use hooks, tongs or other sharp instruments for handling the GCL. Do not lift rolls by use of cables or chains in contact with the GCL. Do not drag GCL along the ground.

1.6 WARRANTY

1. The Manufacturer shall provide a warranty to the OWNER against manufacturing defects or failures related to manufacture on a non-prorata basis for five (5) years after date of shipment.
2. GCL Installer's Warranty: The GCL Installer's warranty shall warrant their workmanship to be free of defects on a non-prorata basis for five (5) years after the final acceptance of the Work. This warranty shall include but not be limited to overlapped seams, anchor trenches, attachments to appurtenances, and penetration seals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Geosynthetic Clay Liners:
   a. Agru America, Inc.
   b. CETCO.
   c. GSE Environmental.

2.2 MATERIALS

A. The GCL shall be GSE BentoLiner CAR NSL or Engineer approved equal.

~~A.~~B. General:

1. **The GCL shall be reinforced.**
2. The GCL shall consist of bentonite encased, front and back, with geotextile. The materials supplied under these Specifications shall be first quality products designed and manufactured specifically for the purposes of this work.
3. The GCL shall be supplied in rolls. The roll length shall be maximized to provide the largest manageable sheet for the fewest overlaps. Labels on the roll shall identify the sheet number, date of fabrication, proper direction of unrolling, and minimum recommended overlap. A quality control certificate shall be supplied with each roll.
4. The active ingredient of the GCL shall be natural sodium bentonite. Polymer enhancement shall be added to the sodium bentonite formulation as necessary to be chemical compatible with typical CCR waste leachate.
~~4.~~5. Encapsulate bentonite between two geotextiles. A nominal 5 mil polypropylene resin shall be impregnated in the carrier geotextile portion of the GCL (to be installed as the bottom side) to lower the hydraulic conductivity.
~~5.~~6. Lock-stitch or heat-seal needle punched geotextile backed GCL with high strength polypropylene thread, if required, to provide internal shear strength reinforcing. The internal shear reinforcing mechanism shall resist failure due to thread pull-out over long-term creep situations.

~~6.~~7. Continuously adhere the bentonite to both geotextiles to ensure that the bentonite will not be displaced during handling, transportation, storage and installation, including cutting, patching and fitting around penetrations. The bentonite sealing compound or bentonite granules used to seal penetrations and make repairs shall be made of the same natural sodium bentonite as the GCL and shall be as recommended by the GCL manufacturer. The permeability of the GCL overlap seams shall be equal to or less than the permeability of the body of the GCL sheet.

~~B.~~C. Physical Properties: Physical properties of GCL shall be as shown in Table 1 of this Section. The manufacturer shall certify that materials provided meet these criteria according to ASTM D5889 and GRI GCL3 as modified by this Specification.

TABLE 1: REQUIRED GCL PROPERTIES

GCL PROPERTY	TEST METHOD	REQUIRED VALUE
Cap Non Woven Geotextile, Mass/ Unit Area	ASTM D5261	6.0 oz/sy MARV
Carrier Woven Geotextile, Mass/ Unit Area	ASTM D5261	3.1 oz/sy MARV
Hydraulic Conductivity	ASTM D5887	≤ 5x10~~$^{-9}$~~$^{-10}$ cm/s
Index Flux	ASTM D5887	≤ 1x10^{-9} cm/s
Bentonite Content (@ 0% moisture)	ASTM D5993	≥ 0.75 lb/sf
Hydrated Internal Shear Strength	ASTM D6243	≥ 500 psf
Free Swell	ASTM D5890	≥ 24 mL
Fluid Loss	ASTM D5891	≤ 18 mL
Peel Strength, MD	ASTM D6496	≥ 3.5 ppi
~~MARV~~ Tensile Strength, MD	ASTM D6768	≥ ~~30~~ 40 ppi MARV

~~**C. The GCL shall be GSE BentoLiner CAR NSL, GSE BentoLiner CAR NWL, or Engineer approved equal.**~~

D. Interface Friction Tests.

1. Test this and adjacent materials using ASTM D 6243. Section 01060-Special Conditions, outlines the conditions under which this material shall be tested.
2. This material is part of a system. The system shall meet the requirements before the component material can be deemed acceptable.

PART 3 - EXECUTION

3.1 CONSTRUCTION

A. Shipping, Handling, and Storage:

1. During periods of shipment and storage, all GCL shall be protected from direct sunlight, water, mud, dirt, dust, and debris. To the extent possible, the GCL shall be maintained wrapped in heavy-duty protective covering until use. GCL delivered to the project site without protective wrapping shall be rejected.
2. The Engineer shall approve the shipping and delivery schedule prior to shipment. The Engineer shall approve the on-site storage area for the GCL. Unloading and storage of GCL shall be the responsibility of the Contractor.
3. GCL that is damaged during shipping, handling, or storage shall be rejected and replaced at Contractor's expense.

B. Installation of GCL:

1. Prior to placement, the surface must be prepared as follows:
   a. Lines and grade must be verified by a Licensed Land Surveyor.
   b. The surface must be proofrolled to verify the supporting soil condition.
   c. The surface must be inspected for rocks larger than 0.75 IN.
   d. Steel drum rolled in preparation for the GCL.
   e. Thickness shall be verified by an approved method. Refer to Specification 01060 and the CQA Plan.
2. GCL shall be placed to the lines and grades shown on the Contract Drawings. At the time of installation, GCL shall be rejected by the CQA/CQC Consultant if it has defects, rips, holes, flaws, evidence of deterioration, or other damage.
3. The surface receiving the GCL shall be prepared to a relatively smooth condition, free of obstructions, excessive depressions, debris, and very soft or loose pockets of soil. This surface shall be approved by the CQA Consultant prior to GCL placement.
4. The GCL shall be placed smooth and free of excessive wrinkles.
5. The GCL shall be installed on sideslopes with vertical seams only.
6. When GCL is placed with upslope and downslope portions, the upslope portion shall be lapped such that it is the upper or exposed surface.
7. The GCL shall not be placed in standing water or while raining. Any material that becomes partially/totally hydrated shall be removed and replaced.
8. The GCL seams shall be laid with a minimum overlap equal to 6 IN or the manufacturer's recommendation, whichever is greater. Bentonite powder shall be placed at all GCL seams.
9. GCL shall be temporarily secured in a manner approved by the CQA Consultant prior to placement of overlying materials.
10. Any GCL that is torn or punctured shall be repaired or replaced as directed by the Geotech Engineer, by the Contractor at no additional cost to the Owner. The repair shall consist of a patch of GCL placed over the failed areas and shall overlap the existing GCL a minimum of 12 IN from any point of the rupture.
11. If in-place GCL is not otherwise protected from hydration due to rainfall, the GCL shall be covered with a minimum of 12 IN of the overlying design material within 12 hours of GCL placement.
12. Take necessary precautions to protect underlying soil and geomembrane liners from damage due to any construction activity. Damage to liners shall be repaired at Contractor’s expense.
13. The Contractor shall ensure that adequate dust control methods are in effect to prevent the unnecessary accumulation of dust and dirt on geosynthetic surfaces, which hampers the efficient field seaming of geosynthetic panels.
14. The Contractor shall maintain natural surface water drainage diversions around the work area. The Contractor shall provide for the disposal of water that may collect in the work area, from precipitation falling on the work or from inadequate diversion structures.

3.2 FIELD QUALITY CONTROL

A. The Geotech Engineer shall monitor and document the installation of GCL to ensure that the installation and necessary repairs are made in accordance with these Specifications.

3.3 GCL ACCEPTANCE

A. The GCL Installer shall retain all ownership and responsibility for the GCL until final acceptance by the Owner. The Owner will accept the GCL installation when the installation is finished, all required submittals have been received and approved, and CQC/CQA verification of the adequacy of all field seams and repairs, including associated testing, is complete.

END OF SECTION

LEGEND

—PL—	PROPERTY LINE
—290—	EXISTING TOPOGRAPHY
	EXISTING ROAD
— — —	CELL LIMITS
	RIPRAP DROP DOWN (REFER TO THE EROSION CONTROL PLAN)
—ohe—	OVERHEAD ELECTRIC
- - - -	PARCEL BOUNDARIES
++++++	RAILROAD
— — —	CELL BOUNDARIES
	PLANIMETRICS
	OPEN WATER

NOTES:

1. THESE PROPOSED GRADES REPRESENT SUBGRADE.
2. DEVELOPMENT OF CELLS 1-5 WILL OCCUR IN THREE PHASES:
   - PHASE 1: CELLS 1 AND 2
   - PHASE 2: CELLS 3 AND 4
   - PHASE 3: CELL 5
3. SOIL STOCKPILE AREAS TO BE DESIGNED AND PERMITTED AS NEEDED FOR OPERATIONS.
4. THE CONTOUR INTERVAL FOR THIS DRAWING IS 2-FEET. REFER TO SHEET 01C-12 FOR THE SEDIMENT BASIN SCHEDULE FOR SPECIFIC ELEVATIONS.

HDR

HDR Engineering, Inc. of the Carolinas
440 S. Church St. Suite 1000
Charlotte, NC 28202-2075
704.338.6700
N.C.B.E.L.S. License Number F-0116

ISSUE	DATE	DESCRIPTION
C	03/2015	RAISED FLOOR GRADES 6"
B	12/31/14	REVISED PER NCDENR COMMENTS
A	11/2014	ISSUED FOR APPROVAL

PROJECT MANAGER	M.D. PLUMMER, P.E.
DESIGNED BY	P. WESTMORELAND, P.E.
DRAWN BY	J. GAUL
CHECKED BY	J. READLING, P.E.
PROJECT NUMBER	453925-235691-018

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 025495 MICHAEL D. PLUMMER

Charah®

COLON MINE SITE STRUCTURAL FILL
SANFORD, NC

BASEGRADE PLAN (BOTTOM OF SOIL LINER)

FILENAME	00C-02.dwg
SCALE	1"=200'

SHEET 00C-02

LEGEND

- EXISTING TOPOGRAPHY
- EXISTING ROAD
- CELL LIMITS
- SUBCELL LIMITS
- FORCEMAIN
- LEACHATE COLLECTION PIPE (SOLID)
- LEACHATE COLLECTION PIPE (PERFORATED)
- LEACHATE COLLECTION PIPE CLEANOUT
- OVERHEAD ELECTRIC
- RAILROAD
- CELL BOUNDARIES
- PLANIMETRICS
- OPEN WATER

NOTES:

1. THE GRADES SHOWN REPRESENT THE TOP OF THE LINER SYSTEM AND ARE 1.5 FT ABOVE THE BASEGRADE.
2. DEVELOPMENT OF CELLS 1–5 WILL OCCUR IN THREE PHASES
   PHASE 1: CELLS 1 AND 2
   PHASE 2: CELLS 3 AND 4
   PHASE 3: CELL 5
3. EXISTING HAUL ROAD TO COLON ROAD TO BE MAINTAINED AS NEEDED.

HDR Engineering, Inc. of the Carolinas
440 S. Church St. Suite 1000
Charlotte, NC 28202-2075
704.338.6700
N.C.B.E.L.S. License Number F-0116

ISSUE	DATE	DESCRIPTION
C	03/2015	RAISED FLOOR GRADES 6", RESIZED SUBCELLS
B	12/31/14	REVISED PER NCDENR COMMENTS
A	11/2014	ISSUED FOR APPROVAL

PROJECT MANAGER	M.D. PLUMMER, P.E.
DESIGNED BY	P. WESTMORELAND, P.E.
DRAWN BY	J. GAUL
CHECKED BY	J. READLING, P.E.
PROJECT NUMBER	453925-235691-018

NORTH CAROLINA SEAL 025495 ENGINEER MICHAEL D. PLUMMER

Charah®

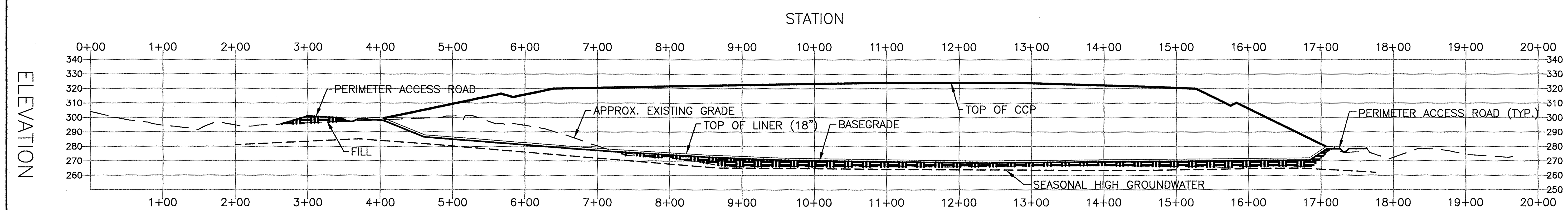
COLON MINE SITE STRUCTURAL FILL
SANFORD, NC

TOP OF LINER

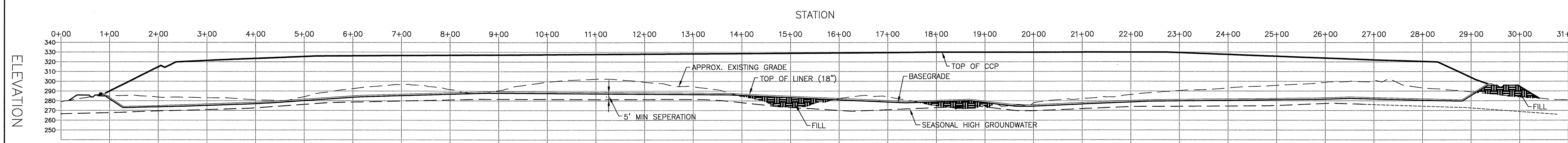
FILENAME 00C-03.dwg
SCALE 1"=200'

SHEET 00C-03

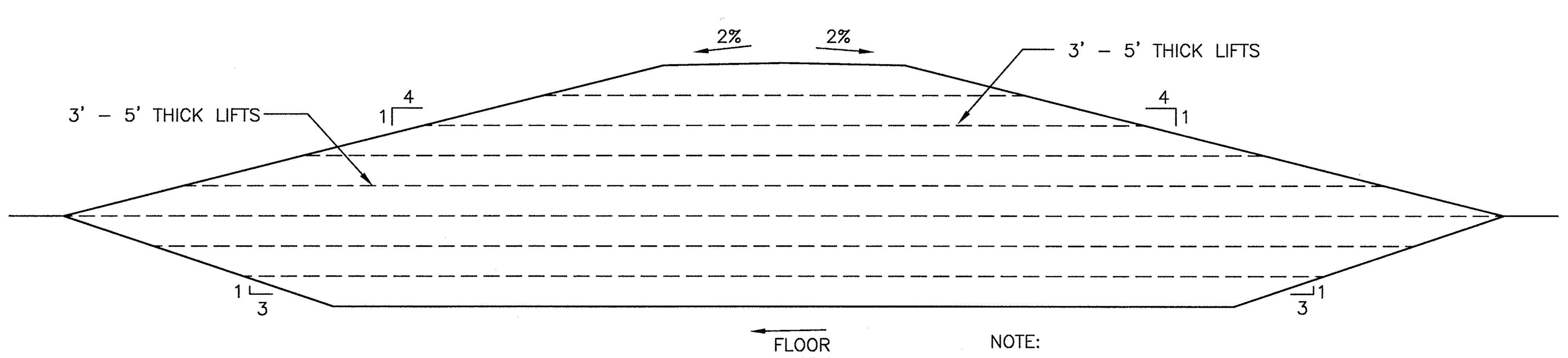
SECTION A
HORIZONTAL: 1"=100'; VERTICAL: 1"=50'



SECTION B
HORIZONTAL: 1"=100'; VERTICAL: 1"=50'



SECTION C
HORIZONTAL: 1"=100'; VERTICAL: 1"=50'



NOTE:
1. EACH CELL WILL BE FILLED FROM HIGH TO LOW IN 3' TO 5' THICK LIFTS.

FILL SEQUENCE
3/4"=1'-0"

NOTES:
1. IN THE AREAS WHERE SUBGRADE IS HIGHER THAN EXISTING GRADE, CLEAN SOIL WILL BE USED TO BRING EXISTING GRADE TO SUBGRADE. THE CLEAN SOIL WILL BE COMPACTED AS REQUIRED.
2. THE SEPARATION BETWEEN THE TOP OF THE CAP SYSTEM AND THE OVERHEAD ELECTRICAL WILL BE MAINTAINED.
3. REFER TO SHEET 00C-04 FOR SLOPE OF THE TOP OF THE CCP.

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N.C.B.E.L.S. License Number F-0116

ISSUE	DATE	DESCRIPTION
C	03/2015	RAISED SUBGRADE AND LINER 6"
B	12/31/14	REVISED PER NCDENR COMMENTS
A	11/2014	ISSUED FOR APPROVAL

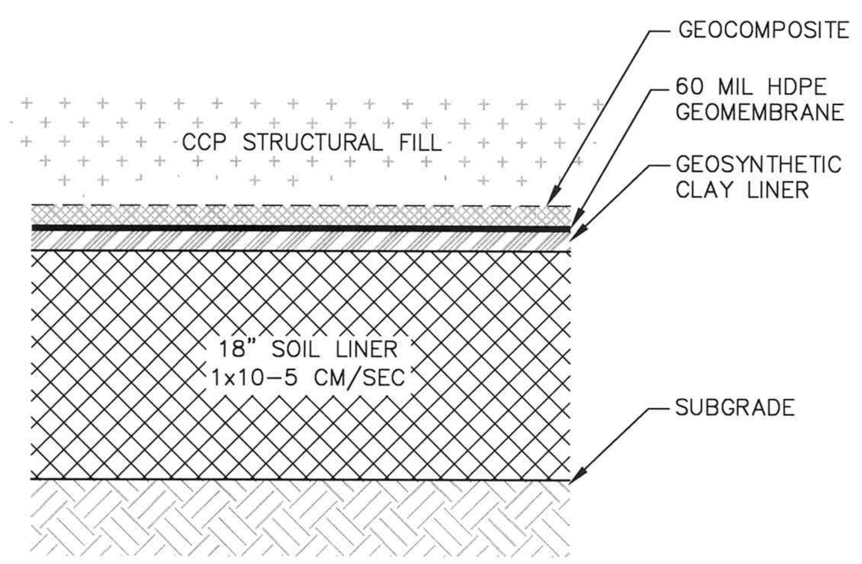
PROJECT MANAGER	M.D. PLUMMER, P.E.
DESIGNED BY	P. WESTMORELAND, P.E.
DRAWN BY	J. GAUL
CHECKED BY	J. READLING, P.E.
PROJECT NUMBER	453925-235691-018

SEAL 025495 MICHAEL D. PLUMMER

Charah®
COLON MINE SITE STRUCTURAL FILL
SANFORD, NC

SITE CROSS SECTIONS

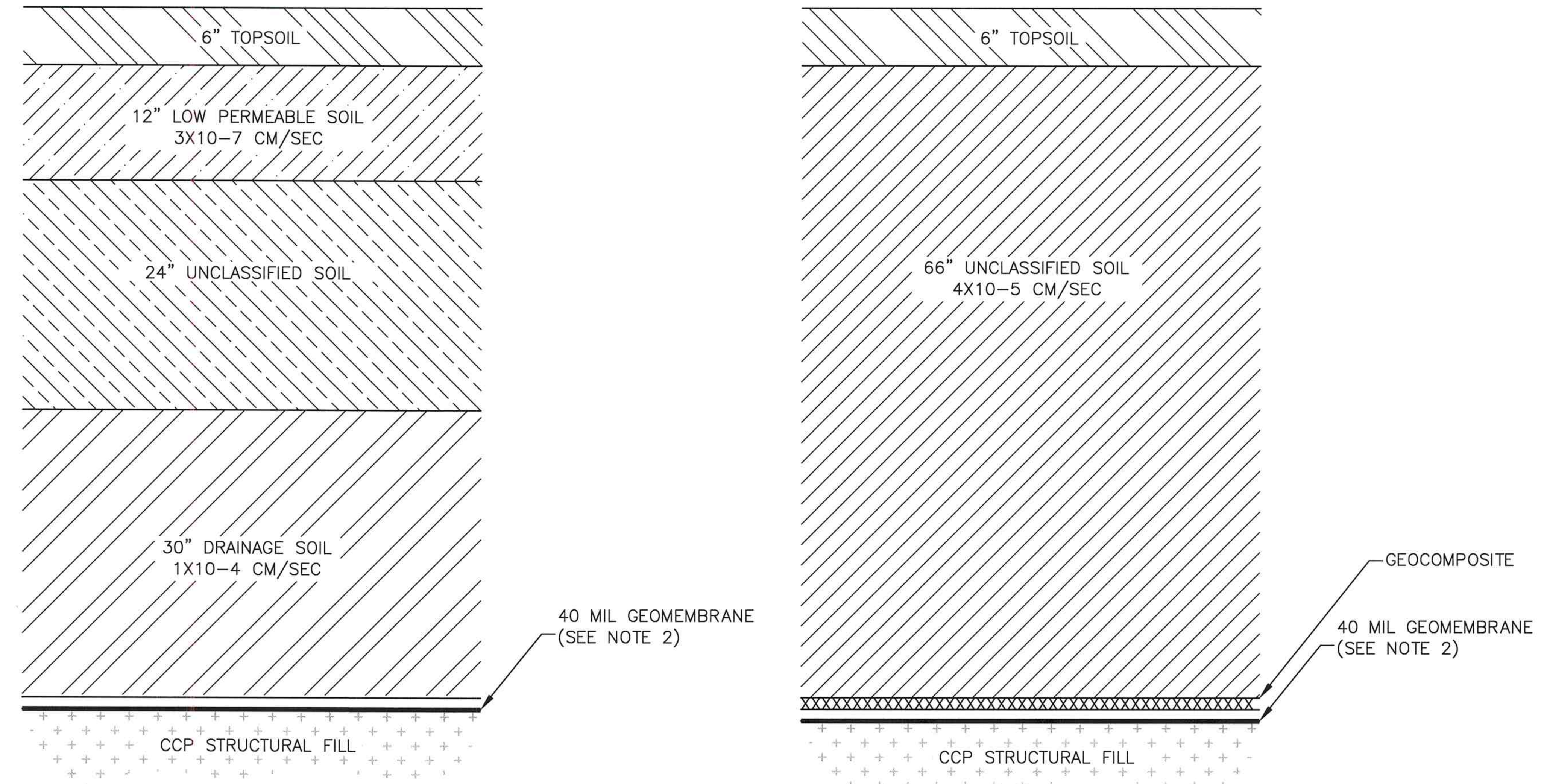
FILENAME 00C-05.dwg
SCALE 1"=100'
SHEET 00C-05



NOTES:

1. CONTRACTOR TO VERIFY THICKNESS PER SPECIFICATIONS.

BASE LINER
1" = 1'
1 / 00C-03



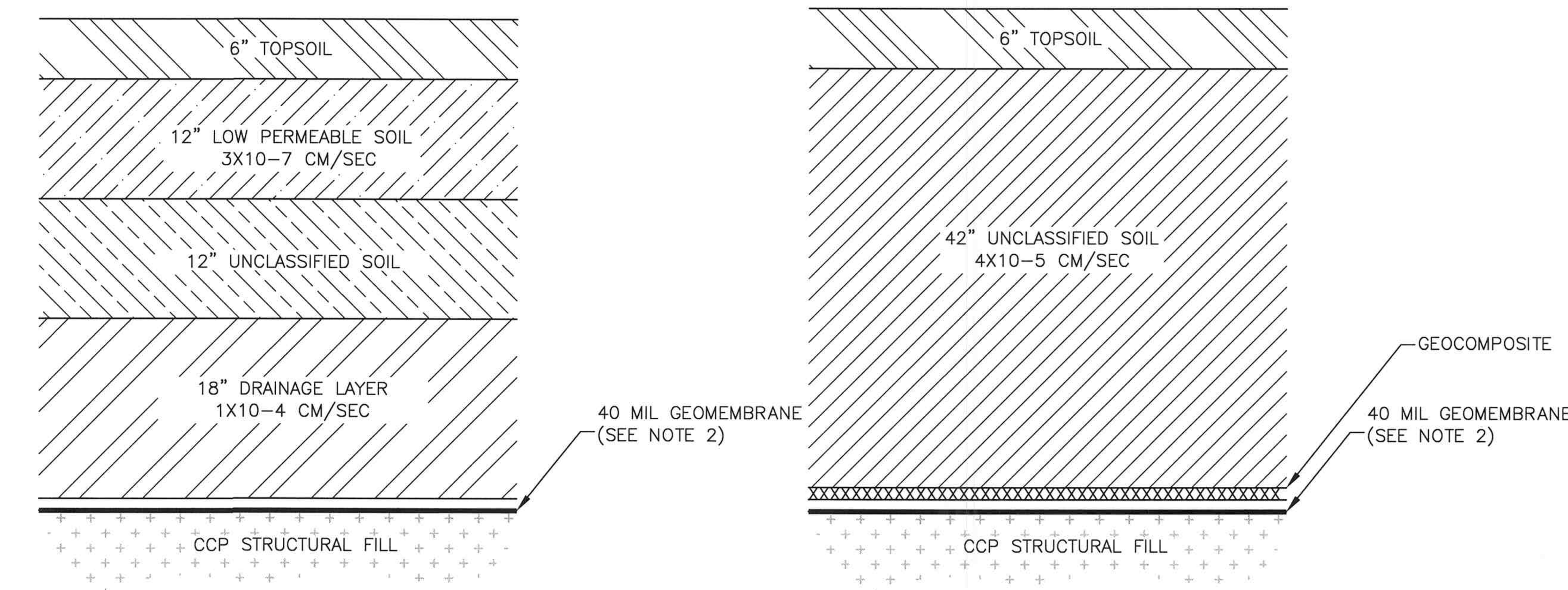
OPTION 1

OPTION 2

NOTES:

1. CONTRACTOR TO VERIFY THICKNESS PER SPECIFICATIONS.
2. THE CONTRACTOR MAY USE EITHER 40 MIL TEXTURED HDPE OR 40 MIL TEXTURED LLDPE FOR THE CAP.

CAP SYSTEM – TOP
1" = 1'
2 / 00C-04



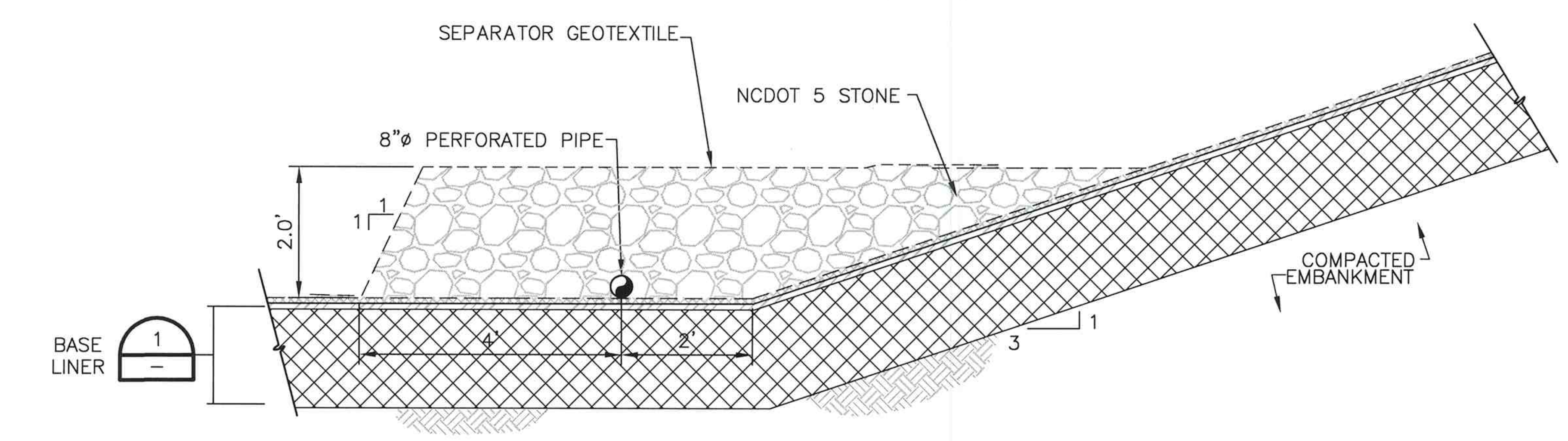
OPTION 1

OPTION 2

NOTES:

1. CONTRACTOR TO VERIFY THICKNESS PER SPECIFICATIONS.
2. THE CONTRACTOR MAY USE EITHER 40 MIL TEXTURED HDPE OR 40 MIL TEXTURED LLDPE FOR THE CAP.

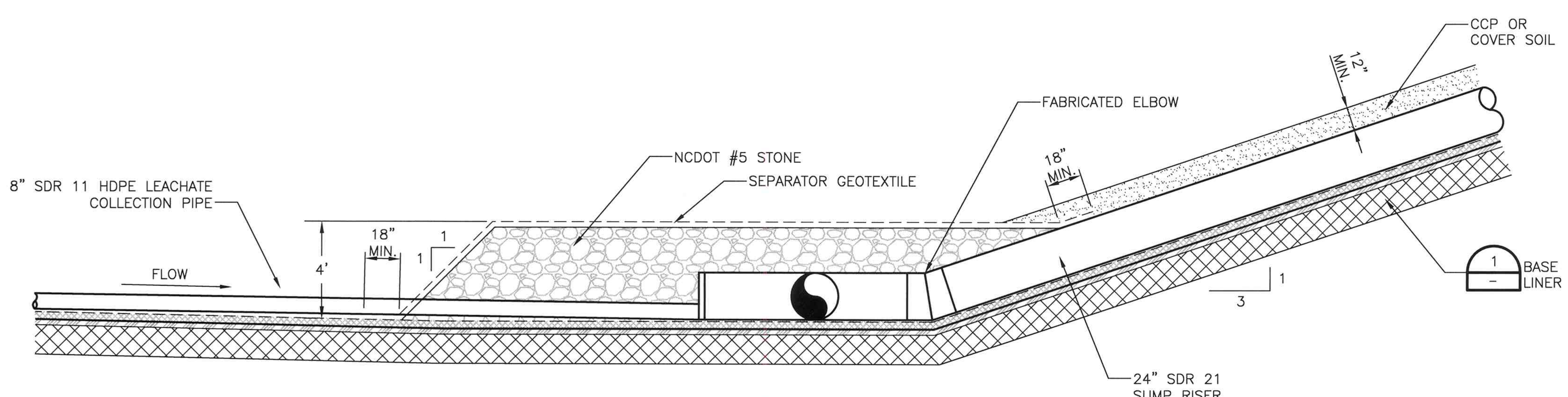
CAP SYSTEM – SIDESLOPE
1" = 1'
3 / 00C-04



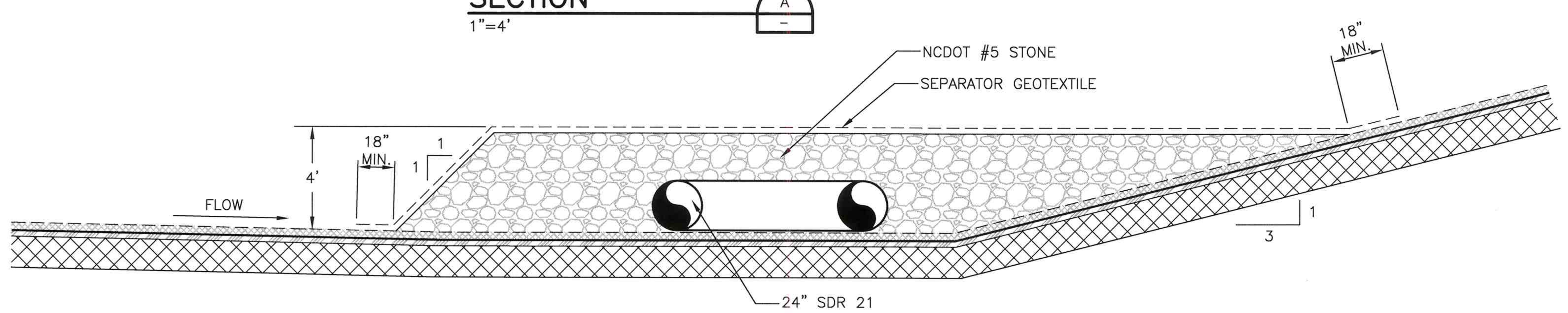
NOTES:

1. THE SEPARATOR GEOTEXTILE WRAPS THE NCDOT #5 STONE.

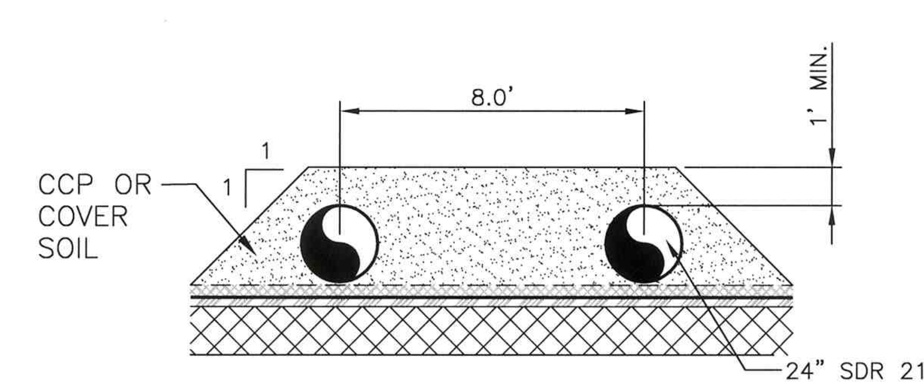
BASE LINER TOE DRAIN
1"=2'
4 / 00C-03



SECTION
1"=4'
A / –



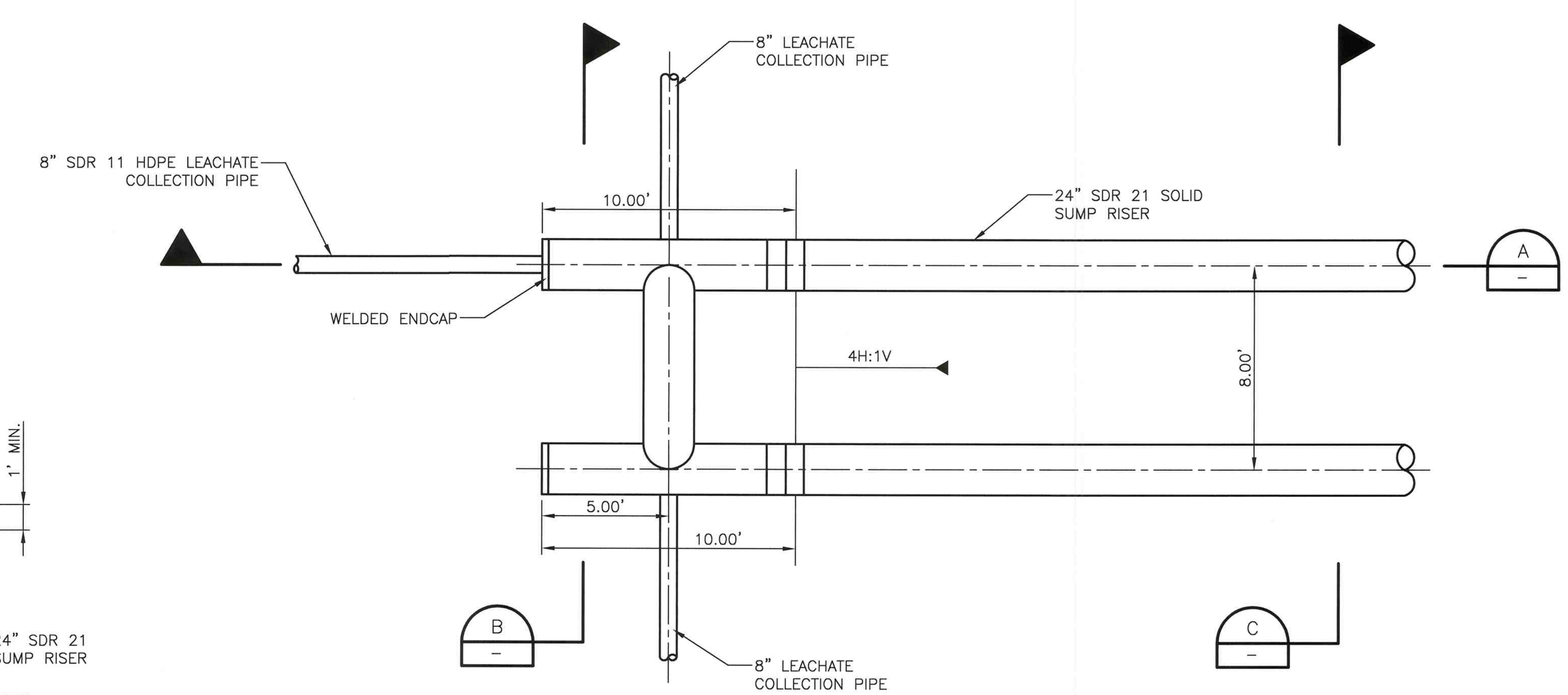
SECTION
1"=4'
B / –



NOTES:

1. PROVIDE A MINIMUM COVER OF 1' OVER ALL PIPES.

SECTION
1"=4'
C / –



SUMP
1"=4'
5 / 00C-03

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N.C.B.E.L.S. License Number F-0116

ISSUE	DATE	DESCRIPTION
C	03/2015	REVISED LEACHATE COLLECTION PIPE
B	12/31/14	REVISED PER NCDENR COMMENTS
A	11/2014	ISSUED FOR APPROVAL

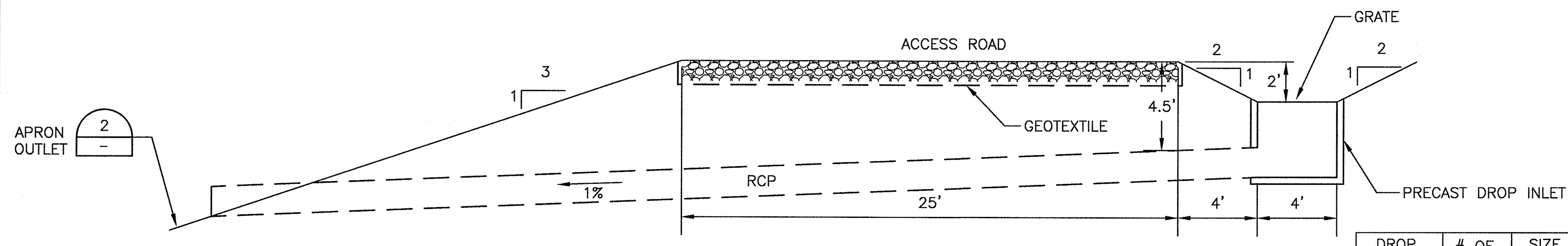
PROJECT MANAGER	M.D. PLUMMER, P.E.
DESIGNED BY	P. WESTMORELAND, P.E.
DRAWN BY	L. MCCAUL
CHECKED BY	J. READLING, P.E.
PROJECT NUMBER	453925-235691-018

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 025495 MICHAEL D. PLUMMER 3/6/15

COLON MINE SITE STRUCTURAL FILL
SANFORD, NC

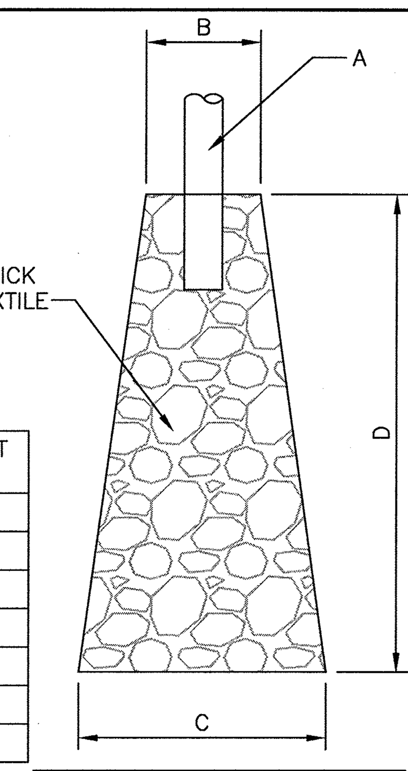
LINER SYSTEM AND SUMP

FILENAME 00C-06.dwg
SCALE AS SHOWN
SHEET 00C-06



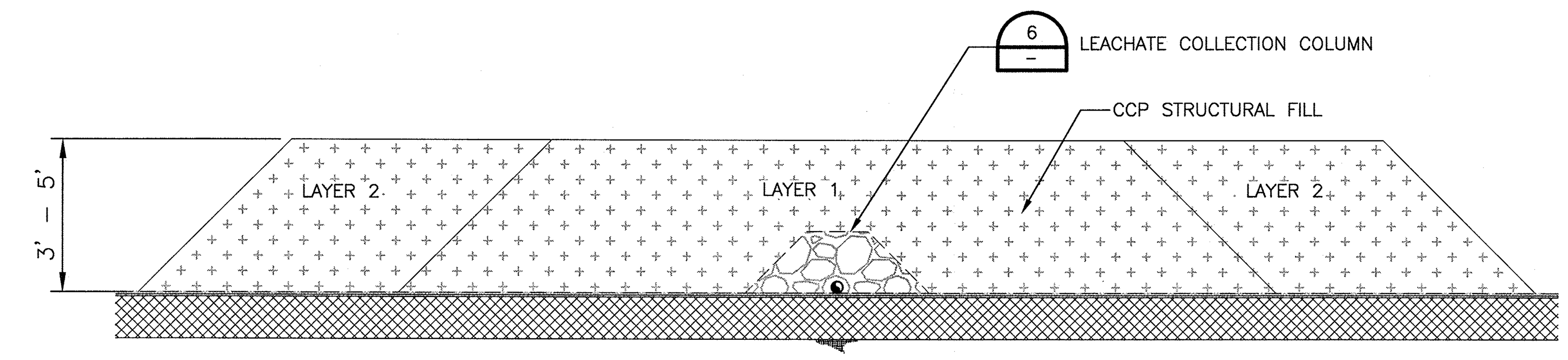
DROP INLET #	# OF PIPES	SIZE OF PIPE (IN)	GRATE INLET AREA (SF)
1	1	30	6
2	1	30	6
3	1	30	6
4	1	18	6
5	1	30	6
6	1	36	12
7	2	36	12

DROP INLET (1 / 00C-02)
1"=5'



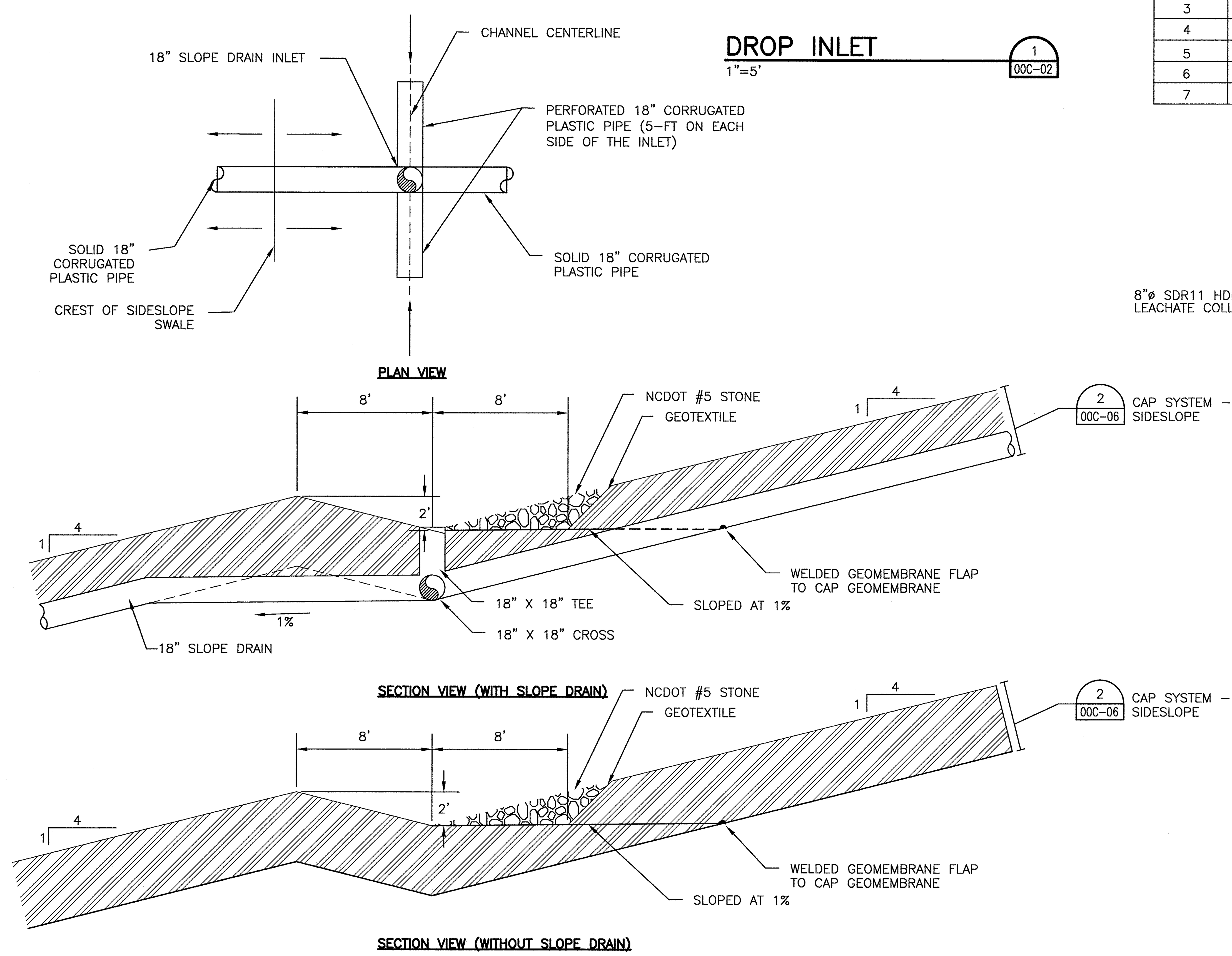
A (IN)	B (FT)	C (FT)	D (FT)
24	6	14	16
36	9	20	23

APRON OUTLET (2 / –)
1"=8'

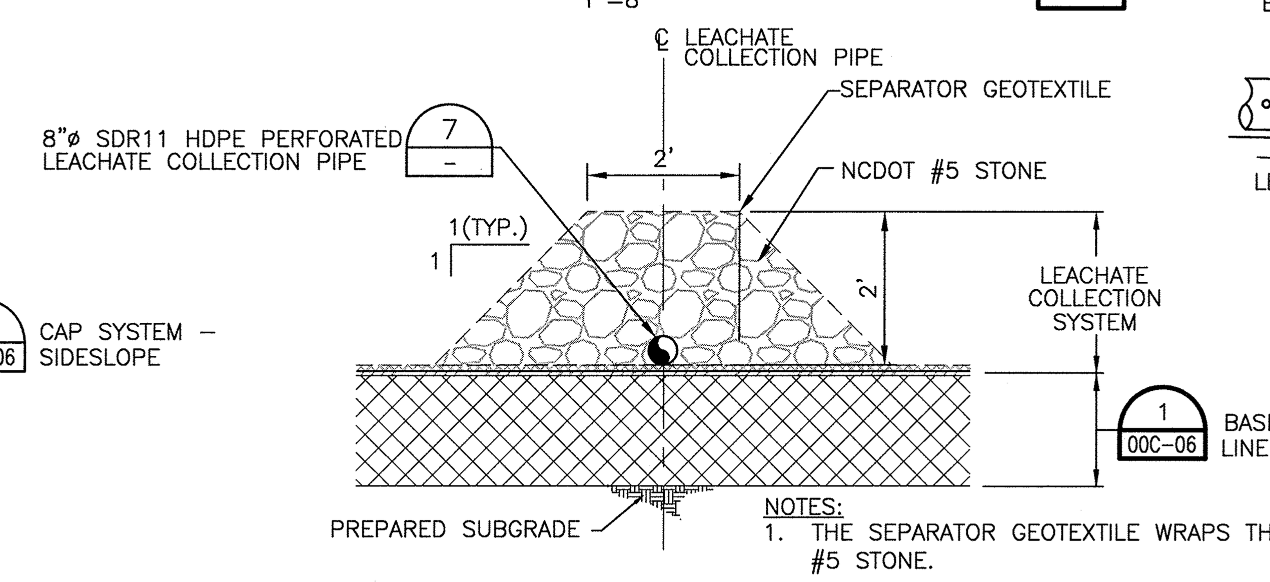


NOTES:
1. HEIGHT OF EACH LAYER IS 3'–5".
2. WIDTH OF EACH LAYER VARIES.
3. OPERATOR SHOULD PLACE CCP DIRECTLY OVER THE PERFORATED PIPE FIRST WHEN OPENING A NEW SUBCELL.

SUBCELL INITIAL CCP PLACEMENT (3 / 00C-03)
1"=4'

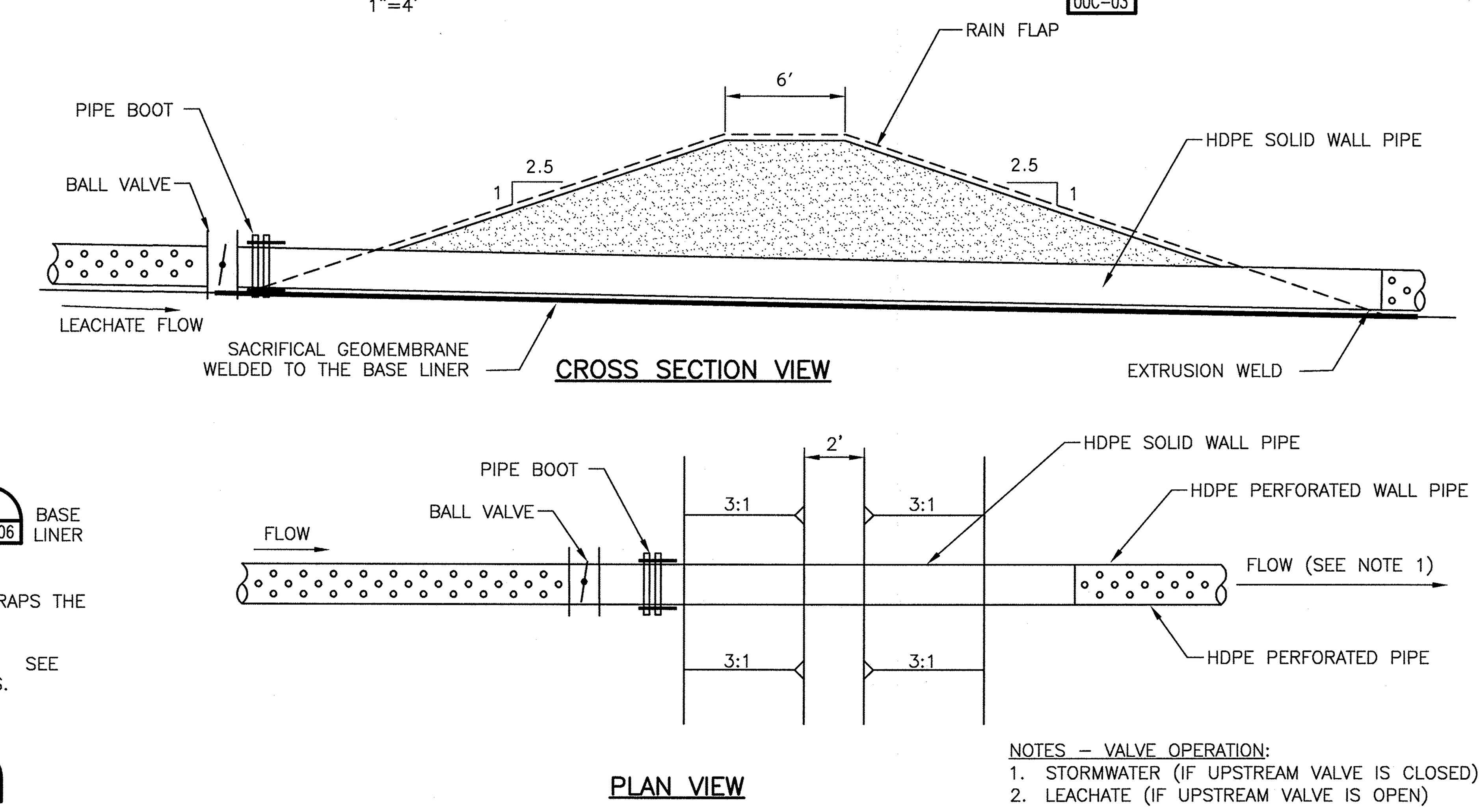


SIDELSLOPE SWALE (4 / 00C-04)
1"=5'



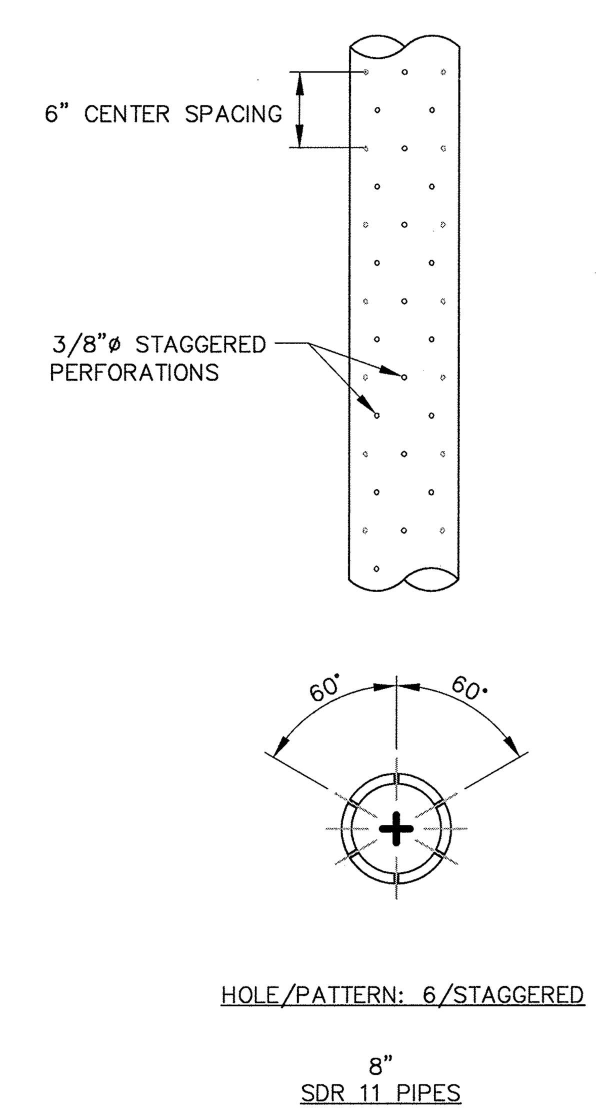
NOTES:
1. THE SEPARATOR GEOTEXTILE WRAPS THE #5 STONE.
2. SOLID PIPE NOT IN ALL AREAS. SEE SHEET 00C-03 FOR LOCATIONS.

LEACHATE COLLECTION COLUMN (6 / –)
1"=2'

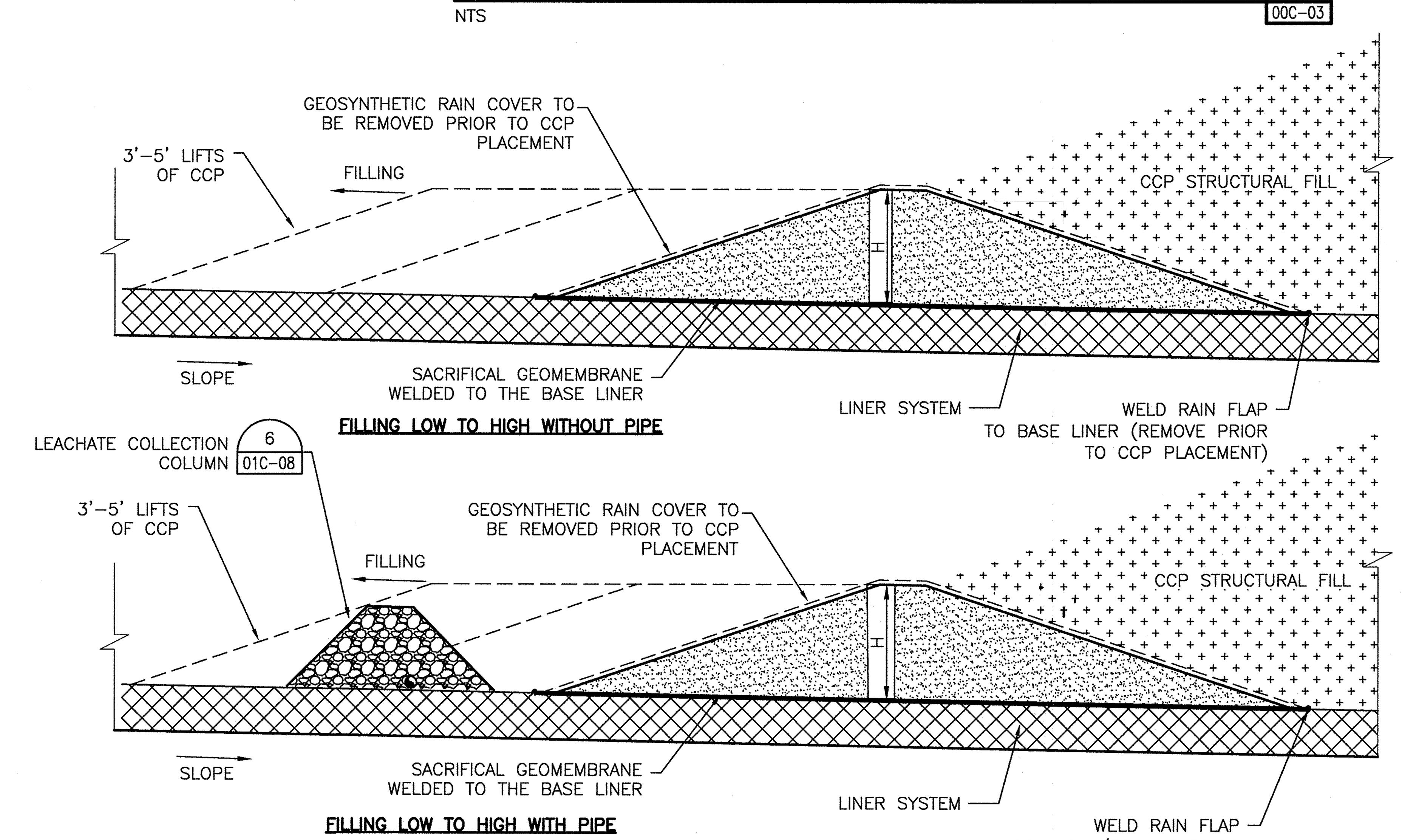


NOTES – VALVE OPERATION:
1. STORMWATER (IF UPSTREAM VALVE IS CLOSED)
2. LEACHATE (IF UPSTREAM VALVE IS OPEN)

SUBCELL DIVIDER BERM AND RAIN FLAP (8 / 00C-03)
NTS

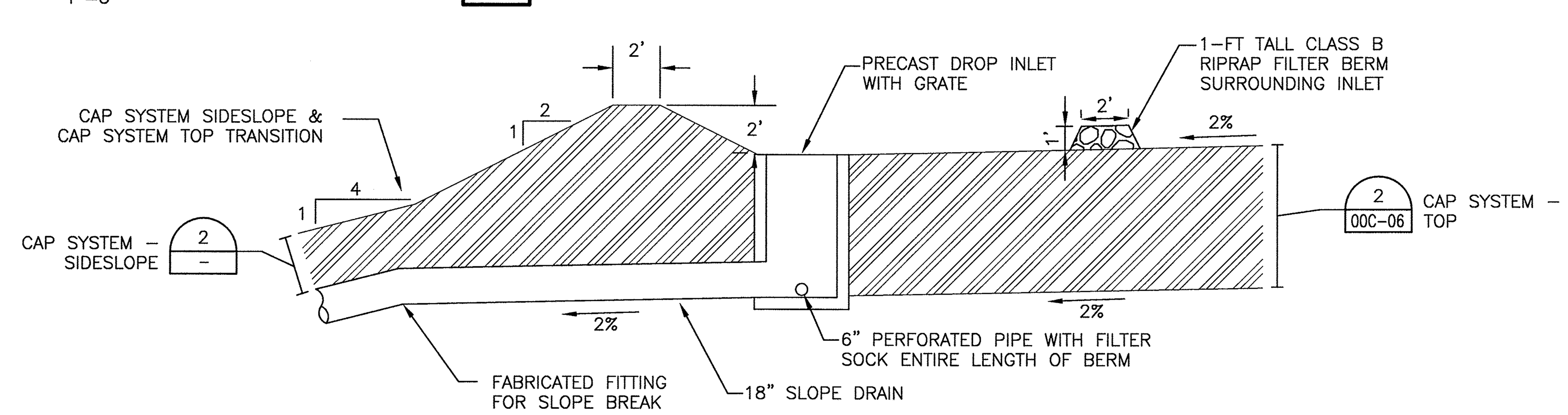


LEACHATE PIPE PERFORATION (7 / –)
N.T.S.



Subcell	H (ft)
1A	5
1B	5
1C	5
1D	9
2A	6
2B	6
2C	6
3A	9
3B	9
3C	8
3D	6
4A	5
4B	7
4C	7
4D	9
4E	9
4F	9
5A	9
5B	9
5C	8
5D	6
5E	7

SUBCELL FILLING (9 / 00C-03)
1"=5'



DIVERSION BERM (5 / 00C-04)
1"=5'

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ISSUE	DATE	DESCRIPTION
C	03/2015	REVISED SUBCELL & FILLING
B	12/31/14	REVISED PER NCDENR COMMENTS
A	11/2014	ISSUED FOR APPROVAL

PROJECT MANAGER	M.D. PLUMMER, P.E.
DESIGNED BY	P. WESTMORELAND, P.E.
DRAWN BY	L. MCCAUL
CHECKED BY	J. READLING, P.E.
PROJECT NUMBER	453925–235691–018

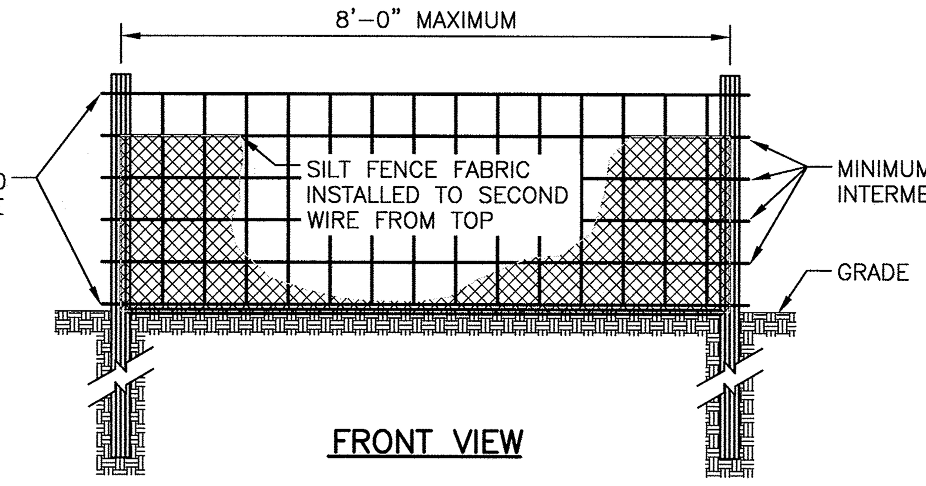
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 025495 MICHAEL D. PLUMMER

Charah®

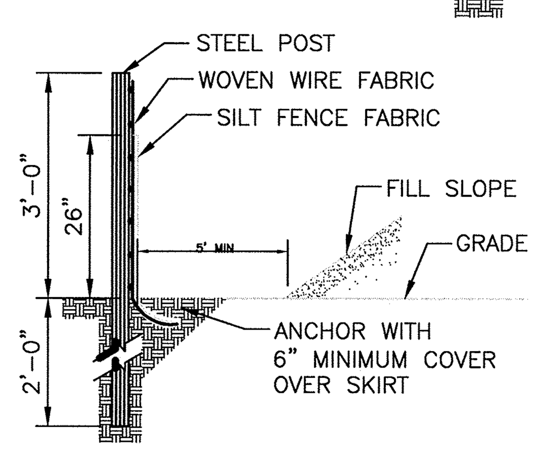
COLON MINE SITE STRUCTURAL FILL
SANFORD, NC

MISCELLANEOUS DETAILS

FILENAME 00C–08.dwg
SCALE AS SHOWN
SHEET 00C-08



FRONT VIEW



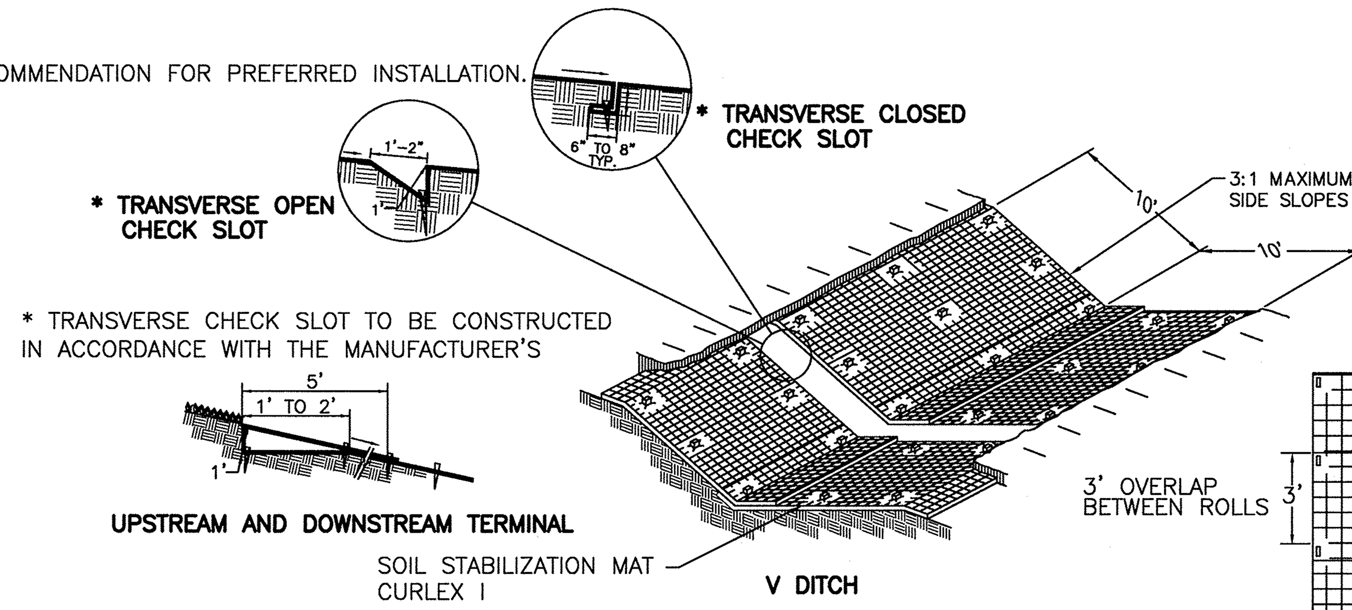
SIDE VIEW

NOTE:

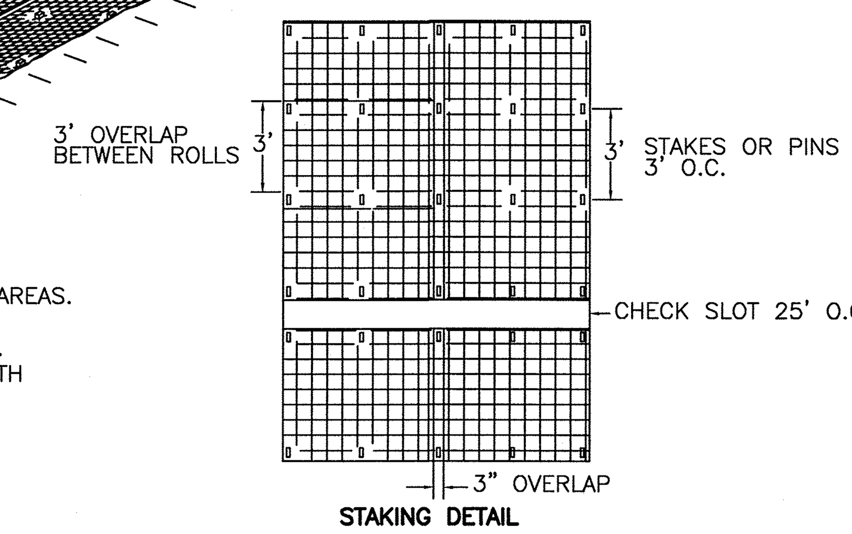
1. USE SILT FENCE ONLY WHEN DRAINAGE AREA DOES NOT EXCEED 1/4 ACRE AND NEVER IN AREAS OF CONCENTRATED FLOW.
2. SILT FENCE IS TO BE SECURELY FASTENED TO EACH STEEL SUPPORT POST OR TO WOVEN WIRE WHICH IS IN TURN ATTACHED TO THE STEEL FENCE POST.
3. INSPECT FREQUENTLY AND REPAIR OR REPLACE PROMPTLY AS NEEDED.
4. REMOVE SEDIMENT DEPOSITED AS NEEDED TO PROVIDE STORAGE VOLUME FOR THE NEXT RAIN AND TO REMOVE PRESSURE ON THE SILT FENCE. UNIFORMLY DISTRIBUTE ON THE SOURCE AREA PRIOR TO TOPSOILING.

TEMPORARY SILT FENCE DETAIL (1)

NO TO SCALE



LINING SHALL EXTEND 10' UP SIDE SLOPES OF LINED AREAS.
LINING SHALL BE CURLEX I OR EQUAL.
SIDE SLOPES SHALL BE A MAXIMUM SLOPE OF 3 TO 1.
LINING SHALL BE INSTALLED IN STRICT ACCORDANCE WITH MANUFACTURER'S INSTALLATION PROCEDURES.



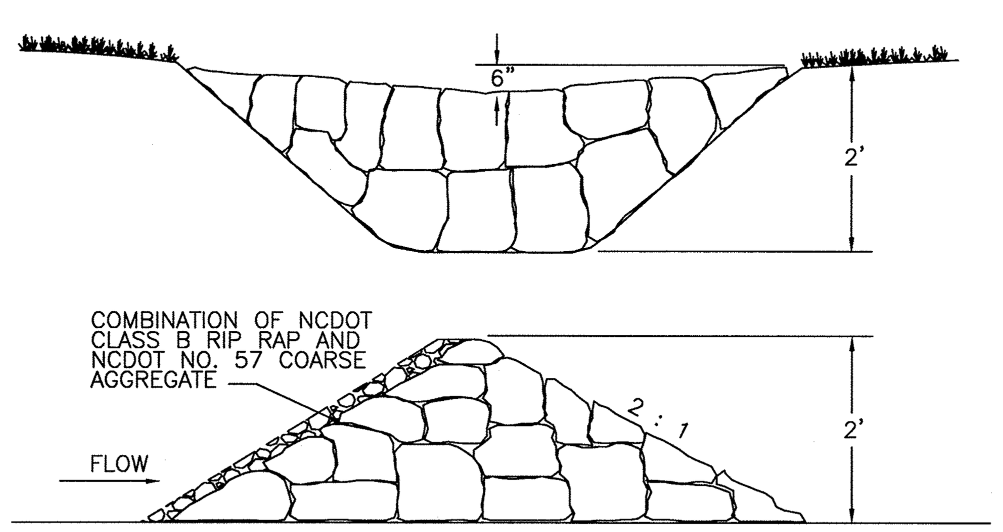
NOTE: STAKES SHALL BE WOOD OR METAL AS RECOMMENDED BY MANUFACTURER AND SHALL BE AT LEAST 12" IN LENGTH.

SLOPE INSTALLATION–EROSION CONTROL BLANKET NOTES:

1. PREPARE SOIL BEFORE INSTALLING BLANKETS, INCLUDING APPLICATION OF FERTILIZER AND SEED.
2. BEGIN AT THE TOP OF THE SLOPE BY ANCHORING THE BLANKET IN A 6" DEEP x 6" WIDE TRENCH WITH APPROXIMATELY 12" OF BLANKET EXTENDED BEYOND THE UP–SLOPE PORTION OF THE TRENCH. ANCHOR THE BLANKET WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" APART IN THE BOTTOM OF THE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING.
3. APPLY SEED TO COMPACTED SOIL AND FOLD REMAINING 12" PORTION OF BLANKET BACK OVER SEED AND COMPACTED SOIL. SECURE BLANKET OVER COMPACTED SOIL WITH A ROW OF STAPLES/STAKES SPACED APPROXIMATELY 12" APART ACROSS THE WIDTH OF THE BLANKET.
3. ROLL THE BLANKETS DOWN OR HORIZONTALLY ACROSS THE SLOPE. BLANKETS WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE SOIL SURFACE. ALL BLANKETS MUST BE SECURELY FASTENED BY PLACING STAPLES/STAKES IN APPROXIMATE LOCATIONS, SEE MANUFACTURER'S INSTALLATION INSTRUCTIONS.
4. THE EDGES OF PARALLEL BLANKETS MUST BE STAPLED WITH APPROXIMATELY 2"–5" OVERLAP DEPENDING ON BLANKET TYPE. TO ENSURE PROPER SEAM ALIGNMENT, PLACE THE EDGE OF THE OVERLAPPING BLANKET EVEN WITH THE COLORED SEAM STITCH ON THE PREVIOUSLY INSTALLED BLANKET.
5. CONSECUTIVE BLANKETS SPLICED DOWN THE SLOPE MUST BE PLACED END OVER END (SHINGLE STYLE) WITH AN APPROXIMATE 3" OVERLAP. STAPLE THROUGH OVERLAPPED AREA, APPROXIMATELY 12" APART ACROSS ENTIRE BLANKET WIDTH.

TYPICAL SECTION FOR SOIL STABILIZATION MAT LINED AREAS (TYP.) (2)

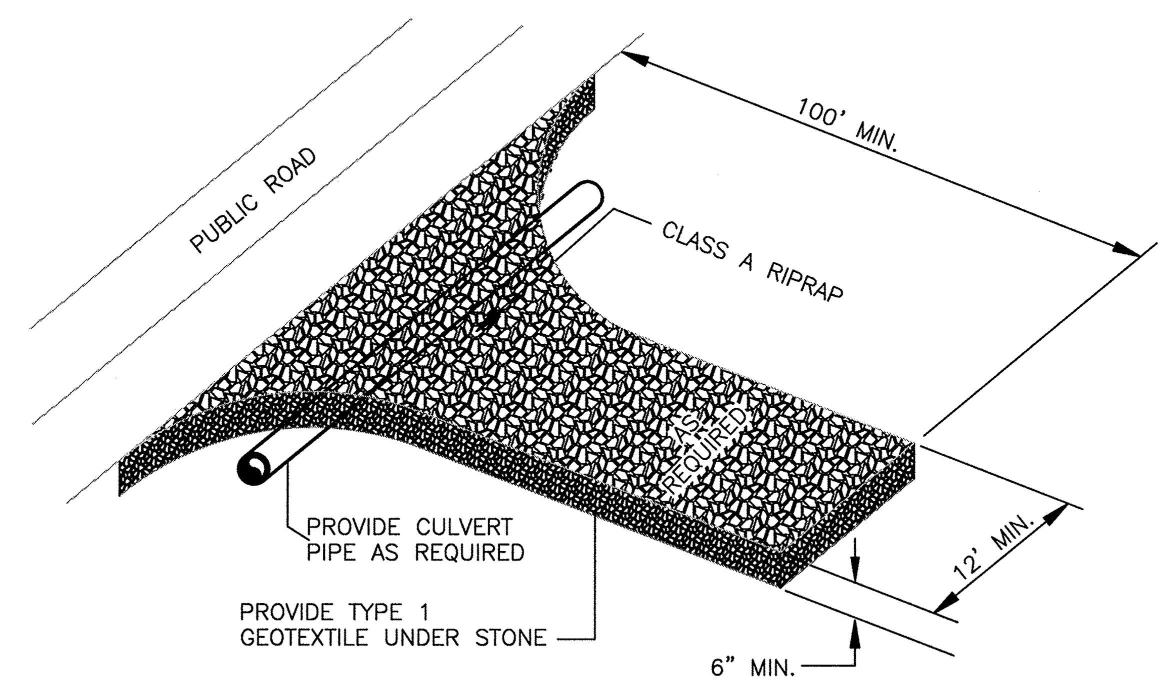
NTS



NOTE:
PLACE EVERY 100' ALONG FLOW PATH.

ROCK CHECK DAM (3)

NTS



TEMPORARY GRAVEL CONSTRUCTION ENTRANCE DETAIL (4)

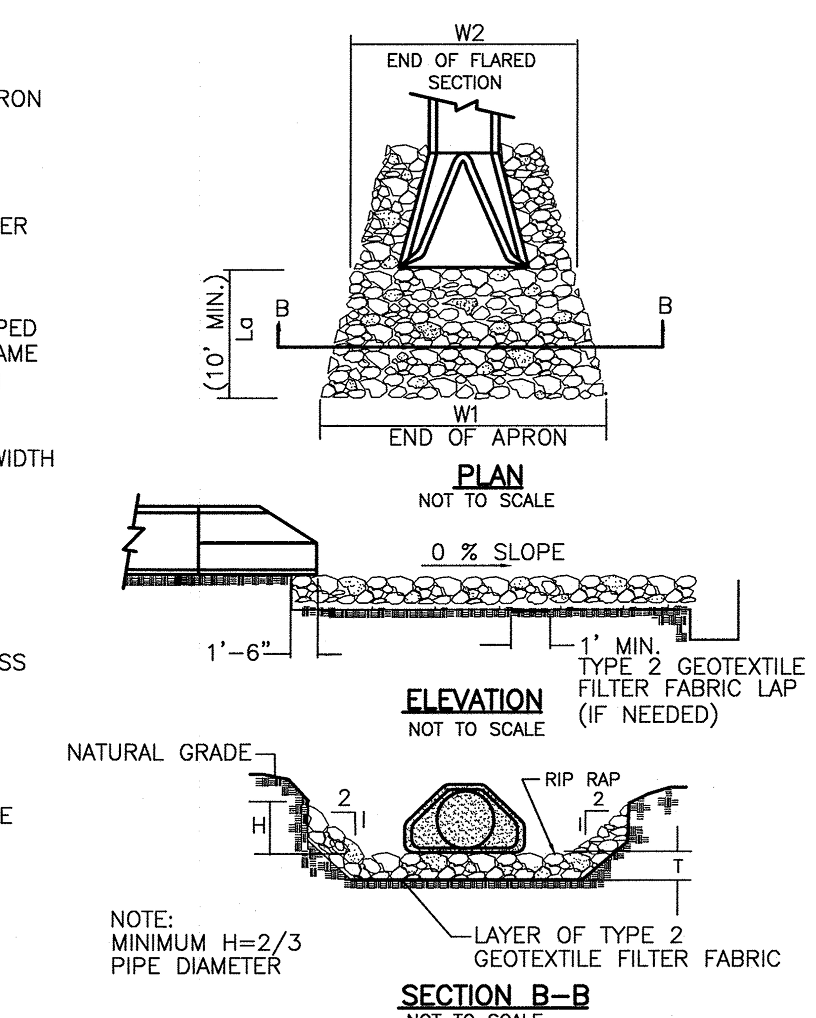
NOT TO SCALE NCDENR 6.06

NOTES:

1. CLASS OR MEDIAN SIZE OF RIP RAP AND LENGTH, WIDTH AND DEPTH OF APRON TO BE SHOWN ON PLANS.
2. RIP RAP SHOULD EXTEND UP BOTH SIDES OF THE APRON AND AROUNG THE END OF THE PIPE OR CULBVERT AT THE DISCHARGE OUTLET AT A MAXIMUM SLOPE OF 2:1 AND A HEIGHT NOT LESS THAN TWO THIRDS THE PIPE DIAMETER OR CULVERT HEIGHT.
3. THERE SHALL BE NO OVERFLOW FROM THE END OF THE APRON TO THE SURFACE OF THE RECEIVING CHANNEL. THE AREA TO BE PAVED OR RIP RAPPED SHALL BE UNDERCUT SO THAT THE INVERT OF THE APRON SHALL BE THE SAME GRADE (FLUSH) WITH THE SURFACE OF THE RECEIVING CHANNEL. THE APRON SHALL HAVE A CUTOFF OR TOE WALL AT THE DOWNSTREAM END.
4. THE WIDTH OF THE END OF THE APRON SHALL BE EQUAL TO THE BOTTOM WIDTH OF THE RECEIVING CHANNEL. MAXIMUM TAPER TO RECEIVING CHANNEL 5:1.
5. ALL SUBGRADE FOR STRUCTURE TO BE COMPACTED TO 95% OR GREATER.
6. THE PLACING OF FILL, EITHER LOOSE OR COMPACTED IN THE RECEVIGING CHANNEL SHALL NOT BE ALLOWED.
7. NO BENDS OR CURVES IN THE HORIZONTAL ALIGNMENT OF THE APRON UNLESS OTHERWISE SHOWN.
8. TYPE 2 GEOTEXTILE FILTER FABRIC SHALL BE INSTALLED ON COMPACTED SUBGRADE PRIOR TO PLACEMENT OF RIP RAP.
9. ANY DISTURBED AREA FROM END OF APRON TO RECEIVING CHANNEL MUST BE STABILIZED.

LOCATION	W1	W2	La	CLASS	T
SB1	12'	4.5'	10'	B	18"
SB2*	12'	6'	10'	B	18"
SB3	9'	3'	8'	B	18"
SB4	9'	3'	8'	B	18"
SB5*	12'	6'	10'	B	18"
SB6	9'	3'	8'	B	18"
SB7*	12'	6'	10'	B	18"
SB8	9'	3'	8'	B	18"
SB9*	26'	11'	22'	B	18"

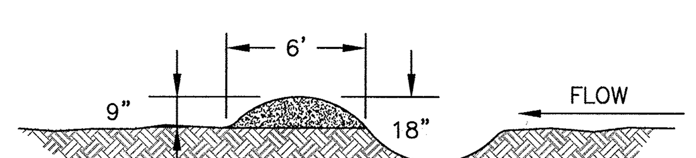
1. SB = SEDIMENT BASIN
2. CLASS = NCDOT CLASS RIP RAP
3. * = FOR EACH BARREL. SEE SEDIMENT BASIN SCHEDULE ON 01C–12.
4. CLASS A RIP RAP MIDRANGE = 4"
5. CLASS B RIP RAP MIDRANGE = 8"
6. CLASS 1 RIP RAP MIDRANGE = 10"
7. CLASS 2 RIP RAP MIDRANGE = 14"



NOTE:
MINIMUM H=2/3 PIPE DIAMETER

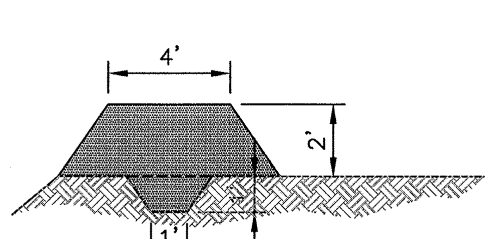
RIPRAP APRON AT PIPE OUTFALLS (5)

NTS



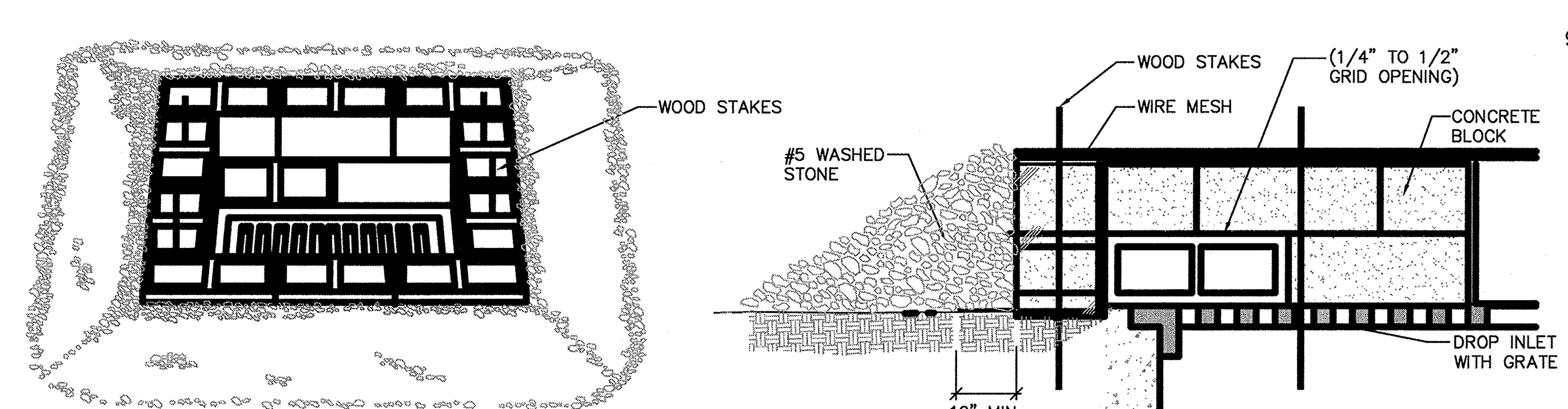
DIVERSION SWALE (6)

N.T.S.



DIVERSION DIKE (8)

N.T.S.



SPECIFIC APPLICATION: THIS METHOD OF INLET PROTECTION IS APPLICABLE WHERE HEAVY FLOWS ARE EXPECTED AND WHERE OVERFLOW CAPACITY IS NECESSARY TO PREVENT EXCESSIVE PONDING AROUND THE STRUCTURE

BLOCK AND GRAVEL STONE INLET SEDIMENT FILTER (7)

NOT TO SCALE

HDR Engineering, Inc.
of the Carolinas

440 S. Church St. Suite 1000
Charlotte, NC 28202-2075
704.338.6700
N.C.B.E.L.S. License Number F-0116

ISSUE	DATE	DESCRIPTION
C	03/2015	REVISED RIPRAP APRON SCHEDULE
B	12/31/14	REVISED PER NCDENR COMMENTS
A	11/2014	ISSUED FOR APPROVAL

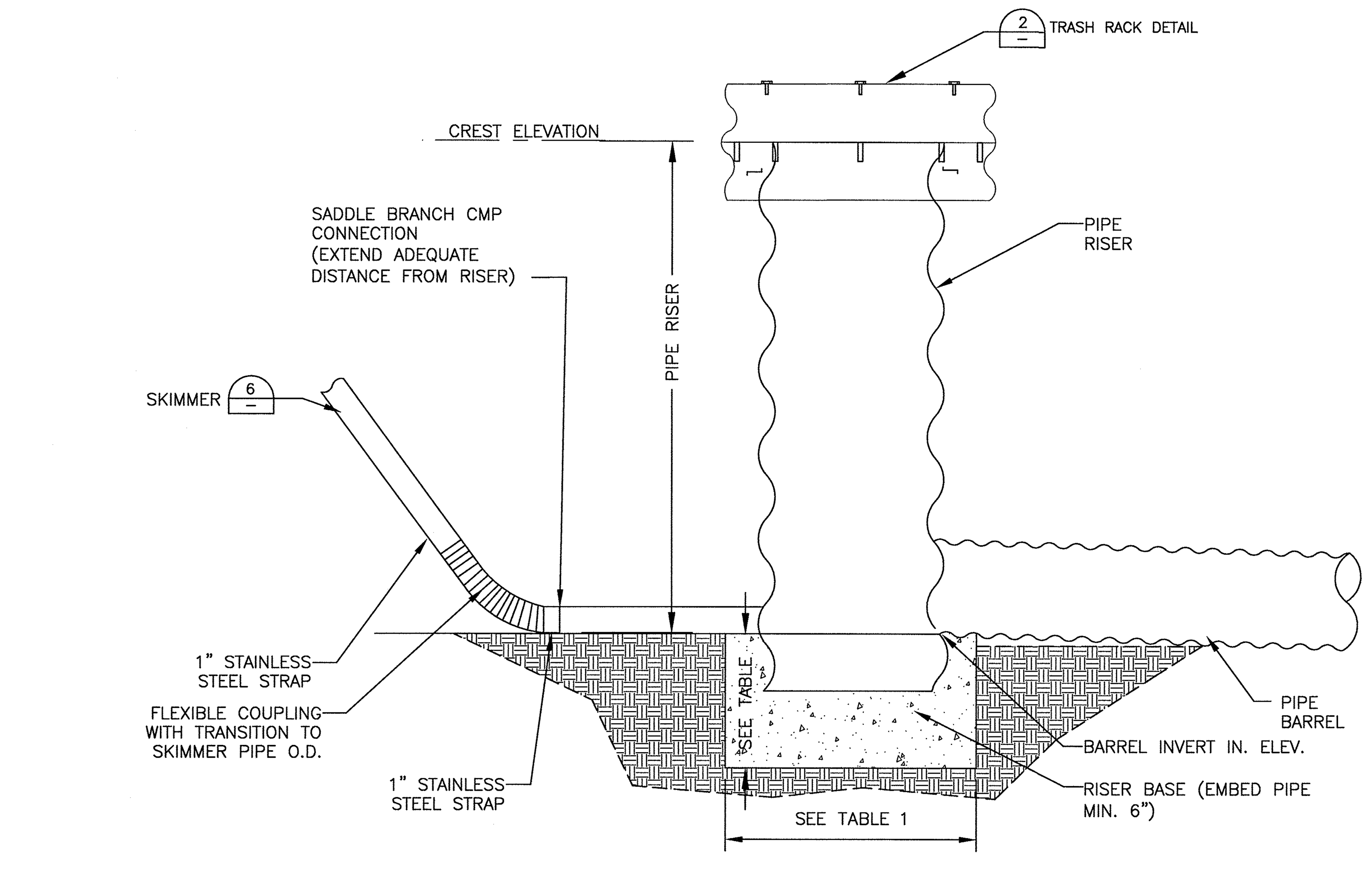
PROJECT MANAGER	M.D. PLUMMER, P.E.
DESIGNED BY	R. BAYSDEN, P.E.
DRAWN BY	R. BAYSDEN, P.E.
CHECKED BY	J. READLING, P.E.
PROJECT NUMBER	453925–235691–018

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 025495 MICHAEL D. PLUMMER

COLON MINE SITE STRUCTURAL FILL
SANFORD, NC

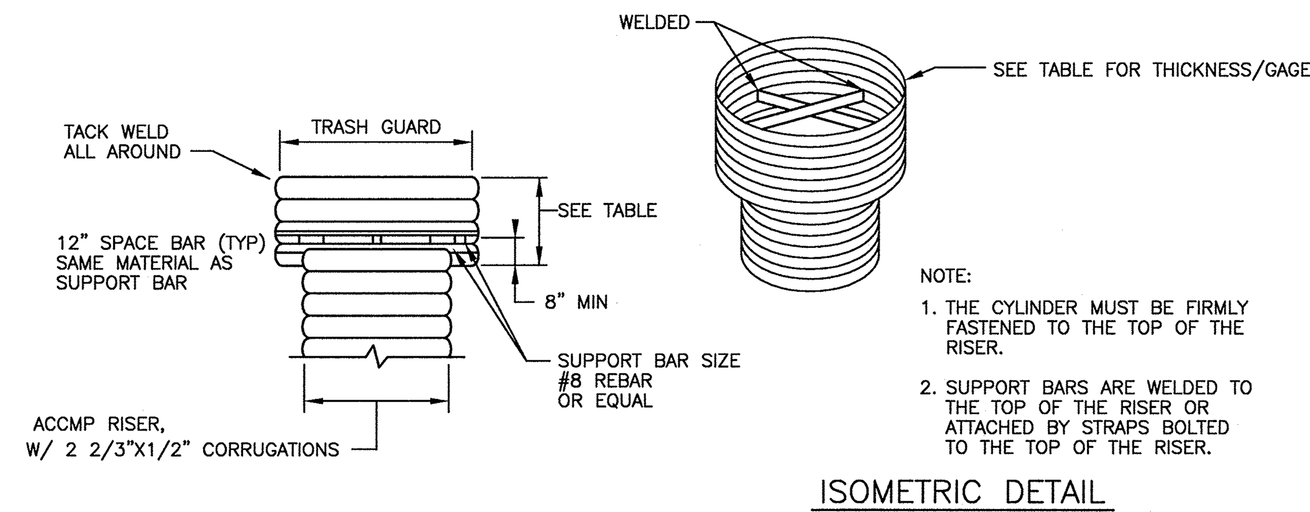
EROSION AND SEDIMENTATION CONTROL DETAILS (1 OF 3)

FILENAME 01C–11.dwg
SCALE AS SHOWN
SHEET 01C-11



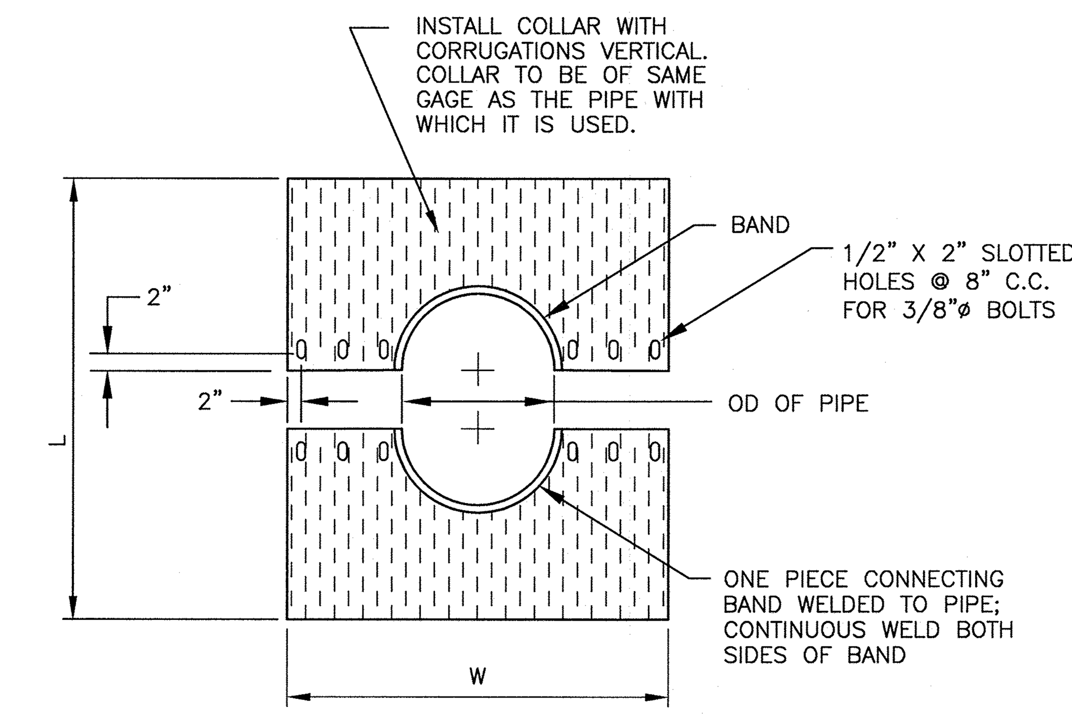
OUTLET STRUCTURE ENLARGEMENT

N.T.S.



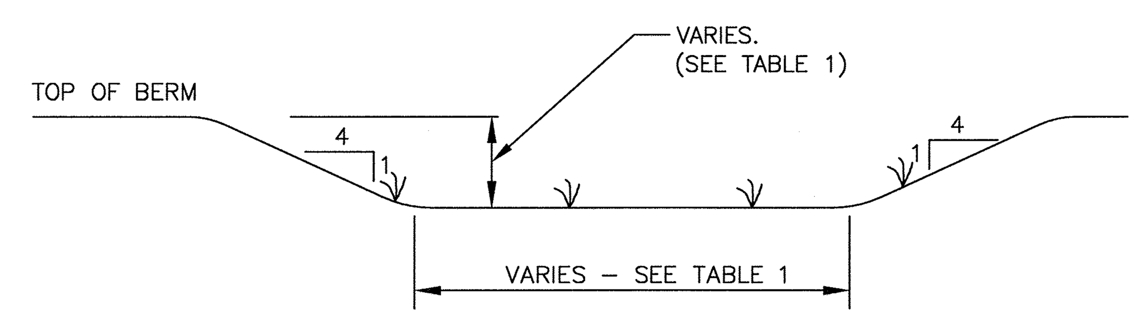
TRASH RACK DETAIL

N.T.S.



ANTI-SEEP COLLAR DETAIL

N.T.S.

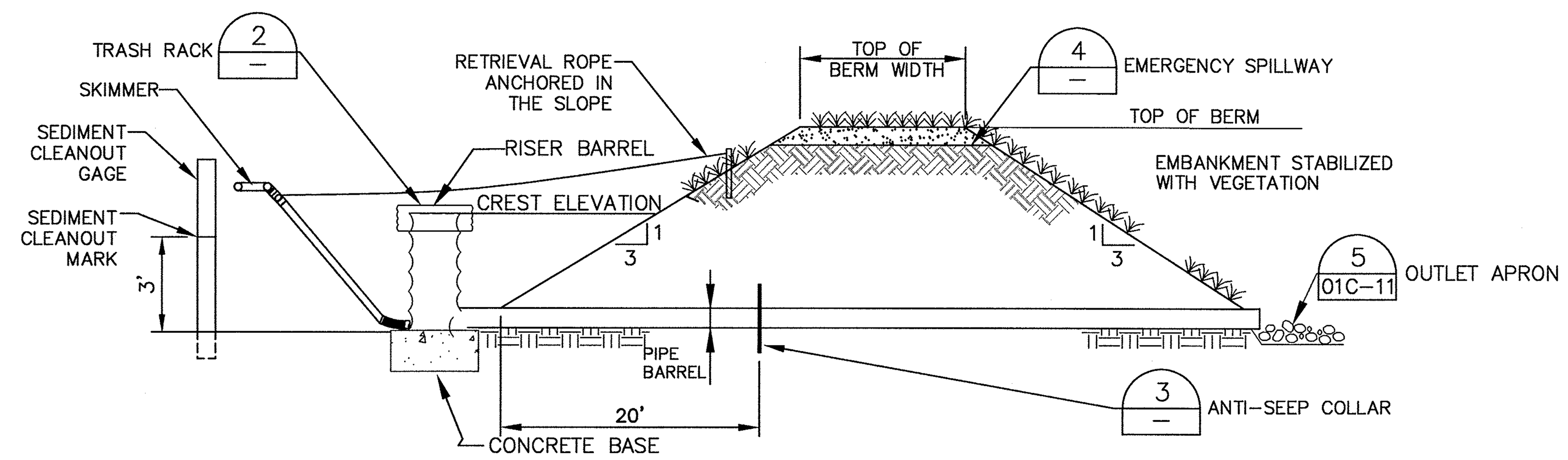


NOTES:

1. EMERGENCY SPILLWAY IS GRASS LINED.

EMERGENCY SPILLWAY TYPICAL

N.T.S.



Sediment Basin #	Useful Life (Phase)	Bottom Elevation (MSL)	Top of Berm Elevation (MSL)	Top of Berm Width (FT)	Emergency Spillway Elevation (MSL)	Emergency Spillway Width (FT)	Number of Riser/Barrel /Skimmer Assemblies	Riser Diameter (IN)	Riser Crest Elevation (MSL)	Trash Guard Diameter (IN)	Trash Guard Thickness (Gage)	Trash Guard Height (IN)	Concrete Ballast Dimensions (FT)	Barrel Diameter (IN)	Barrel Invert In (MSL)	Barrel Invert Out (MSL)	Antiseep Collar Size (FT)	Skimmer Size (IN)	Skimmer Orifice (IN)	Dewatering Time (days)
1	1 & 2	283.0	290.5	3	290.0	20	1	54	289.4	78	16	25	6x6x2	18	283.0	282.5	3x3	4	2.7	5
2	1 & 2	259.0	266.0	6	265.0	15	2	60	264.2	90	14	29	6x6x2	24	259.0	258.5	4x4	4	3.1	5
3	1	244.0	250.0	12	249.0	10	1	24	248.4	36	16	13	3x3x1	12	244.0	243.5	2x2	2.5	2	5
4	1	261.0	267.6	12	267.0	20	1	24	266.3	36	16	13	3x3x2	12	261.0	260.5	2x2	4	3.7	5
5	1 & 2	255.0	262.0	12	261.0	20	2	48	260.3	72	16	21	5x5x2	24	255.0	253.8	4x4	6	5.1	5
6	1	249.0	256.0	12	255.1	10	1	18	254.0	27	16	8	2.5x2.5x1	12	249.0	248.5	2x2	5	4	5
7	1 & 2	238.0	245.5	12	244.9	20	2	60	244.4	90	14	29	6x6x2.5	24	238.0	237.5	4x4	4	3.5	5
8	1	273.0	279.0	12	278.3	10	1	18	277.5	27	16	8	2.5x2.5x1	12	273.0	272.0	2x2	4	3.2	5
9	1 & 2	262.0	270.5	3	269.5	50	2	72	268.7	102	14	36	7x7x3	42	262.0	260.8	7x7	5	4.6	5

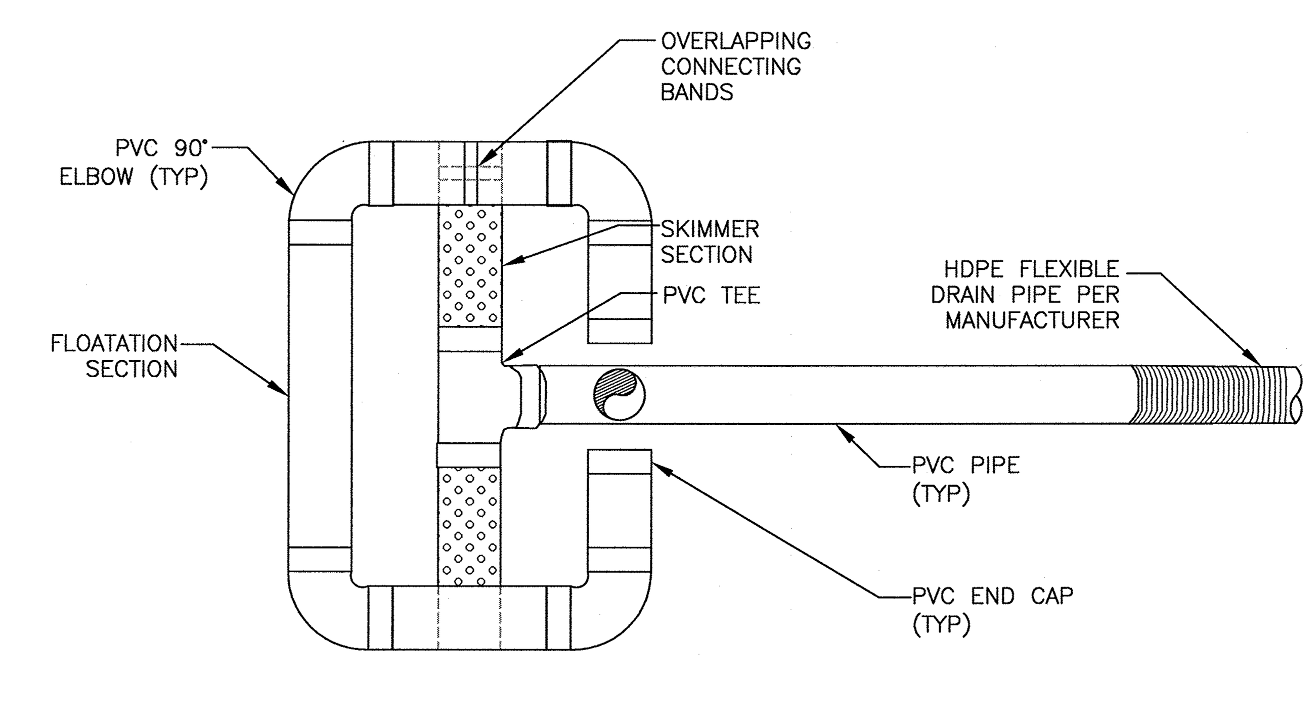
NOTES:
1. MSL = MEAN SEA LEVEL
2. ALL PIPES ARE ASPHALT COATED 16GA OR HEAVIER EXCEPT FOR SKIMMER

SEDIMENT BASIN SCHEDULE DETAIL

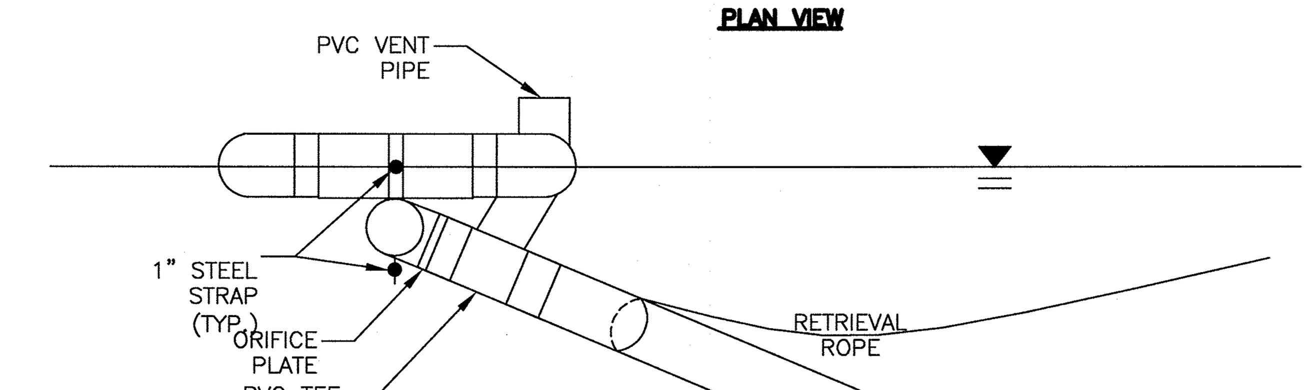
N.T.S.

MAINTENANCE AND INSPECTION

1. INSPECT SEDIMENT BASINS AT LEAST WEEKLY AND AFTER EACH SIGNIFICANT (1/2 INCH OR GREATER) RAINFALL EVENT AND REPAIR IMMEDIATELY.
2. REMOVE SEDIMENT AND RESTORE THE BASIN TO ITS ORIGINAL DIMENSIONS WHEN IT ACCUMULATES TO ONE–HALF THE DESIGN DEPTH. PLACED REMOVED SEDIMENT IN AN AREA WITH SEDIMENT CONTROLS
3. CHECK EMBANKMENT, SPILLWAYS, AND OUTLET FOR EROSION DAMAGE, AND INSPECT THE EMBANKMENT FOR PIPING AND SETTLEMENT. MAKE ALL NECESSARY REPAIRS IMMEDIATELY. REMOVE ALL TRASH AND OTHER DEBRIS FROM THE RISER AND POOL AREA.
4. ALL CMP SHALL BE FULLY ASPHALT COATED, 16 GA. OR HEAVIER
5. POND DIMENSIONS SHOWN ARE FOR THE CONTROLLING PHASE.



PLAN VIEW



NOTES:
1. ALL PVC PIPES ARE TO BE SCHEDULE 40 UNLESS OTHERWISE NOTED.
2. ALL JOINTS OF THE FLOATATION SECTION SHALL BE SOLVENT WELDED. JOINTS OF SKIMMER SECTION NEED NOT BE WATER–TIGHT.
3. HDPE FLEXIBLE DRAIN PIPE IS TO BE ATTACHED TO THE PIPE BARREL STRUCTURE WITH WATER–TIGHT CONNECTIONS.
4. SEE SCHEDULE FOR ORIFICE SIZE.
5. FAIRCLOTH TYPE OR EQUIVALENT SKIMMER TO BE USED.

SIDE VIEW

FAIRCLOTH SKIMMER DETAIL

N.T.S.

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N.C.B.E.L.S. License Number F-0116

ISSUE	DATE	DESCRIPTION
C	03/2015	REVISED SEDIMENT BASIN SCHEDULE
B	12/31/14	REVISED PER NCDENR COMMENTS
A	11/2014	ISSUED FOR APPROVAL

PROJECT MANAGER	M.D. PLUMMER, P.E.
DESIGNED BY	R. BAYSDEN, P.E.
DRAWN BY	R. BAYSDEN, P.E.
CHECKED BY	J. READLING, P.E.
PROJECT NUMBER	453925–235691–018

NORTH CAROLINA PROFESSIONAL SEAL 025495 ENGINEER MICHAEL D. PLUMMER

COLON MINE SITE STRUCTURAL FILL
SANFORD, NC

EROSION AND SEDIMENTATION CONTROL DETAILS (2 OF 3)

0 1" 2"

FILENAME 01C–12.dwg

SCALE AS SHOWN

SHEET 01C-12