Permit No.	Scan Date	DIN
Duke-Dan River	**August 31, 2015**	**24917**

CONSTRUCTION PLAN APPLICATION

DAN RIVER LANDFILL

DAN RIVER STEAM STATION

EDEN, NORTH CAROLINA

Amec Foster Wheeler Project No. 7810140065

August 26, 2015

Volume 1

Solid Waste Rules Cross-Reference Tables
Engineering and Facility Plan
Figures
Appendices I through VI

Volume 2

Engineering and Facility Plan Drawings
Operations Plan
Dust Control Plan
Sequencing Drawings
Closure and Post-Closure Plan
Construction Quality Assurance Plan
Technical Specifications

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AUG 27 2015

SOLID WASTE SECTION
ASHEVILLE REGIONAL OFFICE

3195 Pine Hall Road
Belews Creek, NC 27009

336-215-4576

August 26, 2015

North Carolina Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
2090 U.S. Highway 70
Swannanoa, North Carolina 28778

Attn: Mr. Larry Frost

Re: Industrial Landfill Permit to Construct Application Submittal
Permit No.: TBD
Dan River Steam Station
Rockingham County
Eden, North Carolina 27009

Dear Mr.Frost,

Attached you will find the Permit to Construct (PTC) Application for the Duke Energy Dan River Steam Station Landfill prepared by Amec Foster Wheeler under the direction of Duke Energy. The PTC Application consists of the Water Quality Monitoring Plan (WQMP), and the Construction Plan Application (CPA) which is submitted as two volumes and provides details on landfill design, operations, closure, and post-closure elements.

The PTC application is being submitted to fulfill the requirements of Title 15A Subchapter 13B of the North Carolina Administrative Code (NCAC) to meet the requirements of Section .0500 for industrial landfills and substantive requirements of Section .1600 for municipal solid waste (MSW) landfills for compliance with Senate Bill 729. Duke Energy requests a 5-Year Solid Waste permit for the Dan River Landfill facility.

Respectfully submitted,

Kimberlee Hutchinson

Kimberlee Hutchinson, PE
Environmental Services

Attachments: (2) CPA Hard Copy (Volumes 1 and 2)
(2) CPA Electronic Copy
(2) WQMP Hard Copy
(2) WQMP Electronic Copy

August 26, 2015

Duke Energy
526 South Church Street
Charlotte, North Carolina 28202

Attention: Ms. Kimberlee Hutchinson, P.E.

Subject: Construction Plan Application and Water Quality Monitoring Plan Proposed Dan River Landfill
Duke Energy – Dan River Steam Station
Eden, North Carolina
Amec Foster Wheeler Project No. 7810140065

Dear Ms. Hutchinson:

Amec Foster Wheeler is pleased to provide this Construction Plan Application and Water Quality Monitoring Plan to Duke Energy (Duke) for the proposed Dan River Landfill at Duke's Dan River Steam Station.

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The Construction Plan Application and Water Quality Monitoring Plan are being submitted in parallel with on-going activities including collection of monthly water level collection. The additional information including the estimated seasonal high groundwater table will be provided as a revision to these reports at a later date.

Amec Foster Wheeler appreciates the opportunity to provide these reports to Duke. Please contact us at your convenience with questions.

Sincerely,

Amec Foster Wheeler

NORTH CAROLINA PROFESSIONAL SEAL 038320 ENGINEER CEDRIC H. RUHL

NORTH CAROLINA LICENSED SEAL 2203 GEOLOGIST COURTNEY WITHERS MURPHY

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Table 1 - Siting and Design Requirements for Disposal Sites
Dan River Landfill
Duke Energy - Dan River Steam Station

Section	Description	Location	Comments
.0503 Siting and Design Requirements for Disposal Sites			
(2)	A site shall meet the following design requirements:		
(a)	The concentration of explosive gases generated by the site shall not exceed:		
(i)	twenty-five percent of the limit for the gases in site structures (excluding gas control or recovery system components); and	N/A	Not Applicable (N/A) for ash landfill
(ii)	the lower explosive limit for the gases at the property boundary;	N/A	N/A for ash landfill
(b)	A site shall not allow uncontrolled public access so as to expose the public to potential health and safety hazards at the disposal site;	•Operations Plan - Section 1.4	
(c)	A site shall meet the following surface water requirements:		
(i)	A site shall not cause a discharge of pollutants into waters of the state that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES), under Section 402 of the Clean Water Act, as amended, or that is in violation of standards promulgated under G.S. 143-214.1 and G.S. 143-215;	•Operations Plan - Section 2.4.1	
(ii)	A site shall not cause a discharge of dredged material or fill material into waters of the state that is in violation of the requirements under Section 404 of the Clean Water Act, as amended, or that is in violation of any state requirements regulating the discharge of dredged or fill material into waters of the state, including wetlands; and	•Operations Plan - Section 2.4.1	
(iii)	A site shall not cause non-point source pollution of waters of the state that violates assigned water quality standards.	•Operations Plan - Section 2.4.1	

Table 1 - Siting and Design Requirements for Disposal Sites
Dan River Landfill
Duke Energy - Dan River Steam Station

Section	Description	Location	Comments
.0503 Siting and Design Requirements for Disposal Sites			
(d)	A site shall meet the following ground water requirements:		
(i)	A site, except for land clearing and inert debris landfills subject to Rule .0564(8)(e) of this Section, shall be designed so that the bottom elevation of solid waste will be a minimum of four feet above the seasonal high water table;	•Engineering and Facility Plan - Section 3.2.2 •Drawings C-3.3, C-4.3, C-5.3	
(ii)	Operators of new industrial solid waste landfills, lateral expansions of existing industrial solid waste landfills, and industrial solid waste landfills receiving solid waste on or after January 1, 1998 shall submit to the Division a design which satisfies one of the following criteria:		
(A)	a design that will ensure that the ground water standards established under 15A NCAC 2L will not be exceeded in the uppermost aquifer at the compliance boundary established by the Division in accordance with 15A NCAC 2L. The design shall be based upon modeling methods acceptable to the Division, which shall include, at a minimum, the following factors: (I) the hydrogeologic characteristics of the facility and surrounding lands; (II) the climatic factors of the area; and (III) the volume and physical and chemical characteristics of the leachate; or	N/A	Section 0.503(2)(d)(ii)(B) chosen for design criteria.
(B)	a design with a leachate collection system, a closure cap system, and a composite liner system consisting of two components; the upper component shall consist of a minimum 30-mil flexible membrane and (FML), the lower components shall consist of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 1x10-7 cm/sec. FML components consisting of high density polyethylene (HDPE) shall be at least 60-mil thick. The FML component shall be installed in direct and uniform contact with the compacted soil component.	•Engineering and Facility Plan - Section 3.3.3	
(iii)	The Division reserves the right to require an applicant to submit a liner design if the groundwater protection demonstration in sub-item (ii) of this paragraph is not satisfactory.	N/A	Proposed landfill liner system is anticipated to be acceptable
(iv)	Industrial solid waste landfills shall comply with ground water standards established under 15A NCAC 2L at the compliance boundary.	•Operations Plan - Section 2.6	

Table 1 - Siting and Design Requirements for Disposal Sites
Dan River Landfill
Duke Energy - Dan River Steam Station

Section	Description	Location	Comments
.0503 Siting and Design Requirements for Disposal Sites			
(e)	A site shall not engage in open burning of solid waste;	•Operations Plan - Section 2.1.4	
(f)	A site, except a land clearing and inert debris landfill, shall meet the following buffer requirements:		
(i)	A 50-foot minimum buffer between all property lines and disposal areas;	•Site Suitability Study - Figure 5 •Engineering and Facility Plan - Drawing C-1.1	
(ii)	A 500-foot minimum buffer between private dwellings and wells and disposal areas; and	•Site Suitability Study •Engineering and Facility Plan - Drawing C-1.1	
(iii)	A 50-foot minimum buffer between streams and rivers and disposal areas; and	•Site Suitability Study •Engineering and Facility Plan - Drawing C-1.1	
(g)	Requirements of the Sedimentation Pollution Control Law (15A NCAC 4) shall be met.	•Engineering and Faciltiy Plan - Section 5.2 •Operations Plan - Section 3.0	

Table 2 - Application Requirements for Sanitary Landfills
Dan River Landfill
Duke Energy - Dan River Steam Station

Section	Description	Location	Comments
.0504 Application Requirements for Sanitary Landfills			
(2)	The following information shall be required for reviewing a construction plan application for a proposed sanitary landfill:		
(a)	A map showing existing features to include:		
(i)	existing topography of the site on a scale of at least 1 inch equals 200 feet with five foot contours;	•Engineering and Facility Plan - Drawing C-1.2	
(ii)	bench marks;	•Engineering and Facility Plan - Drawing C-1.2	
(iii)	springs;	•Engineering and Facility Plan - Drawing C-1.2	
(iv)	streams;	•Engineering and Facility Plan - Drawing C-1.2	
(v)	potential ground-water monitoring sites;	•Site Suitability Study - Figure 2	
(vi)	pertinent geological features; and	•Site Suitability Study	
(vii)	soil boring locations.	•Engineering and Facility Plan - Drawing C-1.2 •Hydrogeologic Study - Drawing 3	
(b)	A grading plan that provides:		
(i)	proposed excavated contours;	•Engineering and Facility Plan - Drawings C-3.1, C-4.1, C-5.1	
(ii)	soil boring locations;	•Engineering and Faciltiy Plan - Drawings C-1.1, 1.2, C-2.1 •Hydrogeologic Study - Drawing 3	
(iii)	locations and elevations of dikes or trenches;	•Engineering and Facility Plan - Drawings	
(iv)	designated buffer zones;	•Site Suitability Study •Engineering and Facility Plan - Drawings C-1.1, C-1.2	
(v)	diversion and controlled removal of surface water from the work areas; and	•Engineering and Facility Plan - Drawings	
(vi)	proposed utilities and structures.	•Engineering and Facility Plan - Drawings	
(c)	A construction plan that provides:		
(i)	engineering design for liners, leachate collections systems;	•Engineering Facility Plan - Sections III, IV, V, VI, Drawings	
(ii)	proposed final contours showing removal of surface water runoff; and	•Engineering Facility Plan - Drawing C-6.2	
(iii)	locations of slope drains or other drop structures.	•Engineering Facility Plan - Drawing C-6.2	
(d)	An erosion control plan that identifies the following:		
(i)	locations of temporary erosion control measures (sediment basins, stone filters, terraces, silt fences, etc.);	•In-Progress	NCDEMLR Approval prior to contstruction
(ii)	locations of permanent erosion control measures (rip-rap, energy dissipators, ditch stabilization, pipe drain, etc.); and	•In-Progress	NCDEMLR Approval prior to contstruction
(iii)	seeding specifications and schedules.	•In-Progress	NCDEMLR Approval prior to contstruction
(e)	Detailed diagrams showing typical sections of:		
(i)	dikes,	N/A	
(ii)	trenches,	•Engineering and Facility Plan - Drawing Details	
(iii)	diversions,	•Engineering and Facility Plan - Drawing Details	
(iv)	sediment basins, and	•Engineering and Facility Plan - Drawing Details	
(v)	other pertinent details.	•Engineering and Facility Plan - Drawing Details	

Table 2 - Application Requirements for Sanitary Landfills
Dan River Landfill
Duke Energy - Dan River Steam Station

Section	Description	Location	Comments
.0504 Application Requirements for Sanitary Landfills			
(f)	A minimum of two cross sections per operational area showing:		
(i)	original elevations,	•Engineering and Facility Plan - Drawing C-9.1	
(ii)	proposed excavated depths,	•Engineering and Facility Plan - Drawing C-9.1	
(iii)	proposed final elevations,	•Engineering and Facility Plan - Drawing C-9.1	
(iv)	ground-water elevation, and	•Engineering and Facility Plan - Drawing C-9.1	
(v)	soil borings.	•Engineering and Facility Plan - Drawing C-9.1	
(g)	Site development showing phases or progression of operation.	•Engineering and Facility Plan - Drawing C-3.1 through 6.1	
(h)	A written report that contains the following:		
(i)	A copy of the deed or other legal description of the landfill site that would be sufficient as a description in an instrument of conveyance and property owner's name;	•Engineering and Facility Plan - Appendix I	
(ii)	Name of individual responsible for operation and maintenance of the site;	•Operations Plan - Section 1.2	
(iii)	Projected use of land after completion of the sanitary landfill;	•Closure and Post-Closure Plan - Section 3.4 •Engineering and Facility - Section 3.3.9	
(iv)	Anticipated lifetime of the project;	•Engineering and Facility Plan - Section 7.1, Appendix II •Operations Plan - Section 2.1.1	
(v)	Description of systematic usage of area, operation, orderly development and completion of the sanitary landfill;	•Engineering and Facility Plan •Operations Plan •Closure and Post-Closure Plan	
(vi)	Earthwork calculations;	•Engineering and Facility Plan - Section 7.1, Appendix II	
(vii)	Seeding specifications and schedules;	•In-Progress	NCDEMLR Approval prior to contstruction
(viii)	Calculations for temporary and permanent erosion control measures;	•Engineering and Faciltiy Plan - Section 5.2, Appendix VI	
(ix)	Any narrative necessary to describe compliance with the Sedimentation Pollution Control Act of 1973 (15A NCAC 4);	•Engineering and Facility Plan - Section 5	
(x)	A discussion of compliance with design requirements in Rule .0503(2) of this Section; and	N/A	Refer to Table 1 for list of requirements in Rule .0503 (2) and location within Engineering Documents
(xi)	Any other information pertinent to the proposed construction plan.	•Regulatory Cross Reference Tables •Engineering and Facility Plan •Technical Specifications •CQA Plan •Operations Plan Closure and Post-Closure Plan	

Table 3 - Operational Requirements for Sanitary Landfills
Dan River Landfill
Duke Energy - Dan River Steam Station

Section	Description	Location	Comments
.0505 Operational Requirements for Sanitary Landfills			
(1)	Plan and Permit Requirements		
(a)	Construction plans shall be approved and followed.	•Engineering and Faciltiy Plan - Section 6 •CQA Plan	
(b)	Specified monitoring and reporting requirements shall be met.	•Operations Plan - Section 6	
(2)	Spreading and Compacting Requirements		
(a)	Solid waste shall be restricted into the smallest area feasible.	•Operations Plan - Appendix I	
(b)	Solid waste shall be compacted as densely as practical into cells.	•Operations Plan - Section 2.1.7	
(3)	Cover Requirements		
(a)	Solid waste shall be covered after each day of operation, with a compacted layer of at least six inches of suitable cover or as specified by the Division.	•Operations Plan - Section 2.1.8.1 •Engineering and Facility Plan - Section 3.3.7	Ash landfill assumed to be covered with once per week during operations
(b)	Areas which will not have additional wastes placed on them for 12 months or more, but where final termination of disposal operations has not occurred, shall be covered with a minimum of one foot of intermediate cover.	•Operations Plan - Section 2.1.8.2 •Engineering and Facility Plan - Section 3.3.7	
(c)	After final termination of disposal operations at the site or a major part thereof, or upon revocation of a permit, the area shall be covered with at least two feet of suitable compacted earth.	•Operations Plan - Section 2.1.8.3 •Engineering and Faciltiy Plan - 3.3.8 •Closure and Post-Closure Plan - Section 2.1	
(4)	Erosion Control Requirements		
(a)	Adequate erosion control measures shall be practiced to prevent silt from leaving the site.	•Operations Plan - Section 3.0 •Engineering and Facility Plan - 5.2, Appendix VI	
(b)	Adequate erosion control measures shall be practiced to prevent excessive on-site erosion.	•Operations Plan - Section 3.0 •Engineering and Facility Plan - 5.2, Appendix VI	
(5)	Drainage Control Requirements		
(a)	Surface water shall be diverted from the operational area.	•Operations Plan - Section 2.4	
(b)	Surface water shall not be impounded over or in waste.	•Operations Plan - Section 2.4	
(c)	Completed areas shall be adequately sloped to allow surface water runoff in a controlled manner.	•Operations Plan - Section 2.4	
(6)	Vegetation Requirements		
(a)	Within six months after final termination of disposal operations at the site or a major part thereof or upon revocation of a permit, the area shall be stabilized with native grasses.	•Operations Plan - Section 4 •Closure and Post-Closure Plan - Section 2.6 •Engineering and Facility Plan - Section 3.3.8.1	
(b)	Temporary seeding will be utilized as necessary to stabilize the site.	•Operations Plan - Section 4.1	

Table 3 - Operational Requirements for Sanitary Landfills
Dan River Landfill
Duke Energy - Dan River Steam Station

Section	Description	Location	Comments
.0505 Operational Requirements for Sanitary Landfills			
(7)	Water Protection Requirements		
(a)	The separation distance of four feet between waste and water table shall be maintained unless otherwise specified by the Division in the permit.	•Engineering and faciltiy Plan - Section 3.2.2, Drawings C-5.3, 9.1	
(b)	Solid waste shall not be disposed of in water.	•Operations Plan - Section 2.1.6	
(c)	Leachate shall be contained on site or properly treated prior to discharge. An NPDES permit may be required prior to the discharge of leachate to surface waters.	•Operations Plan - Section 2.3 •Engineerign and Facility Plan - Section 4.3	
(8)	Access and Security Requirements		
(a)	The site shall be adequately secured by means of gates, chains, berms, fences, and other security measures approved by the Division, to prevent unauthorized entry.	•Operations Plan - Section 1.4	
(b)	An attendant shall be on duty at the site at all times while it is open for public use to ensure compliance with operational requirements.	N/A	The ash landfill will be located at a private facility to be used solely by Duke Energy
(c)	The access road to the site shall be of all-weather construction and maintained in good condition.	•Operations Plan - Section 1.4	
(d)	Dust control measures shall be implemented where necessary.	•Operations Plan - Section 2.1.3 •Engineering and Facility Plan - Section 5.1	
(9)	Sign Requirements		
(a)	Signs providing information on dumping procedures, the hours during which the site is open for public use, the permit number and other pertinent information shall be posted at the site entrance.	•Operations Plan - Section 1.6	Private Facility
(b)	Signs shall be posted stating that no hazardous or liquid waste can be received without written permission from the Division.	•Operations Plan - Section 1.6	
(c)	Traffic signs or markers shall be provided as necessary to promote an orderly traffic pattern to and from the discharge area and to maintain efficient operating conditions.	•Operations Plan - Section 1.6	

Table 3 - Operational Requirements for Sanitary Landfills
Dan River Landfill
Duke Energy - Dan River Steam Station

Section	Description	Location	Comments
.0505 Operational Requirements for Sanitary Landfills			
(10)	Safety Requirements		
(a)	Open burning of solid waste is prohibited.	•Operations Plan - Section 2.1.4	
(b)	Equipment shall be provided to control accidental fires or arrangements shall be made with the local fire protection agency to immediately provide fire-fighting services when needed.	•Operations Plan - Section 2.1.4	
(c)	Fires that occur at a sanitary landfill shall be reported to the Division within 24 hours and a written notification shall be submitted within 15 days.	•Operations Plan - Section 2.1.4	
(d)	The removal of solid waste from a sanitary landfill is prohibited unless the owner/operator approves and the removal is not performed on the working face.	•Operations Plan - Section 2.1.4	
(e)	Barrels and drums shall not be disposed of unless they are empty and perforated sufficiently to ensure that no liquid or hazardous waste is contained therein.	•Operations Plan - Section 2.1.4	

Table 3 - Operational Requirements for Sanitary Landfills
Dan River Landfill
Duke Energy - Dan River Steam Station

Section	Description	Location	Comments
.0505 Operational Requirements for Sanitary Landfills			
(11)	Waste Acceptance and Disposal Requirements		
(a)	A site shall only accept those solid wastes which it is permitted to receive. The landfill operator shall notify the Division within 24 hours of attempted disposal of any waste the landfill is not permitted to receive, including waste from outside the area the landfill is permitted to serve.	•Operations Plan - Section 2.1.2	
(b)	No hazardous or liquid waste shall be accepted or disposed of in a sanitary landfill.	•Operations Plan - Section 2.1.2	
(c)	Spoiled foods, animal carcasses, abattoir waste, hatchery waste, and other animal waste delivered to the disposal site shall be covered immediately.	N/A	
(d)	Asbestos waste that is packaged in accordance with 40 CFR 61, which is adopted by reference in accordance with G.S. 150B-14(c), may be disposed of separate and apart from other solid wastes at the bottom of the working face or in an area not contiguous with other disposal areas, in either case, in virgin soil. Separate areas shall be clearly marked so that asbestos is not exposed by future land- disturbing activities. The waste shall be covered immediately with soil in a manner that will not cause airborne conditions. Copies of 40 CFR 61 may be obtained and inspected at the Division.	•Engineering and Facility Plan - Section 1.2 •Operations Plan - Section 1.2	Asbestos waste will not be accepted at the Dan River Landfill
(e)	Wastewater treatment sludges may only be used as a soil conditioner and incorporated into the final two feet of cover. Sludges shall be examined for acceptance by Waste Determination procedures in Rule .0103(d) of this Subchapter.	•Operations Plan - Section 1.2	
(12)	Miscellaneous Requirements		
(a)	Effective vector control measures shall be applied to control flies, rodents, and other insects or vermin when necessary.	N/A	
(b)	Appropriate methods such as fencing and diking shall be provided within the area to confine solid waste subject to be blown by the wind. At the conclusion of each day of operation, all windblown material resulting from the operation shall be collected and returned to the area by the owner or operator.	N/A	

Engineering and Facility Plan

Dan River Landfill

Duke Energy – Dan River Steam Station

Eden, North Carolina

Amec Foster Wheeler Project No. 7810140065

NORTH CAROLINA PROFESSIONAL SEAL 038330 ENGINEER CEDRIC H. RUHL 8-26-15

To:	Duke Energy Carolinas, LLC
Date	August 26, 2015
From:	Amec Foster Wheeler

3195 Pine Hall Road
Belews Creek, NC 27009

336-215-4576

August 26, 2015

North Carolina Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
2090 U.S. Highway 70
Swannanoa, North Carolina 28778

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Environmental Services

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cc (letter only, via e-mail): Ed Mussler, NCDENR
Elizabeth Werner, NCDENR
Henry Taylor, Duke Energy
Ed Sullivan, Duke Energy
Cedric Ruhl, Amec Foster Wheeler

August 26, 2015

Duke Energy
526 South Church Street
Charlotte, North Carolina 28202

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Amec Foster Wheeler

NORTH CAROLINA PROFESSIONAL SEAL 036330 ENGINEER CEDRIC H. RUHL 8.26.15

NORTH CAROLINA LICENSED SEAL 2203 GEOLOGIST COURTNEY WITHERS MURPHY 08/26/15

Cedric H. Ruhl
Senior Engineer

Courtney Murphy
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1 Introduction

This Engineering and Facility Plan is being submitted as part of the Construction Plan Application and was prepared for the proposed Dan River Landfill in accordance with Title 15A Subchapter 13B of the North Carolina Administrative Code (NCAC) to meet the requirements of .0503(2), .0504(2), and .0505 for industrial landfills; and substantive requirements of the .1600 Rules for municipal solid waste (MSW) landfills. The proposed Dan River Landfill will be an industrial landfill and therefore some of the requirements of the .1600 Rules do not apply.

1.1 Project Description

Duke Energy intends to construct a landfill on Dan River Steam Station property to store existing coal combustion residuals (CCRs) currently located in four units on site. The units consist of the Primary Ash Basin, Secondary Ash Basin, and two unlined ash structural fills (Ash Fills 1 and 2). Electricity production from coal combustion ceased on April 1, 2012 and the coal-fired plant is currently undergoing decommissioning; therefore, no new CCRs are currently being generated at Dan River Steam Station. A combined cycle plant on station property currently produces electricity from natural gas.

The proposed landfill will be constructed to enable transfer of ash from existing on-site ash basins to a lined facility by August 1, 2019 as required by the North Carolina Coal Ash Management Act of 2014 (CAMA). Duke Energy also intends to remove some of the on-site ash by rail for disposal at the Maplewood Landfill in Jetersville, Virginia. Discussion of the rail haul is beyond the scope of this study other than describing impacts to required landfill capacity.

1.2 Site Description

The Dan River Steam Station is located at 900 South Edgewood Road in Eden, Rockingham County, North Carolina. The proposed landfill will be located largely within the footprint of existing Ash Fill 1 on the northeastern portion of the property. The general location of the proposed Dan River Landfill is shown on a topographic map on Figure 1 and aerial map on Figure 2.

The CCR material within Ash Fill 1 will be removed prior to construction of the proposed landfill. The proposed landfill will be bounded by existing overhead electrical lines to the west and north, rail lines to the east, and a natural gas pipeline to the south.

The proposed landfill footprint is currently vegetated with grass in the vicinity of Ash Fill 1 and wooded in areas north of Ash Fill 1. The majority of the site drains to an area between Ash Fills 1 and 2 which discharges into the Secondary Ash Basin and ultimately into the Dan River. A portion of the northern and eastern areas of the proposed landfill drains to an existing stream east of the station property which discharges into the Dan River.

2 Solid Waste Management Rules

The Dan River Landfill was designed in accordance with state and federal rules governing disposal of CCR material.

2.1 North Carolina Solid Waste Rules

The Dan River Landfill will store CCRs and is being permitted under the North Carolina rules governing industrial landfills commonly referred to as the .0500 rules. Consistency with the .0500 rules is documented in the Solid Waste Rules Cross-Reference Tables provided as part of the Construction Plan Application. The tables provide a brief description of the rule requirement and where it is addressed in the submittal documents. The submittal documents consist of the Construction Plan Application submitted on August 26, 2015 and the Site Suitability Study and the Hydrogeology Study which were submitted on July 15, 2015 as amended. See Section 9, “Pertinent Permit Application Documents”.

2.2 EPA CCR Rules

The Environmental Protection Agency (EPA) promulgated 40 CFR Parts 257 and 261 on April 17, 2015, commonly referred to as the EPA CCR rules. The EPA CCR rules regulate disposal of CCR materials as a Subtitle D (MSW) material and provides landfill design criteria, much of which is consistent with the

current North Carolina solid waste rules with several exceptions including liner system configuration and groundwater separation.

2.3 Liner System Configuration

North Carolina solid waste rule .1624(b)(1)(A)(i) through (iii) describes three prescribed liner system options to satisfy state requirements. The first liner system option incorporates a geomembrane and 24-inch thick compacted soil layer with a maximum permeability of $1x10^{-7}$ cm/s. The second liner system option incorporates a geomembrane, a geosynthetic clay liner, and 18-inch thick compacted soil layer with a maximum permeability of $1x10^{-5}$ cm/s. The third liner system option incorporates two geomembranes separated by a drainage layer and 12-inch thick compacted soil layer with a maximum permeability of $1x10^{-5}$ cm/s.

The proposed liner system configuration was developed to satisfy both North Carolina solid waste rules and EPA CCR rules regarding liner system configuration and will utilize two geomembrane liners to satisfy North Carolina solid waste rules .1624(b)(1)(A)(iii). The proposed Dan River Landfill liner system will satisfy EPA CCR rules for an alternative composite liner in accordance with Part 257.70(c). Specifically, a geosynthetic clay liner (GCL) will be selected that is equivalent to two feet of compacted soil with a maximum permeability of $1x10^{-7}$ cm/sec. A "Composite Liner Hydraulic Equivalency Calculation" demonstrating GCL equivalency is included in Appendix V.

The proposed liner system satisfying state and federal rules will consist of (from top to bottom):

- 24-inch thick protective cover;
- Geocomposite drainage layer (EPA and state rules);
- Primary 60-mil HDPE geomembrane (EPA and state rules);
- Geocomposite leak detection layer (state rules);
- Secondary 60-mil HDPE geomembrane (state rules);
- Geosynthetic clay liner (EPA rules); and
- 12-inch thick compacted soil liner with a maximum hydraulic conductivity of $1x10^{-5}$ cm/sec (state rules).

Based on the proposed liner system configuration, the landfill liner system subgrade with respect to the EPA CCR rules is the bottom of the GCL, while the liner system subgrade with respect to the North Carolina solid waste rules is the bottom of the compacted soil liner. Note that the EPA CCR rules provide guidelines for a liner system incorporating one geomembrane and do not address a double-liner system, which could be anticipated to allow less leakage than a single-liner system. The selected liner system provides three geosynthetic barrier components and a soil barrier component for a total of four barrier components between waste and groundwater.

2.4 Vertical Groundwater Separation

The proposed landfill base grades were developed to satisfy both North Carolina solid waste rules and EPA CCR rules regarding vertical groundwater separation. The proposed Dan River Landfill base grades will have a four-foot vertical separation from groundwater to satisfy North Carolina solid waste rules .1624(b)(4), and a five-foot vertical separation to satisfy EPA CCR rule Part 257.60(a). As previously described, the landfill liner subgrade with respect to the EPA CCR rules is the bottom of the GCL while the landfill liner subgrade with respect to the North Carolina solid waste rules is the bottom of the compacted soil liner.

Monthly water level collection is currently in progress (with first complete round collected in April 2015) to define the estimated long-term seasonal high groundwater table. The landfill grading plan may be either raised or lowered as appropriate to optimize separation from groundwater. A supplemental data package will be submitted to NCDENR at a later date demonstrating the estimated long-term seasonal high groundwater table and any resultant changes to the design.

3 Landfill Design

The landfill design elements are summarized in the following sections of this report. Additional design information is shown on the Drawings included with this Engineering and Facility Plan, and the Construction Quality Assurance (CQA) Plan and Technical Specifications submitted in the Construction Plan Application.

3.1 Site Development

The proposed landfill will have a limit of waste encompassing 23.3 acres. The proposed landfill will be located largely within the footprint of existing Ash Fill 1 on the northeastern end of the property. The CCR material within Ash Fill 1 will be removed prior to construction of the proposed landfill. The 23.3 acre landfill will be constructed in three cells. The northwestern portion of the CCR material within Ash Fill 1 will be strategically removed by rail to facilitate construction of Dan River Landfill Cell 1. Cell 1 construction (5.2 acres) will occur in parallel with removal of the northeastern portion of the CCR material, facilitating construction of Dan River Landfill Cell 2. Cell 2 construction (7.4 acres) will occur in parallel with removal of the remainder of ash by rail to facilitate construction of Dan River Landfill Cell 3 (10.8 acres). Successive applications for a Permit to Operate will be submitted upon completion of each cell of the landfill.

3.2 Subsurface Conditions

Subsurface conditions in the vicinity of the proposed Dan River Landfill generally consist of soil fill, CCR material (fill), alluvium, residuum, saprolite, partially weathered rock (PWR), weathered/fractured bedrock, and sound bedrock. Boring logs, well construction records, and detailed descriptions and analyses are described in the July 15, 2015 Hydrogeology Study as amended. Elements relevant to landfill design are summarized in the following sections of this report.

3.2.1 Bedrock

State rules require a minimum four feet of separation between bedrock and the liner system subgrade. The Dan River Landfill subgrade was designed to maintain the required minimum four feet of separation from bedrock. As previously described, the landfill subgrade with respect to North Carolina solid waste rules is the bottom of the compacted soil liner. As indicated on the Drawings, the separation from bedrock is at least four feet from the bottom of the compacted soil liner in accordance with state rules.

3.2.2 Groundwater

State rules require a minimum four feet of separation between the estimated long-term seasonal high groundwater and the liner system subgrade, while the EPA CCR rules require a minimum separation of five feet. As previously described, the landfill subgrade with respect to North Carolina solid waste rules is the bottom of the compacted soil liner while the landfill subgrade with respect to the EPA CCR rules is the bottom of the GCL. As indicated on the Drawings, the separation from estimated long-term seasonal high groundwater is at least four feet from the bottom of the compacted soil liner in accordance with state rules and at least five feet from the bottom of the GCL in accordance with the EPA CCR rules.

Monthly water level collection is currently in progress to define the estimated long-term seasonal high groundwater table and is expected to be completed in September, 2015. The landfill grading plan may be either raised or lowered as appropriate to optimize separation from groundwater. A supplemental data package will be submitted to NCDENR at a later date demonstrating the estimated long-term seasonal high groundwater table and any resultant changes to the design.

3.2.3 Foundation and Borrow Soils

Soils for landfill construction, operations, and closure will be generated during landfill construction and closure of ash units.

The proposed Dan River Landfill will be located largely within the footprint of existing Ash Fill 1 on the northeastern end of the property. The CCR material within Ash Fill 1 will be removed prior to construction of the proposed landfill. Two soil stockpiles on top of Ash Fill 1 and the cover soils over the CCR material

will be harvested and stockpiled for future re-use. Additional soil will be generated during excavation of residual material to landfill subgrade. These soil materials will be available for landfill construction including structural fill for perimeter roads and berms and compacted soil liner. Any soils that may have been in direct contact with CCR material will only be utilized within the limit of waste boundary above the base liner system and below the final cover system.

The proposed Dan River Landfill will be operated to contain CCR material generated during closure of the ash basins and Ash Fill 2. Ash Fill 2 cover soils over CCR material and excess ash basin embankment material will be stockpiled for future re-use. Because closure of the ash basins and Ash Fill 2 will occur at the same time as operations for the Dan River Landfill, these soil materials will be available for landfill operation and closure but not for construction subject to the limitations on material in direct contact with CCR material described above.

Compacted soil liner material will be generated from on-site sources and amended as needed to achieve permeability requirements. The protective cover material on top of the landfill liner system is anticipated to consist of CCR material.

A “Soil Life Cycle Calculation” is included in Appendix II and demonstrates that sufficient soils are on-site to construct, operate, and close the proposed Dan River Landfill. If required, additional soil may be obtained from on-site or off-site sources such as the property east of Dan River Steam Station that was recently purchased by Duke Energy. Geotechnical boring logs, well construction records, and laboratory test data are included in the Hydrogeology Study which was submitted on July 15, 2015 as amended.

3.3 Description of Landfill Components and Summary of Analyses

The main elements of the proposed Dan River Landfill are described in the following sections of this report. A summary of supporting engineering design analyses is presented in Section 7. Additional design detail is provided in the Drawings included with this Engineering and Facility Plan, and the Construction Quality Assurance (CQA) Plan and Technical Specifications submitted in the Construction Plan Application.

3.3.1 Perimeter Berms and Liner System Subgrade

The perimeter berms and liner system subgrade will be constructed using structural fill from on-site sources consisting of material stockpiled during closure of Ash Fill 1 and/or soil cut to landfill subgrade. The perimeter berm will encircle the landfill limit of waste and will include the perimeter road and stormwater channel systems. The perimeter berm was designed to have a minimum height of approximately five feet as measured from the floor of the landfill.

Perimeter berm slopes, including the landfill side slope to the floor of the landfill, will generally be constructed with maximum side slopes of 3 horizontal to 1 vertical (3H:1V). Exterior slopes around the perimeter of the landfill that tie-in to existing grades adjacent to sensitive areas such as wetlands, railroad tracks, or existing utilities will be constructed with side slopes of 2H:1V and stabilized with riprap.

Structural fill for the perimeter berm and liner system subgrade will be moisture conditioned and compacted as necessary to achieve the specified compaction criteria. The suitability of subgrade which consists of residual material (i.e. areas requiring cut to subgrade) will be evaluated by conducting a proof-roll. Areas of cut or fill to subgrade exhibiting rutting, pumping, or otherwise do not meet specifications will be undercut and replaced with compacted structural fill material or stabilized as directed by the Engineer.

Monthly water level collection is currently in progress to define the estimated long-term seasonal high groundwater table. The landfill grading plan may be either raised or lowered as appropriate to optimize separation from groundwater. A supplemental data package will be submitted to NCDENR at a later date demonstrating the estimated long-term seasonal high groundwater table and any resultant changes to the design.

3.3.2 Compacted Soil Liner

The compacted soil liner is the bottom of the liner system subgrade with respect to the North Carolina solid waste rules. The compacted soil liner will be constructed over areas of the landfill subgrade that

have been approved by the Engineer and will provide a relatively low-permeability (less than $1x10^{-5}$ cm/s) soil barrier to impede infiltration into the underlying soil materials. Compacted soil liner material will be generated from on-site soils and amended and/or moisture conditioned as necessary to achieve the specified permeability and compaction requirements.

3.3.3 Geosynthetic Liner System

The geosynthetic liner system consists of a double-liner system that provides three barrier geosynthetics as well as leak detection and leachate collection components. The geosynthetic liner system will be constructed over areas of the compacted soil liner system that have been approved by the Engineer. As previously described, the geosynthetic components of the proposed liner system were selected to satisfy state and federal rules and will consist of (from bottom to top):

- Geosynthetic clay liner;
- Secondary 60-mil HDPE geomembrane;
- Geocomposite leak detection layer;
- Primary 60-mil HDPE geomembrane; and
- Geocomposite leachate collection drainage layer.

The geosynthetic components of the liner system will be manufactured and installed in accordance with the Construction Quality Assurance (CQA) Plan and Technical Specifications submitted in the Construction Plan Application.

3.3.4 Protective Cover

The protective cover provides a buffer zone to protect the underlying geosynthetics during landfill operations. The protective cover material will be constructed to a depth of two feet over areas of the geosynthetic liner system that have been approved by the Engineer. Protective cover outside of the limit of waste footprint will be constructed using soil material. As a beneficial re-use, the protective cover material within the limit of waste footprint may consist of CCR material.

3.3.5 Leachate Collection and Removal System (LCRS)

It is anticipated that leachate generated at the Dan River Landfill will ultimately discharge to a publically owned treatment works (POTW) for treatment. Modifications to the Engineering and Facility Plan may be required pending discussions with the POTW which are currently in progress.

The leachate collection system is designed to pass the 50-year design storm and return head levels to less than one foot within 72 hours of exceeding one foot.

The leachate collection system includes a geosynthetic composite drainage layer, leachate collection pipes with clean-outs, and a protective cover layer designed to prevent physical clogging of the system. Leachate will be initially pumped from each of the three cells to the proposed on-site force main with dual containment and to the proposed storage tank facility area.

The storage tank facility area will provide temporary leachate storage in case of extenuating circumstances. It is anticipated that leachate will be pumped from the storage tank facility to a sanitary sewer force main along the northern edge of the landfill area for treatment by a POTW or alternative leachate treatment approach as approved by the Division. Leachate may be used as a dust suppressant only in areas that drain to the leachate collection system (i.e. active face of the landfill) in accordance with the Dust Control Plan.

3.3.5.1 Geocomposite Drainage Layer

The leachate collection system geocomposite will be installed between the primary geomembrane and the protective cover. The geocomposite will consist of an HDPE geonet core with geotextiles thermally bonded to each side. Laboratory testing will be performed prior to construction to demonstrate the geotextile's ability to pass water while retaining the protective cover material as required by the specifications and CQA Plan. The leachate collection system geocomposite will collect infiltration through the waste mass and convey the leachate to leachate collection lateral and header pipes.

The leak detection geocomposite will be installed between the primary and secondary geomembrane and will consist of a similar material as the leachate collection system geocomposite. The leak detection geocomposite will convey leakage through the primary geomembrane, if any, to leak detection lateral and header pipes.

3.3.5.2 Piping

Leachate collection and leak detection pipe networks will be installed to convey flow from the geocomposite to the leachate collection and leak detection sumps, respectively. The pipes will consist of SDR-17 HDPE perforated pipes. The pipes will be surrounded by drainage aggregate and a sand layer will be used as a filtration media between the drainage aggregate and the overlying material (protective cover or CCR). Cleanouts will be installed to allow periodic maintenance and cleaning.

3.3.5.3 Sumps and Force Mains

Sumps will be located at the low portion of Cell 1, Cell 2, and Cell 3 for a total of three sumps. Each sump will have leachate collection system and leak detection system components. The leak detection system sump will consist of an aggregate zone that will collect flows from the LDS header pipes. A pump and perforated sideslope riser system will convey flow from the sump through a flowmeter and into a force main manifold located near the pump control panels.

The leachate collection system sump will consist of an aggregate zone that will collect flow from the LCS header pipes. A sand layer will be used as a filtration media between the drainage aggregate and the overlying material (protective cover or waste). Each of two pumps (a low-flow pump and a high-flow pump) will be located in a perforated sideslope riser. The pump and riser system will convey flow from the sump through a flowmeter and into a force main manifold located near the pump control panels. The pump system has been designed such that the low-flow pump will convey flows for normal operating conditions and the high-flow pump will be utilized to pass excess flow following a storm event.

A manifold will be located near the pump control panels to combine the flows from the LCS high-flow pump, LCS low-flow pump, and LDS pump into one force main. A dual-contained force main will convey flow to the leachate storage tank facility. Based on the configuration of the sumps it is anticipated that each sump will have a dedicated force main line to the leachate storage tank facility.

3.3.5.4 Leachate Storage Tank Facility and Disposal

It is anticipated that leachate generated at the Dan River Landfill will ultimately discharge to a publically owned treatment works (POTW) for treatment. Modifications to the Engineering and Facility Plan may be required pending discussions with the POTW which are currently in progress.

A leachate storage tank facility utilizing dual-containment will be located near the northwestern corner of the landfill to provide temporary leachate storage in case of extenuating circumstances. It is anticipated that leachate will be pumped from the storage tank facility to a sanitary sewer force main along the northern edge of the landfill area for treatment by a POTW or alternative leachate treatment approach as approved by the Division. Leachate may be used as a dust suppressant only in areas that drain to the leachate collection system (i.e. active face of the landfill) in accordance with the Dust Control Plan.

3.3.6 Stormwater Run-Off and Conveyance

The stormwater run-off conveyance system was designed to pass the 50-year, 24-hour design storm. Non-contact water is water that has not contacted waste material and can be handled as stormwater. Contact water is water that has contacted waste and will be treated as leachate.

3.3.6.1 Non-Contact Water

The non-contact water collection and conveyance system will generally consist of:

- Tack-on benches;
- Downdrains;
- Channels; and
- Ancillary drop inlets and culverts.

During operations, interim cover will be placed on exterior side slopes. During operations, tack-on benches will be installed at a two percent slope along the interim cover to interrupt the slope and prevent erosion. The tack-on benches will discharge into downdrains that will convey the flows to channels located around the perimeter of the landfill. The tack-on benches and downdrains will be extended as operations progress. A similar tack-on bench and downdrain system will be installed as part of landfill closure.

Perimeter channels will be lined with concrete to provide hydraulic capacity and prevent erosion. The perimeter channels will convey flow from the downdrains and ancillary run-on to a drop inlet that will be located at the southern corner of the landfill perimeter. The drop inlet and culvert system will convey stormwater flows to the dredge area between existing Ash Fills 1 and 2. An existing drop inlet and culvert is located in the dredge area between existing Ash Fills 1 and 2. During ash basin decommissioning the culvert will discharge into the ash basin or as required by state and federal permits. Following completion of ash removal activities at Dan River Steam Station, the culvert will discharge across the abandoned ash basin footprint and ultimately will discharge into the Dan River.

3.3.6.2 Contact Water

Chimney drains will be used during landfill operations to convey contact water at the active face of the landfill to the leachate collection system. The chimney drains will consist of vertical perforated HDPE pipes with an aggregate drainage zone and sand filtration zone. Chimney drains will be located adjacent to LCS pipes to facilitate transfer of contact water into the leachate collection system. Obsolete chimney drains will be abandoned by capping the top of the chimney drain as landfilling progresses.

Ash will be excavated from existing on-site CCR units and placed in the landfill, during which time trucks will enter and exit the landfill and ash units. No truck washes are proposed at this time because the haul paths and ash units drain to the existing ash basin. Upon completion of disposal of on-site CCR materials, the haul roads will be remediated by removing the top several inches of road material or as necessary and disposing in a lined facility permitted to receive CCR materials.

3.3.7 Operational Cover / Interim Cover

The Dan River Landfill will be operated in a manner to prevent fugitive dust as described in the Dust Control Plan. In addition to operational soil cover, dust control methods for the landfill include watering, establishing vegetative cover, mulching, structural controls, spray applied dust suppressants, calcium chloride, soil stabilizers, modifying the active working area, and modifying operations.

An interim cover soil layer with an approximate thickness of 12-inches will be installed on areas that are exposed for more than 12 months or where final waste grades have been achieved, such as exterior side slopes. The interim cover soil layer will be seeded in accordance with the Operations Plan. The vegetation on the interim cover layer will be removed prior to cover system construction and the remaining interim cover material will be the subgrade for the cover system geosynthetics.

3.3.8 Final Cover System

The final cover system will generally be constructed at side slopes of 3H:1V and a top deck area with a slope of 8 percent. The proposed cover system will consist of the following components, from top to bottom:

- 6-inch thick vegetative soil cover;
- 18-inch thick final cover soil;
- Geocomposite drainage layer (or 8 oz/sy non-woven geotextile alternate); and
- 40-mil thick double-sided textured linear low density polyethylene (LLDPE) geomembrane (or 50-mil LLDPE structured geomembrane alternate).

Additional details are described in the Closure and Post-Closure Plan.

3.3.8.1 Vegetative Soil Cover

The vegetative soil layer will consist of 6 inches of uncompacted soil materials capable of sustaining vegetation, which will preserve the integrity of the cover system by preventing erosion.

3.3.8.2 Final Cover Soil

The final cover soil layer will consist of 18 inches of compacted soil materials. The final cover soil layer will protect the geosynthetic components of the cover system and reduce infiltration.

3.3.8.3 Geocomposite Drainage Layer

A geocomposite drainage layer will be located beneath the final cover soil layer. The geocomposite will promote veneer stability and reduce infiltration through the closed landfill by conveying infiltration to regularly spaced geocomposite outlets.

The alternate cover system option includes an 8 oz/sy non-woven geotextile which will provide soil separation and allow infiltration into the underlying 50-mil LLDPE structured geomembrane.

3.3.8.4 Geomembrane

A 40-mil thick double-sided textured LLDPE geomembrane barrier will be installed between the geocomposite drainage layer and the interim cover to prevent infiltration through the closed landfill. The geomembrane will have texturing on both sides to improve veneer stability.

The alternate cover system option includes a 50-mil LLDPE structured geomembrane to prevent infiltration through the closed landfill. The structured component allows drainage and is an integral component of the geomembrane.

3.3.9 Post-Closure

The Closure and Post-Closure Plan outlines the monitoring and maintenance activities intended to maintain cover system integrity during the post-closure care period. Consistent with the requirements of MSW landfill rules, the proposed post-closure period is 30 years. During the post-closure period, the landfill cover system and related facilities must be monitored and maintained.

The Dan River Landfill will be vegetated following closure. Site access to the public will remain restricted through landfill closure and the post-closure care period. There are no current anticipated post-closure uses for the proposed Dan River Landfill. Duke Energy will obtain approval from NCDENR if a proposed post-closure use is identified.

4 Leachate Management

Leachate is water that has percolated through waste material and has the potential to leach contaminants from the waste. Leachate is generally produced when precipitation infiltrates through waste. Contact water is surface water that has contacted waste. Contact water will be managed as leachate.

The quantity of leachate will be managed in accordance with the Operations Plan and Dust Control Plan by maintaining a limited active face during waste placement, application of dust suppressant measures, and placement of interim soil cover on exterior side slopes.

Contact water generated during landfill operations will discharge to chimney drains and into the leachate collection system. Contact water and leachate will be conveyed to a storage tank facility via leachate collection pipes, pumps, and a leachate force main.

It is anticipated that leachate generated at the Dan River Landfill will ultimately discharge to a publically owned treatment works (POTW) for treatment. Modifications to the Engineering and Facility Plan may be required pending discussions with the POTW which are currently in progress, or alternative leachate treatment approach as approved by the Division. Leachate may be used as a dust suppressant only in areas that drain to the leachate collection system (i.e. active face of the landfill) in accordance with the Dust Control Plan.

4.1 Leachate Generation

Anticipated leachate generation rates were estimated as shown in the "Leachate Generation Calculation" in Appendix IV utilizing the Environmental Protection Agency's (EPA's) Hydrologic Evaluation of Landfill Performance (HELP) software. Average and peak leachate generation rates for both LCS and LDS systems were estimated for a theoretical 50-year timespan for the following conditions:

- Case 1 – 10 feet of ash without cover;
- Case 2 – 50 feet of ash without cover;
- Case 3 – 100 feet of ash without cover; and
- Case 4 – closed landfill.

Contact water generation rates for stormwater flows to chimney drains were estimated as shown in the "Leachate Collection Calculation" in Appendix IV. Contact water generation rates were estimated based on the 50-year, 24-hour design storm.

4.2 Leachate Migration

The leachate generation rates were utilized to design the leachate migration systems as shown in the "Leachate Collection Calculation" in Appendix IV and the "Liner System Geocomposite Calculation" in Appendix V. Vertical migration through the landfill liner system will be prevented by the following four barrier components:

- Primary geomembrane;
- Secondary geomembrane;
- Geosynthetic clay liner; and
- Compacted soil liner.

Vertical migration through the landfill liner system will be further prevented by maintaining a low driving head within the landfill cell. The LCS geocomposite drainage layer was designed to pass the leachate through the thickness of the geocomposite. A typical geocomposite thickness is 300 mil (3/10 inches), while the maximum allowable head on the liner system is 12 inches in accordance with the North Carolina solid waste rules. This indicates that the head on the liner system for typical conditions will be approximately 2.5 percent of the maximum allowed by state rules.

4.3 Leachate Discharge

Leachate will be pumped from the LCS and LDS sumps to a leachate storage tank facility via force mains. It is anticipated that leachate generated at the Dan River Landfill will ultimately discharge to a publically owned treatment works (POTW) for treatment. Modifications to the Engineering and Facility Plan may be required pending discussions with the POTW which are currently in progress, or alternative leachate treatment approach as approved by the Division. Leachate may be used as a dust suppressant only in areas that drain to the leachate collection system (i.e. active face of the landfill) in accordance with the Dust Control Plan.

4.4 Chimney Drains

Chimney drains will be used during landfill operations to convey contact water at the active face of the landfill to the leachate collection system. The chimney drains will consist of vertical perforated HDPE pipes with an aggregate drainage zone and sand filtration zone. Chimney drains will be located adjacent to LCS pipes to facilitate transfer of contact water into the leachate collection system. Obsolete chimney drains will be abandoned by capping the top of the chimney drain as landfilling progresses.

5 Environmental Controls and Management

Environmental controls and management will be implemented in accordance with the Operations Plan and Dust Control Plan.

5.1 Nuisance Controls

Litter, odors, and vectors are not anticipated to be concerns at the Dan River Landfill. The waste placed in the landfill does not attract vectors, and windblown material is not anticipated to be a problem. Odors are typically not a problem at CCR waste landfills.

Dust control is addressed in the Dust Control Plan. Generally, dust control measures will be implemented when necessary, and will include at a minimum, watering of dusty roads and exposed work areas. Other measures include physical measures such as fencing and/or berms, temporary covers (like tarps), spraying dust suppressants, and modifying the active work area. Leachate may be used as a dust suppressant in areas that drain to the leachate collection system (i.e. active face of the landfill) in accordance with the Dust Control Plan. Additionally, interim cover will be vegetated as soon as practical in order to minimize the blowing of dust on-site.

5.2 Erosion and Sedimentation Control

Erosion and sedimentation control (E&SC) during landfill operations will consist of monitoring and repairing E&SC stormwater conveyance features and surface erosions. Erosion and sediment control measures will be inspected every 7 days and within 24 hours of rainfall events 0.5 inches or greater.

Following landfill closure and stabilization of disturbed areas, the landfill will be periodically inspected in accordance with the Closure and Post-Closure Plan. Areas exhibiting erosion will be repaired and re-seeded as necessary.

5.2.1 Cover Drainage

Stormwater drainage will be managed during operations and following closure utilizing a series of tack-on benches and downdrains. The tack-on benches will be spaced at regular intervals along the slope of the landfill to maintain sheet flow along the face of the landfill and prevent erosion. The tack-on benches will discharge to a series of downdrains that will convey stormwater flow to the landfill perimeter channels.

5.2.2 Run-On Diversion and Run-Off Drainage

Stormwater run-on to the active face will be prevented by installing berms or other stormwater features to divert flow. Contact water generating areas within the landfill will be graded to drain towards chimney drains which discharge to the leachate collection system and prevent contact water run-off.

6 Construction

The proposed Dan River Landfill will be constructed as three cells. Construction will include installation of erosion and sediment control measures, cut and fill for perimeter features and landfill subgrade, placement of compacted soil liner, installation of geosynthetic liner system components, construction of leak detection and leachate collection systems, placement of protective cover, and construction of haul roads.

6.1 Sequence of Construction

The proposed landfill will be constructed as three cells. The anticipated sequence of construction is listed as follows:

- Selectively remove CCR's from Ash Fill 1 within the proposed Dan River Landfill Cell 1 construction footprint;
- Construct Dan River Landfill Cell 1 while selectively removing CCR's from Ash Fill 1 within the proposed Dan River Landfill Cell 2 construction footprint;
- Obtain Permit to Operate for Cell 1 and begin landfilling in Cell 1 while constructing Dan River Landfill Cell 2 and removing the remainder of CCR's from Ash Fill;
- Obtain Permit to Operate for Cell 2 and begin landfilling in Cells 1 and 2 while constructing Dan River Landfill Cell 3; and
- Obtain Permit to Operate for Cell 3.

6.2 Site Preparation

Prior to construction of each cell, CCR material will be removed from the portion of Ash Fill 1 within the cell construction footprint. Erosion and sedimentation control (E&SC) measures will be installed in accordance with the approved E&SC Plan prior to conducting land disturbing activities. Vegetation will be removed and topsoil will be stripped and stockpiled for future re-use prior to mass grading.

6.3 Construction Elements

The following sections of this report provide a brief description of landfill construction elements. The Construction Quality Assurance (CQA) Plan provides additional information regarding quality assurance and monitoring and testing programs to be implemented before, during, and after construction.

6.3.1 Perimeter Berms

A perimeter berm system requiring soil cut and fill activities will be located around the outer edges of the landfill facility. Fill material will consist of structural fill placed in accordance with the specifications and CQA Plan. The perimeter berms will include the following features (from limit of waste outwards):

- Limit of waste markers;
- Liner system anchor trench and limit of liner markers;
- Concrete perimeter stormwater channels;
- Aggregate haul road graded to drain to the perimeter stormwater channels; and
- Cut and fill tie-in slopes to existing grades.

6.3.2 Compacted Soil Liner Subgrade

Soil cut and fill activities will be required to achieve compacted soil liner subgrade. Fill material will consist of structural fill placed in accordance with the specifications and CQA Plan. The subgrade grading plan has been designed to achieve separation from bedrock and the anticipated estimated long-term seasonal high groundwater table. Monthly water level collection is currently in progress to define the estimated long-term seasonal high groundwater table. The landfill grading plan may be either raised or lowered as appropriate to optimize separation from groundwater. A supplemental data package will be submitted to NCDENR at a later date demonstrating the estimated long-term seasonal high groundwater table and any resultant changes to the design.

6.3.3 Compacted Soil Liner

The compacted soil liner will be placed after the Engineer's approval of compacted soil liner subgrade and will consist of a compacted soil fill placed to meet permeability requirements in accordance with the specifications and CQA Plan. The compacted soil liner will provide a low-permeability hydraulic barrier to the underlying compacted soil liner subgrade. Compacted soil liner material will be generated from on-site sources and amended as needed to achieve permeability requirements. The protective cover material on top of the landfill liner system is anticipated to consist of CCR material.

6.3.4 Geosynthetic Liner System

The geosynthetic liner system will be installed after the Engineer's approval of compacted soil liner placement and will consist of (from bottom to top):

- Geosynthetic clay liner;
- Secondary 60-mil HDPE geomembrane;
- Geocomposite leak detection layer;
- Primary 60-mil HDPE geomembrane; and
- Geocomposite drainage layer.

The geosynthetic components of the liner system will be manufactured and constructed in accordance with the Construction Quality Assurance (CQA) Plan and Technical Specifications submitted in the Construction Plan Application.

6.3.5 Protective Cover

The protective cover will be placed after the Engineer's approval of the geosynthetic liner system in accordance with the specifications and CQA Plan. Protective cover outside of the limit of waste footprint will be constructed using soil material. As a beneficial re-use, the protective cover material within the limit of waste footprint may consist of CCR material.

6.3.6 Leachate Collection and Removal System (LCRS)

The leachate collection and removal system will consist of leak detection and leachate collection components. Within the landfill floor area the leak detection system will consist of a geocomposite drainage layer and collection piping located between the primary and secondary geomembranes. Within the landfill floor area the leachate collection system will consist of a geocomposite drainage layer and collection piping located above the primary geomembrane. Leachate and leakage will be conveyed to sumps located at the low points of each cell.

Side slope risers located in the sump will contain pumps that will convey flow through a leachate force main to the leachate storage tank facility. It is anticipated that leachate will be pumped from the storage tank facility to a sanitary sewer force main along the northern edge of the landfill area for treatment by a POTW, or alternative leachate treatment approach as approved by the Division.

The leachate collection and removal system components will be constructed in accordance with the specifications and CQA Plan.

6.3.7 Potential Underdrain

The CCR material within Ash Fill 1 will be removed prior to landfill construction. During CCR removal it is possible that conditions will be encountered that justify installation of an underdrain system below the landfill. An underdrain, if required, will be designed for the conditions encountered and constructed prior to or during landfill construction. If an underdrain is installed, design details and record drawing information showing the underdrain location will be provided as part of the Construction Certification Report.

7 Design Analysis

This Dan River Landfill was designed in accordance with Title 15A Subchapter 13B of the NCAC to meet the requirements of .0503(2), .0504(2), and .0505 for industrial landfills; and substantive requirements of the .1600 Rules for municipal solid waste (MSW) landfills. The proposed Dan River Landfill is an industrial landfill and therefore some of the requirements of the .1600 Rules do not apply.

A summary description of the various design elements is presented in the following sections of this report. Detailed calculations are provided in the Appendices as follows:

- Appendix II - Calculations Addressing Landfill Capacity and Soil Quantity
- Appendix III - Calculations Addressing Stability
- Appendix IV - Calculations Addressing the Leachate Collection and Removal System
- Appendix V - Calculations Addressing Geosynthetics
- Appendix VI - Calculations Addressing Stormwater Management

It is anticipated that leachate will be pumped from a storage tank facility to a sanitary sewer force main along the northern edge of the landfill area for treatment by a POTW. Discussions with the POTW are in progress which will affect the design of the leachate force main, storage tank facility, and tie-in to the existing sanitary sewer force main. Detailed design of these elements will be completed after an agreement is reached with the POTW or alternative leachate treatment facility.

7.1 Landfill Airspace and Soil Quantity

7.1.1 Landfill Airspace

The 23.3 acre landfill will be constructed in three cells. Cell 1 (5.2 acres) will consist of the northwestern portion of the landfill, cell 2 (7.4 acres) will consist of the northeastern portion of the landfill, and cell 3 (10.8 acres) will consist of the southern portion of the landfill.

7.1.1.1 Waste Types and Estimated Disposal Rates

Duke Energy intends to construct a landfill on Dan River Steam Station property to store existing coal combustion residuals (CCRs) currently located in four units on site. The units consist of the Primary Ash Basin, Secondary Ash Basin, and two unlined ash structural fills (Ash Fills 1 and 2). Electricity production from coal combustion ceased on April 1, 2012 and the coal-fired plant is currently undergoing decommissioning; therefore, no new CCRs are currently being generated at Dan River Steam Station. A combined cycle plant on station property currently produces electricity from natural gas.

The Dan River Landfill will contain predominantly of CCR waste which was generated at the Dan River Steam Station and are currently stored within the on-site ash basins and ash fills. The Dan River Landfill will be permitted for the acceptance of the following on-site waste types:

- Coal combustion residuals (CCRs) (including fly and bottom ash)
- Waste soils (i.e. from ash removal activities or soil that has contacted petroleum); and
- Small quantities of inert debris from CCR unit decommissioning activities.

The proposed Dan River landfill will be operated to enable transfer of ash from existing on-site ash basins to a lined facility by August 1, 2019 as required by the North Carolina Coal Ash Management Act of 2014. Upon closure of existing on-site coal combustion residual (CCR) units, the landfill may remain active for the benefit of Duke Energy until the entire landfill waste capacity is realized.

7.1.1.2 Conceptual Landfill Expansion Size and Lifetime

The landfill airspace is defined as the volume between the liner system protective cover and the top of waste grades. Landfill airspace for Cells 1 and 2 was estimated by calculating the volume between the liner system protective cover and interim top of waste grades. Landfill airspace for Cell 3 was estimated by calculating the volume between the liner system protective cover and landfill final cover grades, and subtracting estimated quantities of interim and final cover soils. The estimated capacity of the landfill is presented in the following table:

Table 1: Landfill Airspace

Cell	Gross Airspace (cy)	Volume of Interim Cover (cy)	Volume of Final Soil Cover (cy)	Incremental Net Airspace Volume (cy)	Cumulative Net Airspace Volume (cy)
1	170,153	0	0	170,153	170,153
2	683,055	0	0	512,902	683,055
3	2,246,635	39,846	79,692	1,444,042	2,127,097

The Dan River Landfill is being developed primarily to contain CCR materials from existing on-site CCR units Duke Energy also intends to remove some of the on-site ash by rail to the existing Maplewood Landfill in Jetersville, Virginia. The environmental closure requirements for soil in contact with ash units is currently uncertain; therefore, the Dan River Landfill was designed with contingency airspace. A summary of the estimated volume of on-site CCR's and disposal volumes is presented in the following table:

Table 2: Landfill Capacity							
Volume of CCRs in Primary and Secondary Ash Basins (cy)	Volume of CCRs in Ash Fill 1 (cy)	Volume of CCRs in Ash Fill 2 (cy)	Total Volume of CCRs On Site (cy)	Volume of CCRs Removed by Rail (cy)	Required Landfill Capacity (cy)	Cumulative Net Airspace Volume (cy)	Contingency Airspace Volume (cy)
1,335,000	795,000	345,000	2,475,000	1,000,000	1,475,000	2,127,097	652,097

As previously stated, the proposed Dan River landfill will be operated to enable transfer of ash from existing on-site ash basins to a lined facility by August 1, 2019 as required by the North Carolina Coal Ash Management Act of 2014. Upon closure of existing on-site coal combustion residual (CCR) units, the landfill may remain active for the benefit of Duke Energy until the entire landfill waste capacity is realized.

7.1.2 Soil Quantity Evaluation

Soil will be generated during cut and fill during landfill subgrade construction, and during closure of the existing ash units (Primary and Secondary Ash Basins, Ash Fill 1, and Ash Fill 2). Soil will be required during construction for subgrade and compacted soil liner components, during operations for interim cover, and during closure for construction of the final cover system. Protective cover may consist of ash or soil material. It was assumed that alternative dust control measures will be utilized such that operational cover will not consist of soil aside from the interim cover that will be placed on exterior side slopes.

Soil materials may be stockpiled on top of existing Ash Fill 2 or the area north of Ash Fill 2. Additional soil stockpile locations may be identified during landfill construction or closure of the existing ash units. Soil stockpile areas will be addressed by an approved E&SC Plan prior to development of a new stockpile area. The anticipated volume of soil available for landfill construction, operations, and closure is presented in the following table:

Table 3: Soil Quantity			
Condition	Volume of Soil Generated (cy)	Volume of Soil Required (cy)	Net Volume of Soil (cy)
Protective Cover Consists of Soil	641,182	505,059	136,123
Protective Cover Consists of CCR Material	641,182	425,366	215,816

The soil life cycle analysis indicates that, based on the current grading plan, construction of the landfill and closure of Ash Fills 1 and 2 and the ash basins will generate sufficient soil to construct, operate, and close the proposed landfill. If required, additional soil may be obtained from on-site or off-site sources such as the property east of Dan River Steam Station that was recently purchased by Duke Energy.

The subgrade grading plan has been designed to achieve separation from bedrock and the anticipated estimated long-term seasonal high groundwater table. Monthly water level collection is currently in progress to define the estimated long-term seasonal high groundwater table. The landfill grading plan may be either raised or lowered as appropriate to optimize separation from groundwater. A supplemental data package will be submitted to NCDENR at a later date demonstrating the estimated long-term seasonal high groundwater table and any resultant changes to the design.

7.2 Landfill Stability

Slope stability analyses for global, liner interface, and final cover veneer configurations were performed for static and pseudo-static conditions. Anchor trench stability and anticipated settlement were also estimated.

7.2.1 Global and Liner Interface Slope Stability

Four representative cross-sections through the proposed landfill were selected for stability analyses. Stability analyses were performed with the GeoStudios SLOPE/W software program using Spencer's method. Global stability was evaluated using circular slip surface methods, while interface slope stability was evaluated using a block-specified failure plane approach. The shear strength of the liner system was

specified to be 16.5 degrees for the purposes of stability analyses. The results of the slope stability analyses are presented in the following table:

Table 4: Summary of Slope Stability Results

Section	Analysis No.	Failure Type	Condition	Estimated Safety Factor	Minimum Required Safety Factor	Estimated Safety Factor > Minimum Required Safety Factor
1	1	Deep	Pseudo-Static	1.37	1.0	YES
	2		Static	1.79	1.5	YES
	3	Liner	Pseudo-Static	1.12	1.0	YES
	4		Static	1.53	1.5	YES
	5	Shallow	Pseudo-Static	1.19	1.0	YES
	6		Static	1.77	1.5	YES
2	7	Deep	Pseudo-Static	1.20	1.0	YES
	8		Static	1.86	1.5	YES
	9	Liner	Pseudo-Static	1.17	1.0	YES
	10		Static	1.59	1.5	YES
	11	Shallow	Pseudo-Static	1.20	1.0	YES
	12		Static	1.86	1.5	YES
3	13	Deep	Pseudo-Static	1.15	1.0	YES
	14		Static	1.97	1.5	YES
	15	Liner	Pseudo-Static	1.19	1.0	YES
	16		Static	1.63	1.5	YES
	17	Shallow	Pseudo-Static	1.14	1.0	YES
	18		Static	1.95	1.5	YES
4	19	Deep	Pseudo-Static	1.61	1.0	YES
	20		Static	2.04	1.5	YES
	21	Liner	Pseudo-Static	1.49	1.0	YES
	22		Static	1.84	1.5	YES
	23	Shallow	Pseudo-Static	1.54	1.0	YES
	24		Static	1.80	1.5	YES
	25	Slope	Pseudo-Static	1.97	1.0	YES
	26		Static	2.04	1.5	YES

The slope stability results indicate adequate safety factors for global slip surfaces and for liner interface slip surfaces for a liner interface friction angle of 16.5 degrees. Interface friction testing will be performed for liner system components in accordance with the CQA Plan and specifications.

7.2.2 Cover Veneer Stability

The landfill cover system will be constructed with typical side slopes of 3H:1V and a top deck with a slope of 8 percent. The minimum required interface friction angle was evaluated by estimating the required friction angle for static conditions, and then performing a pseudo-static veneer stability analysis. For the purposes of veneer stability it was assumed that the geocomposite drainage layer on the side slopes prevented saturation of the cover soils, while the relatively shallow top deck was evaluated for saturated cover soil conditions. A summary of veneer stability results is presented in the following table:

Table 5: Summary of Veneer Stability Results

Slope Condition	Slope	Analysis Condition	Calculated Safety Factor	Required Safety Factor
Landfill Side Slope	3H:1V	static	1.5	1.5
		pseudo-static	0.98	1.0
Landfill Top Deck	8 percent	static	> 1.5	1.5
		pseudo-static	1.06	1.0

The calculated safety factor for landfill side slope pseudo-static conditions (0.98) is less than the minimum required safety factor for pseudo-static conditions (1.0); therefore, a Newmark deformation was performed. Based on the Newmark deformation analysis, the estimated seismic deformation is

approximately 0.3 feet which is less than the 0.5 to 1 feet typically allowable for liner systems; larger permanent deformations are typically acceptable for cover systems. Interface friction testing will be performed for liner system components in accordance with the CQA Plan and specifications.

7.2.3 Anchor Trench

An anchor trench located at the crest of the landfill perimeter berm will be utilized to anchor the liner system during construction. Anchor trench stability was evaluated for the following conditions:

- Cover soil sloughing;
- Cover soil to geocomposite interface; and
- Anchor trench pullout.

Cover soil sloughing stability was evaluated by assuming an infinite slope failure on the landfill side slope. Cover soil sloughing stability requirements are satisfied assuming a protective cover friction angle of 28 degrees. The cover soil is anticipated to consist of CCR material which typically has friction angles on the order of 30 degrees. The cover soil to geocomposite interface was also evaluated using the infinite slope method, indicating a minimum required interface between geocomposite and cover soil of 22.6 degrees for low normal loads. The anchor trench was designed to pull out of the anchor trench rather than rupture the geomembrane.

7.2.4 Settlement

Approximately two-thirds of the proposed Dan River Landfill will be located in the footprint of existing Ash Fill 1. Ash Fill 1 CCR material will be removed prior to landfill construction, resulting in a soil subgrade that is overconsolidated. Construction of the Dan River Landfill and placement of waste will re-load the subgrade resulting in comparatively less settlement than a normally consolidated material.

The liner system settlement was calculated using a three step method. Step 1 was to estimate the elevations of the surface layers for the different subsurface soil strata based on geotechnical boring information. Step 2 was to estimate the existing pressure exerted on the subgrade soils by the materials composing Ash Fill 1, then to estimate the expected increase in pressure due to the proposed landfill. Step 3 was to evaluate the total settlement based on consolidation theory. After the settlement was evaluated, the post-settlement slopes of the subgrade due to settlement were calculated. Long-term creep settlement of the liner system was assumed to be minimal.

The maximum predicted subgrade settlement was 0.64 ft. The predicted minimum post-settlement subgrade slope was greater than 2%, which is the minimum slope allowable per the North Carolina .1600 rules. Hand calculations performed at discrete points indicate that the geographic information system (GIS) model accurately estimated settlement.

7.3 Leachate Collection and Removal System

The leachate collection and removal system was conservatively designed to lower head levels from the 50-year, 24-hour storm to less than one foot within a 72 hour period.

7.3.1 Leachate Generation

Leachate generation rates were estimated using the software package Hydrologic Evaluation of Landfill Performance (HELP, version 3.95D) for the following scenarios:

- Case 1: 10 feet of ash without cover;
- Case 2: 50 feet of ash without cover;
- Case 3: 100 feet of ash without cover; and
- Case 4: Closed landfill.

Modeling was performed for a time duration of 50 years. Synthetically generated precipitation, temperature, solar radiation, and evaporation data for Greensboro, North Carolina were produced using HELP software. For the purposes of modelling, the landfill was assumed to be a one acre square with side lengths of approximately 209 feet. The slope length was assumed to be the diagonal of the square, or approximately 300 feet. Liner system slopes were assumed to be 2 percent, all other slopes were

assumed to be 5 percent. Contact water runoff will be collected by a series of chimney drains, therefore 100 percent of the area of the landfill was assumed to generate runoff. The estimated infiltration rates are summarized in the following table:

Table 6: Summary of Estimated Leachate Generation Rates

Case No.	Description	Leachate Generation	Average Annual Percolation (in)	Average Daily Percolation (in)	Average Daily Percolation (gpad)	Peak Daily Percolation (in)	Peak Daily Percolation (gpad)
1	open landfill 10-ft waste	Collected in Liner Geocomposite	1.55E+01	4.25E-02	1,155	4.45E-01	12,081
		Leakage through Primary Geomembrane	3.22E-02	8.82E-05	2.39	5.53E-04	15.02
2	open landfill 50-ft waste	Collected in Liner Geocomposite	1.43E+01	3.91E-02	1,063	1.31E-01	3,551
		Leakage through Primary Geomembrane	3.02E-02	8.28E-05	2.25	2.18E-04	5.92
3	open landfill 100-ft waste	Collected in Liner Geocomposite	1.27E+01	3.48E-02	945	1.28E-01	3,478
		Leakage through Primary Geomembrane	2.72E-02	7.45E-05	2.02	2.14E-04	5.81
4	closed landfill 100-ft waste	Collected in Liner Geocomposite	5.59E-03	1.53E-05	0.42	1.34E-03	36.39
		Leakage through Primary Geomembrane	7.00E-05	1.92E-07	0.01	7.00E-06	0.19

As anticipated, leachate generation rates are higher for initial landfill operating conditions and decrease with increasing waste height. The landfill cover system will include a geomembrane component, significantly reducing long-term anticipated leachate generation rates.

7.3.2 Action Leakage Rate

The Dan River Landfill will include a leak detection system. Consistent with other Duke Energy CCR landfills, the Action Leakage Rate (ALR) is 500 gallons per acre per day. The monthly action leakage rate for the 23.3 acre Dan River Landfill is 349,500 gallons assuming a 30-day month. A response action plan is included in the Operations Plan to describe actions in the event the ALR is exceeded.

7.3.3 Leachate Collection

The leachate collection system will include chimney drain pipes to convey contact water from the active face to the landfill sump and solid-walled SDR-17 HDPE collector pipes along the base of the landfill. The chimney drains and leachate collection pipes were designed to pass flow from the 50-year, 24-hour storm event.

Based on the analyses the amount of leachate percolation through the waste material is relatively small compared with the flow from chimney drains during a storm event. The capacity of various diameters of SDR-17 HDPE pipe was estimated and summarized in the following table:

Table 7: Leachate Pipe Design Guidelines

Nominal Diameter (in)	Pipe Inside Diameter {D} (in)	Pipe Capacity {Q} (cfs)	Contribution of Flow from Geocomposite $\{Q_{GCDL}\}$ (cfs)	Contribution of Flow Per Chimney Drain $\{Q_{chimney}\}$ (cfs)	Maximum No. of Chimney Drains
8	7.55	1.12	0.04	1.32	0
10	9.41	2.02	0.04	1.32	1
12	11.16	3.19	0.04	1.32	2
14	12.25	4.09	0.04	1.32	3
16	14.01	5.84	0.04	1.32	4
18	15.76	8.00	0.04	1.32	6
24	21.01	17.23	0.04	1.32	13
30	26.26	31.24	0.04	1.32	23
36	31.51	50.79	0.04	1.32	38

A leachate collection system pipe diameter of 12 inches was selected to provide versatility in terms of number of chimney drains contributing drainage, ease of periodic maintenance, and simplicity of construction.

Leakage detection pipes will collect flow from the leakage detection geocomposite drainage layer, which was designed for two times the action leakage rate of 500 gpad (design flow of 1,000 gpad). The design

flow rate is 0.042 cfs, assuming a 23.3 acre landfill footprint. As shown above, a nominal 8-inch diameter pipe has a capacity of 1.12 cfs; therefore, the leakage detection pipes were selected to be 8-inch diameter SDR-17 HDPE pipes.

7.3.4 Leachate Removal

It is anticipated that leachate will be pumped from a storage tank facility to a sanitary sewer force main along the northern edge of the landfill area for treatment by a POTW. Discussions with the POTW are in progress which will affect the design of the leachate force main, storage tank facility, and tie-in to the existing sanitary sewer force main. Detailed design of these elements will be completed after an agreement is reached with the POTW or alternative leachate treatment facility.

The required capacity of the leachate pumping network was evaluated based on the anticipated sump configuration and leachate and contact water generation rates from the 50-year, 24-hour storm event to draw down the head on the liner system to 1 foot or less within 72 hours. A drawdown summary is presented in the following table:

Table 8: Drawdown Summary

Cell	Sump	Condition	Time One Foot of Head is Exceeded (hours)	Time Leachate Level is Less Than One Foot of Head (hours)	Duration of Head Level in Excess of One Foot (hours)	Maximum Allowable Duration of Head Level in Excess of One Foot (hours)
Cell 1	LDS	average	N/A	N/A	< 1	72
	LDS	peak	N/A	N/A	< 1	72
	LCS	average	N/A	N/A	< 1	72
	LCS	peak	49	108	59	72
Cell 2	LDS	average	N/A	N/A	< 1	72
	LDS	peak	N/A	N/A	< 1	72
	LCS	average	N/A	N/A	< 1	72
	LCS	peak	6	75	70	72
Cell 3	LDS	average	N/A	N/A	< 1	72
	LDS	peak	N/A	N/A	< 1	72
	LCS	average	N/A	N/A	< 1	72
	LCS	peak	7	65	58	72

Additionally, the sumps will have adequate freeboard for the conditions modeled as summarized in the following table:

Table 9: Freeboard Summary

Cell	Peak Sump Elevation (ft)	Peak Leachate Elevation (ft)	Freeboard (in)
Cell 1	5	4.13	10.5
Cell 2	6	4.86	13.6
Cell 3	12	9.31	32.3

7.3.5 Leachate Pipe Stability

Leachate pipe stability was evaluated for SDR-11 and SDR-17 pipes for ring compressive stress, deflection, and buckling failure modes. The maximum allowable waste height was calculated for each pipe SDR and failure mode as summarized in the following table:

Table 10: Maximum Allowable Waste Height

Nominal Size (in)	Standard Dimension Ratio {SDR}	Allowable Waste Height {H_{allow}} (ft)
8	11	231
36	11	231
8	17	184
36	17	184

The maximum landfill waste height is anticipated to be less than 184 feet; therefore SDR-17 pipes will be used for the leachate collection system.

7.3.6 Graded Aggregate Filter

A graded aggregate filter will be utilized in the landfill sump, leachate collection lateral and header pipes, and chimney drains to filter the CCR materials and prevent clogging of the LCS components. A two-stage filter was designed in accordance with NRCS publication "Part 633 National Engineering Handbook", Chapter 26: Gradation Design of Sand and Gravel Filters. The "Ash Filter Calculation" is presented in Appendix IV.

Based on the design methodology, the fine aggregate portion of the two-stage filter will consist of ASTM C-33 fine aggregate and the coarse aggregate portion will consist of NCDOT 78M aggregate. Perforated drainage pipe sections located within the NCDOT 78M portion of the filter should have a maximum perforation size of 3/16 inch.

7.4 Geosynthetics

The geosynthetic components of the proposed liner system satisfying state and federal rules will consist of (from top to bottom):

- Geocomposite drainage layer;
- Primary 60-mil HDPE geomembrane;
- Geocomposite leak detection layer;
- Secondary 60-mil HDPE geomembrane; and
- Geosynthetic clay liner.

7.4.1 Liner System Hydraulic Equivalency

The EPA CCR rules require two feet of compacted soil with a maximum hydraulic conductivity of $1x10^{-7}$ cm/s. The required conductivity for a GCL to be hydraulically equivalent to two feet of compacted soil was estimated using Darcy's Law as described in Article 257.70(c) of the EPA CCR rules as an alternative liner system. Based on the calculations, a GCL with a thickness of 0.2 inches (0.5 cm) and a hydraulic conductivity of less than $2.48x10^{-9}$ cm/s is hydraulically equivalent to two feet of compacted soil with a conductivity of $1x10^{-7}$ cm/s.

7.4.2 Liner System Geocomposite

The liner system geocomposites were designed to pass the design flow within the thickness of the geocomposite, reducing head on the liner system.

The leachate collection geocomposite will be installed over the primary geomembrane and was designed to pass the maximum average daily percolation rate as calculated in the "Leachate Generation Calculation".

The leak detection geocomposite will be installed between the primary and secondary geomembranes and was designed to pass two times the action leakage rate of 500 gpad.

Liner system flow capacity requirements were designed in terms of transmissivity. The required geocomposite transmissivity is the transmissivity required to pass the design infiltration and represents the required in-situ performance of the geocomposite. A safety factor and several reduction factors were applied to obtain the allowable geocomposite transmissivity represents the required transmissivity from laboratory testing. Transmissivity requirements are presented in the following table:

Table 11: Geocomposite Allowable Transmissivity						
Geocomposite Location	Required Geocomposite Transmissivity {θ_{req}} (m^2/s)	Safety Factor for Drainage {FS_D} [Ref. 1]	Reduction Factor for Long-Term Creep {RF_{CR}} [assumed]	Reduction Factor for Chemical Clogging {RF_{CC}} [Ref. 1]	Reduction Factor for Biological Clogging {RF_{BC}} [Ref. 1]	Allowable Geocomposite Transmissivity {θ_{allow}} (m^2/s)
Leachate Collection Geocomposite	9.53E-05	2.0	1.2	1.5	1.1	3.77E-04
Leakage Detection Geocomposite	8.25E-05	2.0	1.2	1.5	1.1	3.27E-04

Transmissivity testing requirements are described in the CQA Plan and specifications.

7.5 Stormwater Management

The leachate stormwater management system components were conservatively designed to provide hydraulic capacity for the 50-year, 24-hour storm.

7.5.1 Cover System Stormwater Management

The cover system stormwater management components will include:

- Cover system geocomposite;
- Top deck underdrain / alternate geocomposite outlet;
- Top deck channel;
- Tack-on benches;
- Downdrains; and
- Drop inlets and flared end sections.

Design of the cover system stormwater management components are summarized as follows.

7.5.1.1 Cover System Geocomposite

The cover system geocomposite capacity was evaluated using the unit gradient method which assumes saturated cover soil conditions. The cover system geocomposite was designed to pass the infiltration through the thickness of the geocomposite, preventing saturation of the overlying soil materials for landfill side slope conditions. The top deck of the landfill will be relatively flat and was therefore allowed to saturate. Veneer stability calculations indicate adequate safety factors for saturated top deck cover soil conditions.

Cover system flow capacity requirements were designed in terms of transmissivity as previously described in this report. Transmissivity requirements are presented in the following table:

Table 12: Cover System Geocomposite Allowable Transmissivity					
Required Geocomposite Transmissivity {θ_{req}} (m^2/s)	Safety Factor for Drainage {FS_D} [Ref. 1]	Reduction Factor for Long-Term Creep {RF_{CR}} [Ref. 1]	Reduction Factor for Chemical Clogging {RF_{CC}} [Ref. 1]	Reduction Factor for Biological Clogging {RF_{BC}} [Ref. 1]	Allowable Geocomposite Transmissivity {θ_{allow}} (m^2/s)
8.67E-05	2.0	1.1	1.2	3.0	6.87E-04

Transmissivity testing requirements are described in the CQA Plan and specifications.

7.5.1.2 Top Deck Underdrain / Alternate Geocomposite Outlet

Infiltration through the geocomposite on the top deck will be intercepted by a top deck underdrain. Additionally, the alternate geocomposite outlet design at tack-on benches and the landfill perimeter consists of a piped system consistent in configuration with the top deck underdrain. The underdrain and alternative geocomposite outlet will consist of a 6-inch diameter corrugated dual-wall HDPE pipe surrounded by NCDOT 78M drainage aggregate. An 8 oz/sy non-woven geotextile filter will be placed between the NCDOT 78M drainage aggregate and adjacent cover soils.

Anticipated unit flow rates (flow per area) were evaluated using the unit gradient method. The pipe capacity was then estimated assuming the pipes are installed at a two percent longitudinal slope. The maximum allowable area to the pipe was then estimated by dividing the pipe capacity by the unit flow rate.

Hydraulic analyses indicate a maximum allowable tributary area of 6 acres to a piped system as specified. The top deck area is approximately 3 acres and tributary drainage area to geocomposite outlets on the landfill side slope are 1 acre, consistent with the drainage area for a tack-on bench, indicating adequate flow capacity.

7.5.1.3 Top Deck Channel

A stormwater channel will be installed along the low portion of the top deck of the landfill to prevent surface water run-off along the top deck from discharging over the side of the landfill. The top deck channel was evaluated assuming a drainage area of 6 acres, consistent with the maximum allowable drainage area to the top deck underdrain. Based on the hydraulic analyses the top deck channel has capacity to pass the 50-year, 24-hour design storm for a drainage area of 6 acres. The top deck area is approximately 3 acres, indicating adequate flow capacity.

7.5.1.4 Tack-On Benches

Tack-on benches are soil berms that will be installed along the side slopes of the landfill to intercept stormwater runoff and outlet the geocomposite drainage layer. For the purposes of constructability it was assumed that the maximum tack-on bench length is 500 linear feet. The tack-on benches will be spaced at 90-foot horizontal intervals (every 30 vertical feet) to prevent surface erosion. Thus, the maximum drainage area to a tack-on bench is 500 ft x 90 ft = 45,000 ft^2 = 1.03 acres. Hydraulic analyses indicate that the tack-on benches as designed have capacity for the 50-year, 24-hour storm event with 3 inches of freeboard.

7.5.1.5 Downdrains

Downdrains will collect flow from tack-on benches, the top deck underdrain, and the top deck channel and convey the flow to channels located around the perimeter of the landfill. The downdrains will consist of 24-inch diameter dual-wall corrugated HDPE pipes.

Downdrain capacity was evaluated by first evaluating the downdrain capacity using Manning's equation, then estimating the maximum allowable tributary drainage area using the SCS method. Downdrain capacity is limited at the location where the downdrain will go beneath the slope access road; therefore, the design longitudinal slope was selected to be 5 percent.

Hydraulic analyses indicate the maximum allowable tributary drainage area to a typical downdrain is 7.5 acres. The Dan River Landfill footprint is approximately 23.3 acres, and the cover system design includes 7 downdrains, indicating an average drainage area of 3.3 acres.

7.5.1.6 Drop Inlets and Flared End Sections

Drop inlets will be installed to convey flow from top deck channels and tack-on benches to downdrains. The drop inlets will have a grate which may impact flow capacity. Additionally, during landfill operations, the flow from tack-on benches will discharge into downdrains through a flared end section. Drop inlets and flared end sections were designed to pass the 50-year, 24-hour storm event.

7.5.2 Perimeter Stormwater Management

Two concrete stormwater perimeter channels will be located around the perimeter of the proposed Dan River Landfill. The eastern perimeter channel will begin at the high point towards the northern end of the landfill and convey stormwater in a clockwise direction to the low point towards the southern end of the landfill, the western perimeter channel will convey flow in a counter-clockwise direction. The perimeter stormwater channels will convey stormwater around the perimeter of the landfill to an outlet structure at the southern end of the landfill.

Additionally, a grass-lined channel will be installed adjacent to the slope access road. The slope access road channel will discharge intermittently into downdrains.

Hydraulic analyses indicate adequate capacity to pass the 50-year, 24-hour storm event for perimeter channels, the slope access road channel, and the drop inlet and culvert outlet point.

8 Conclusions

The information included in this Construction Plan Application demonstrates that the proposed Dan River Landfill was designed to the Title 15A Subchapter 13B NCAC .0500 rules as required, and to the substantive requirements of the .1600 rules.

9 Pertinent Permit Application Documents

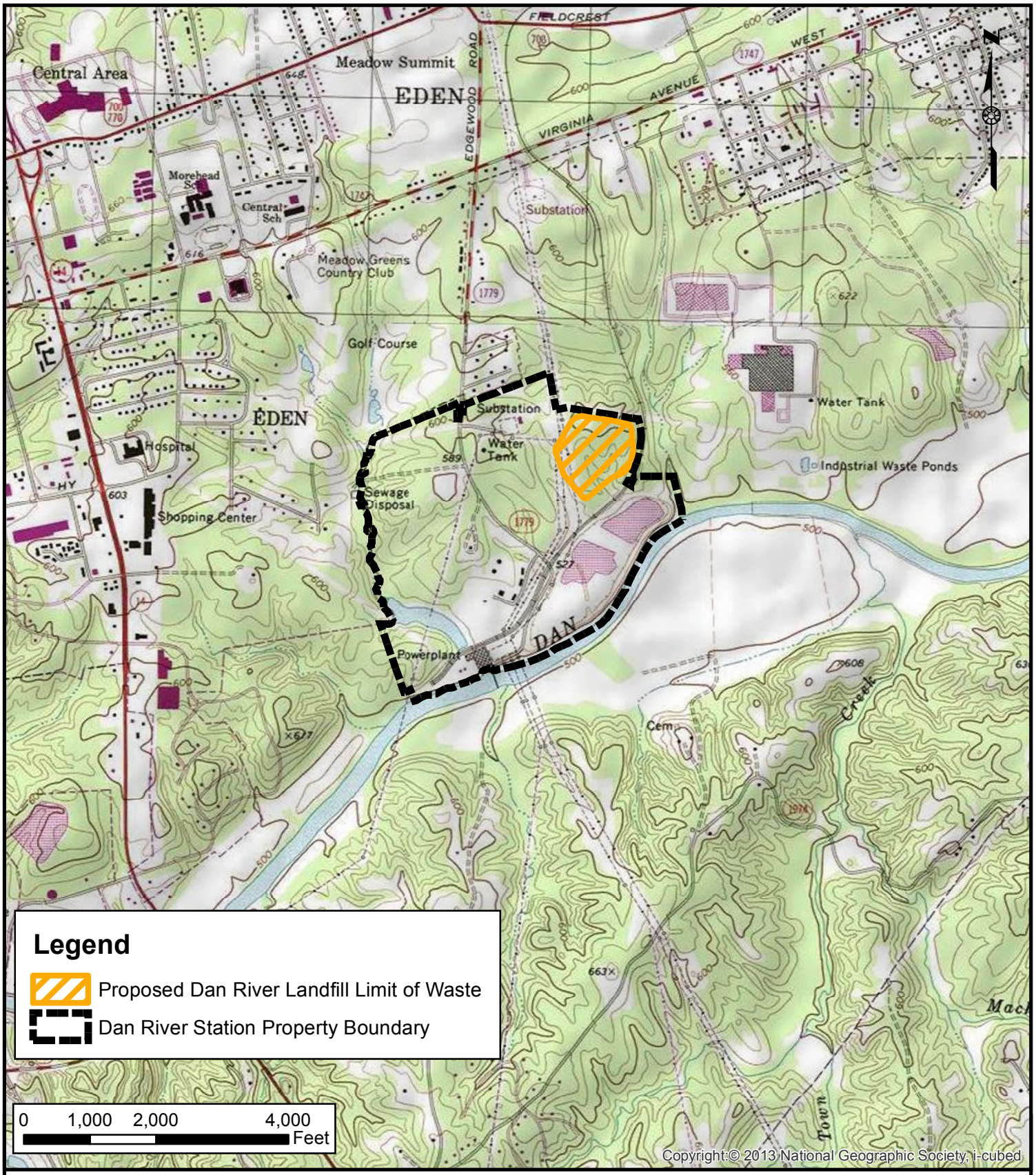
"Construction Plan Application – Dan River Landfill", Amec Foster Wheeler, August 26, 2015.

"Site Suitability Study – Dan River Landfill", Amec Foster Wheeler, July 15, 2015.

"Hydrogeologic Study – Dan River Landfill", Amec Foster Wheeler, July 15, 2015.

"Water Quality Monitoring Plan – Dan River Landfill", Amec Foster Wheeler, August 26, 2015.

FIGURES

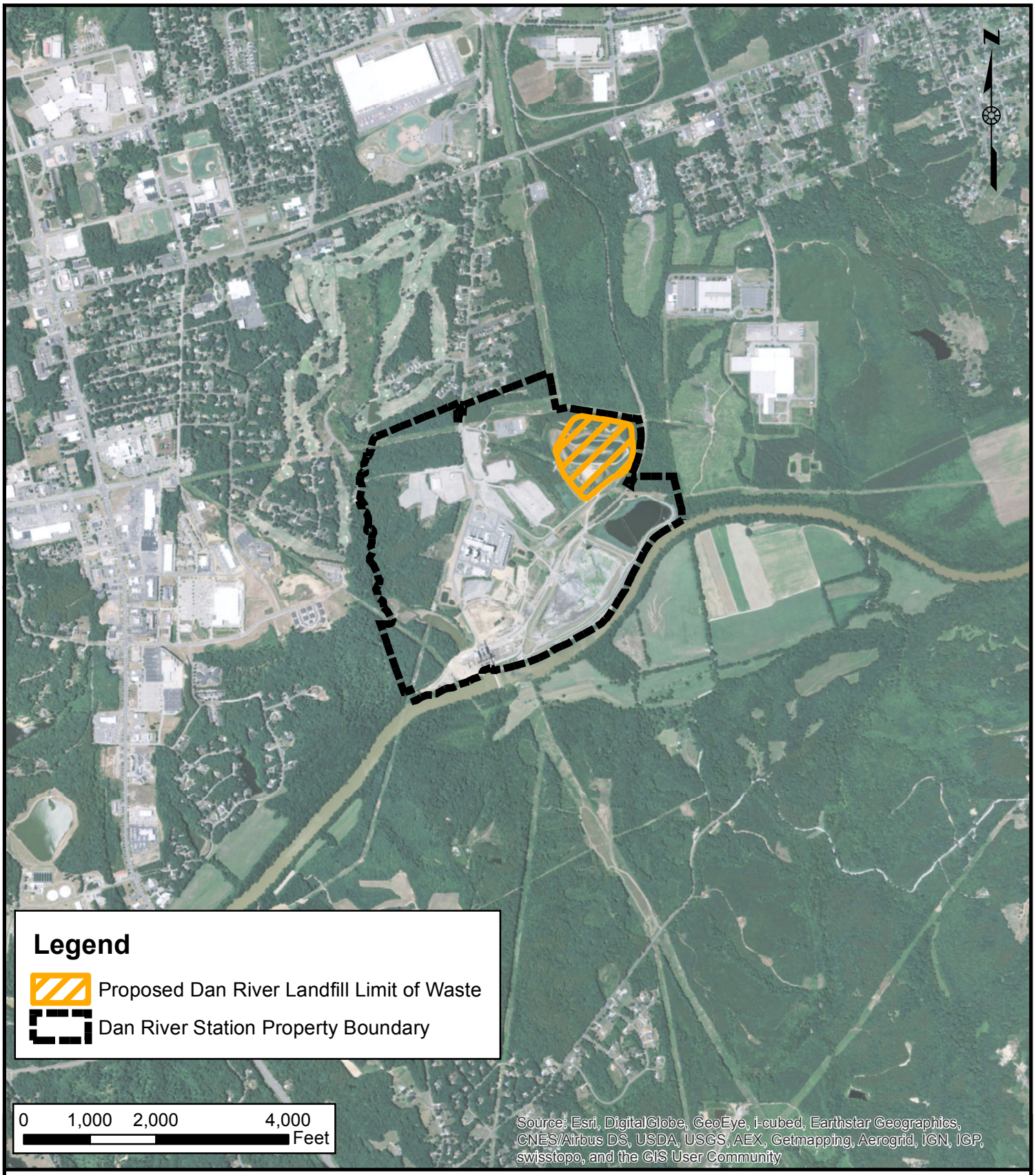


Source: Rockingham County GIS

amec foster wheeler

SITE VICINITY MAP - USGS
DAN RIVER LANDFILL
DUKE ENERGY
ROCKINGHAM COUNTY, NORTH CAROLINA

PREPARED BY	DATE	CHECKED BY	DATE	JOB NUMBER	FIGURE
CHR	7/20/2015	CJ	7/20/2015	7810-14-0065	1



Source: Rockingham County GIS

amec foster wheeler

SITE VICINITY MAP - AERIAL
DAN RIVER LANDFILL
DUKE ENERGY
ROCKINGHAM COUNTY, NORTH CAROLINA

PREPARED BY	DATE	CHECKED BY	DATE	JOB NUMBER	FIGURE
CHR	7/20/2015	CJ	7/20/2015	7810-14-0065	2

APPENDIX I

Legal Property Description and Local Government Approval

APPENDIX I-1

Legal Property Description – To Be Provided Later

APPENDIX I-2

Government Approval

Planning and Inspections Department

P. O. Box 70, 308 E Stadium Drive, Eden NC 27289-0070/Telephone 336-623-2110/Fax 336-623-4057

July 14, 2015

Mr. Davis Montgomery, District Manager
Duke Energy Carolinas
2500 Fairfax Road
Greensboro, NC 27407

Re: Zoning Confirmation for Parcel Number 110532 (known as Hopkins West), Parcel Number 110587 (known as Hopkins East) and Parcel Number 141506 (known as the Duke Energy Eden Plant site).

Dear Mr. Montgomery:

The above-described parcels are zoned Industrial-2 in the City of Eden's extraterritorial jurisdiction and are governed by the City of Eden Zoning Ordinance. I am confirming that certain activities are permitted to be undertaken on said parcels as follows, subject to the approval of the Zoning Amendment to be considered by the Eden City Council:

(a) Permanent Storage of Coal Combustion Residuals, but excluding any such material that was not generated on the site of a former coal fired utility plan located within the planning jurisdiction of the City of Eden, shall be allowed as a matter of right in the Industrial-2 zoning district. Such property shall be identified by its tax parcel number as of January 1, 2015. In this case, the tax parcel number is 141506. The storage shall be permitted by the State of North Carolina as a Coal Ash Landfill and shall be subject to all state and federal rules and regulations.

(b) Removal of soil from Hopkins West or Hopkins East incidental to the construction and operation of a coal ash landfill on the Duke Energy Eden Plant Site is considered accessory to the coal ash landfill on the Duke Energy Eden Plant Site and would therefore be allowed and shall not be considered or constitute mining, extractions and quarries as defined under the City of Eden Zoning Ordinance subject to approval of the Zoning Amendment. Because soil removal from Hopkins East and West is not considered to be mining, extractions and quarries, no special use permit application is necessary for this activity.

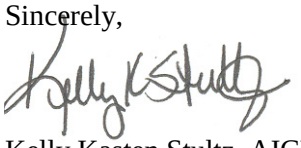
(c) The temporary storage of Coal Combustion Residuals on Hopkins West, Parcel Number 110532, shall be permitted as a part of the construction process of the coal ash landfill on the Duke Energy Eden Plant Site and is accessory to the railroad operations undertaken on the site and is therefore allowed.

(d) The Industrial-3 fees in the City of Eden Budget Ordinance are not applicable to the activities described above.

(e) It is the interpretation of the Planning Department that the Duke Energy Eden Plant site is not subject to regulations affecting water supply watersheds, as illustrated by the attached Water Supply Watershed map.

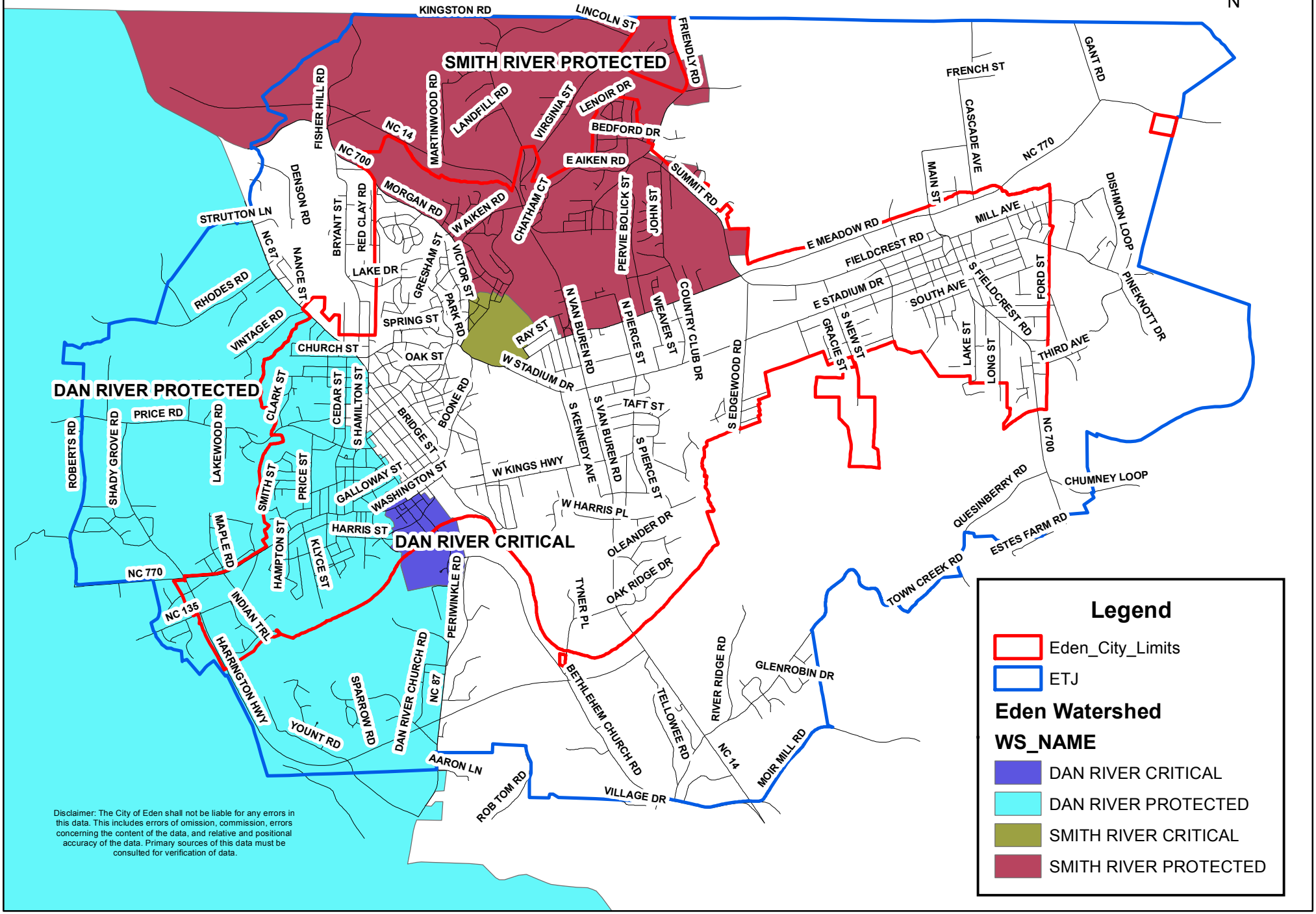
Any land use activities within the planning jurisdiction of the City of Eden are subject to the Eden City Code and all regulations for the use of land approved and adopted by the Eden City Council.

Sincerely,



Kelly Kasten Stultz, AICP #013769
Planning and Inspections Director
and Watershed Administrator

City of Eden Planning Jurisdiction
Watershed Map



Disclaimer: The City of Eden shall not be liable for any errors in this data. This includes errors of omission, commission, errors concerning the content of the data, and relative and positional accuracy of the data. Primary sources of this data must be consulted for verification of data.

APPENDIX II

Calculations Addressing Landfill Capacity and Soil Quantity

APPENDIX II-1

Landfill Airspace Calculation

Calculation Title:
Landfill Airspace Calculation

Summary:
The available landfill airspace is estimated to be approximately 2,120,000 cubic yards, which may increase or decrease depending on changes to the grading plan.

Additional waste storage volume may be obtained by placing ash as protective cover or reducing or eliminating the interim cover.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal	Cedric H Ruhl	Chris Jordan	Thomas B Maier
		Cedric H. Ruhl	**Chris Jordan**	**Thomas B. Maier**

OBJECTIVE:

The objective of this calculation is to estimate the airspace (i.e., disposal capacity) for the proposed Dan River Landfill.

METHOD:

The landfill airspace was estimated by creating AutoCAD Civil 3D 2013 surfaces to approximate volumes.

CALCULATIONS:

1.0 Estimate landfill airspace

The landfill airspace was estimated by comparing the three-dimensional surfaces for the proposed top of protective cover grades and interim and final cover grades [Ref. 1]. Assuming a maximum slope of 3H:1V, the conversion from perpendicular thickness to vertical thickness is a factor of 1.06. Depth was measured vertically in accordance with the design drawings. The airspace available for waste disposal was estimated by subtracting the cover soil thickness (1.06 vertical feet of interim cover and 2.12 vertical feet of final cover) multiplied by the limit of waste footprint. Volume loss due to operational cover was assumed to be negligible from the use of alternative daily cover systems. The landfill airspace is shown in the following table:

Table 1: Landfill Airspace

Cell	Base Surface	Comparison Surface	Estimated Volume from Surface Comparison (cy) [Ref. 1]	Estimated Landfill Limit of Waste (ac)	Volume of Interim Cover (cy) [assume 1.06-ft. thick]	Volume of Final Soil Cover (cy) [assume 2.12-ft. thick]	Incremental Airspace Volume (cy)	Cumulative Airspace Volume (cy)
1	Protective Cover	Cell 1 Interim Waste Grades	170,153	---	0	0	170,153	170,153
2	Protective Cover	Cells 1 and 2 Interim Waste Grades	683,055	---	0	0	512,902	683,055
3	Protective Cover	Final Closure Grades	2,246,635	23.3	39,846	79,692	1,444,042	2,127,097

DISCUSSION:

The available landfill airspace is estimated to be approximately 2,120,000 cubic yards for the grades shown on the accompanying permit drawings. The volume of airspace may increase or decrease depending on changes to the grading plan such as modifying the width of slope access roads, the limit of waste, the landfill subgrade, or other features.

Additional waste storage volume may be obtained by placing ash as protective cover or reducing or eliminating the interim cover.

REFERENCES:

1. AutoCAD Civil 3D 2013 software, an Autodesk, Inc. product.

REFERENCE 1

AutoCAD Civil 3D 2013 software, an Autodesk, Inc. product.

Cut/Fill Report

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By user: chris.jordan

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Volume Summary

Name	Type	Cut Factor	Fill Factor	2d Area (acres)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Cell 1 Volume	full	1.000	1.000	9.36	11.25	170144.77	170133.52<Fill>

Totals

	2d Area (acres)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Total	9.36	11.25	170144.77	170133.52<Fill>

* Value adjusted by cut or fill factor other than 1.0

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Volume Summary

Name	Type	Cut Factor	Fill Factor	2d Area (acres)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Cell 2 Volume	full	1.000	1.000	19.10	7.15	683061.81	683054.66<Fill>

Totals

	2d Area (acres)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Total	19.10	7.15	683061.81	683054.66<Fill>

* Value adjusted by cut or fill factor other than 1.0

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Drawing: Drawing5.dwg

Volume Summary

Name	Type	Cut Factor	Fill Factor	2d Area (acres)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Cell 3 Volume	full	1.000	1.000	29.88	123.05	2246757.56	2246634.51<Fill>

Totals

	2d Area (acres)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Total	29.88	123.05	2246757.56	2246634.51<Fill>

* Value adjusted by cut or fill factor other than 1.0

APPENDIX II-2

Soil Life Cycle Calculation

Calculation Title:
Soil Life Cycle Calculation

Summary:
The soil life cycle analysis indicates that, based on the current grading plan, construction of the landfill and closure of Ash Fills 1 and 2 will generate sufficient soil to construct, operate, and close the proposed landfill provided that the protective cover consists of CCR material. If required, additional soil may be obtained from on-site or off-site sources such as the property east of Dan River Steam Station that was recently purchased by Duke Energy.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal	Cedric H Ruhl	Chris Jordan	Thomas B Maier
		Cedric H. Ruhl	**Chris Jordan**	**Thomas B Maier**

OBJECTIVE:

The objective of this calculation is to estimate the soil supply and demand for the various stages of the proposed Dan River Landfill life cycle.

METHOD:

Soil volumes were estimated by creating AutoCAD Civil 3D 2013 surfaces to approximate volumes, and by calculating depth times area for layers of uniform thickness.

CALCULATIONS:

1.0 Estimate soil supply

The Dan River Landfill will be constructed as three cells. The approximate quantity of cut and fill to compacted soil liner subgrade for each cell was estimated by generating a comparison between the three-dimensional surfaces of the existing grades following ash removal from Ash Fill 1 and compacted soil liner subgrade [Ref. 1]. Next, a shrinkage factor of 20 percent was applied to estimate the net volume of soil available for filling as shown in the following table:

Table 1: Soil Supplied During Landfill Grading

Cell	Base Surface	Comparison Surface	Incremental Soil Cut to Compacted Soil Liner Subgrade (cy) [Ref. 1]	Shrinkage Factor [Ref. 2]	Net Soil Supply from Landfill Subgrade Construction (cy)
1	grades after removal of Ash Fill 1 Ash	compacted soil liner subgrade	34,247	20%	27,398
2	grades after removal of Ash Fill 1 Ash	compacted soil liner subgrade	164,818	20%	131,854
3	grades after removal of Ash Fill 1 Ash	compacted soil liner subgrade	17,124	20%	13,699

The ash within Ash Fill 1 will be removed prior to landfill construction. Two existing soil stockpiles located on top of Ash Fill 1 and the cover soils on top of Ash Fill 1 will be temporarily stockpiled for re-use and will be available for landfill construction, operations, and/or closure.

Additionally, a net excess of soil material will be generated during closure of the Primary and Secondary Ash Basins. The cover soils on top of Ash Fills 1 and 2 will also generate soil. Soil from these sources will be available for landfill operations and closure.

The additional soil supply was estimated as shown in the following table:

Table 2: Additional Soil Supply

Existing Soil Stockpile on Ash Fill 1 (cy)	Volume of Ash Fill 1 Soil Cover (cy)	Assumed Shrinkage Factor [Ref. 2]	Additional Soil Available During Landfill Construction (cy)	Volume of Ash Fill 2 Soil Cover (cy)	Volume of Excess Soil Generated During Ash Basin Closure (cy) [Ref. 1]	Assumed Shrinkage Factor [Ref. 2]	Additional Soil Available During Landfill Operations and Closure (cy)
116,554	47,698	20%	131,402	34,606	386,431	20%	336,830

2.0 Estimate soil life cycle

The estimated soil life cycle was estimated based on the AutoCAD volume report previously described and by calculating depth times area for layers of uniform thickness. Assuming a maximum slope of 3H:1V, the conversion from perpendicular thickness to vertical thickness is a factor of 1.06. Depth was measured vertically in accordance with the design drawings. The estimated soil life cycle is presented in the following tables, assuming protective cover consists of soil (Table 3A) and protective cover consists of ash (Table 3B):

Table 3A: Soil Life Cycle - Protective Cover Consists of Soil

Landfill Phase	Description	Thickness (ft)	Limit of Waste Footprint (ac)	Incremental Volume of Soil Supply (cy)	Incremental Volume of Soil Demand (cy)	Incremental Net (cy)	Cumulative Net (cy)
Ash Fill 1 Ash Removal	Soil Stockpiling	N/A	N/A	131,402	0	131,402	131,402
Cell 1 Construction	Landfill Subgrade	varies	5.1	27,398	45,606	-18,208	113,193
	Compacted Soil Liner	1.06	5.1	0	8,722	-8,722	104,472
	Protective Cover	2.12	5.1	0	17,443	-17,443	87,028
Cell 2 Construction	Landfill Subgrade	varies	7.4	131,854	9,993	121,861	208,890
	Compacted Soil Liner	1.06	7.4	0	12,655	-12,655	196,235
	Protective Cover	2.12	7.4	0	25,310	-25,310	170,925
Cell 3 Construction	Landfill Subgrade	varies	10.8	13,699	210,383	-196,684	-25,759
	Compacted Soil Liner	1.06	10.8	0	18,469	-18,469	-44,229
	Protective Cover	2.12	10.8	0	36,939	-36,939	-81,168
Operations	Interim Cover	1.06	23.3	336,830	39,846	296,983	215,816
Closure	Soil Cover	1.59	23.3	0	59,769	-59,769	156,047
	Vegetative Layer	0.53	23.3	0	19,923	-19,923	136,124

Table 3B: Soil Life Cycle - Protective Cover Consists of CCRs

Landfill Phase	Description	Thickness (ft)	Limit of Waste Footprint (ac)	Incremental Volume of Soil Supply (cy)	Incremental Volume of Soil Demand (cy)	Incremental Net (cy)	Cumulative Net (cy)
Ash Fill 1 Ash Removal	Soil Stockpiling	N/A	N/A	131,402	0	131,402	131,402
Cell 1 Construction	Landfill Subgrade	varies	5.1	27,398	45,606	-18,208	113,193
	Compacted Soil Liner	1.06	5.1	0	8,722	-8,722	104,472
	Protective Cover	2.12	5.1	0	0	0	104,472
Cell 2 Construction	Landfill Subgrade	varies	7.4	131,854	9,993	121,861	226,333
	Compacted Soil Liner	1.06	7.4	0	12,655	-12,655	213,678
	Protective Cover	2.12	7.4	0	0	0	213,678
Cell 3 Construction	Landfill Subgrade	varies	10.8	13,699	210,383	-196,684	16,994
	Compacted Soil Liner	1.06	10.8	0	18,469	-18,469	-1,475
	Protective Cover	2.12	10.8	0	0	0	-1,475
Operations	Interim Cover	1.06	23.3	336,830	39,846	296,983	295,508
Closure	Soil Cover	1.59	23.3	0	59,769	-59,769	235,739
	Vegetative Layer	0.53	23.3	0	19,923	-19,923	215,816

DISCUSSION:

The soil life cycle analysis indicates that, based on the current grading plan, construction of the landfill and closure of Ash Fills 1 and 2 will generate sufficient soil to construct, operate, and close the proposed landfill provided that the protective cover consists of CCR material. If required, additional soil may be obtained from on-site or off-site sources such as the property east of Dan River Steam Station that was recently purchased by Duke Energy.

The actual quantity of soil available may increase or decrease based on final ash removal grades, landfill grading plans, and shrinkage factors. Additionally, the volume of soil suitable for structural fill may be significantly less due to the potential presence of rock fragments, debris, partially weathered rock, or other deleterious material. The suitability of on-site soils for use as compacted soil liner is beyond the scope of this calculation.

REFERENCES:

1. AutoCAD Civil 3D 2013 software, an Autodesk, Inc. product.
2. North Carolina Department of Transportation Soil Shrinkage Map.

REFERENCE 1

AutoCAD Civil 3D 2013 software, an Autodesk, Inc. product.

Cut/Fill Report

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By user: chris.jordan
Drawing: Drawing2.dwg

Volume Summary

Name	Type	Cut Factor	Fill Factor	2d Area (acres)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
BOA VS. CELL 1	full	1.000	1.000	9.30	34246.60	45606.41	11359.82<Fill>
BOA VS. CELL 2	full	1.000	1.000	18.54	199065.17	55598.84	143466.32<Cut>
BOA VS. CELL 3	full	1.000	1.000	29.91	216189.15	265982.47	49793.32<Fill>

Totals

	2d Area (acres)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Total	57.74	449500.91	367187.72	82313.19<Cut>

* Value adjusted by cut or fill factor other than 1.0

Cut/Fill Report

Generated: 2015-07-18 09:23:05
By user: chris.jordan
Drawing: Drawing1.dwg

Volume Summary

Name	Type	Cut Factor	Fill Factor	2d Area (acres)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
BOA vs. Final ABC Grades	full	1.000	1.000	54.22	603250.58	216819.42	386431.15<Cut>

Totals

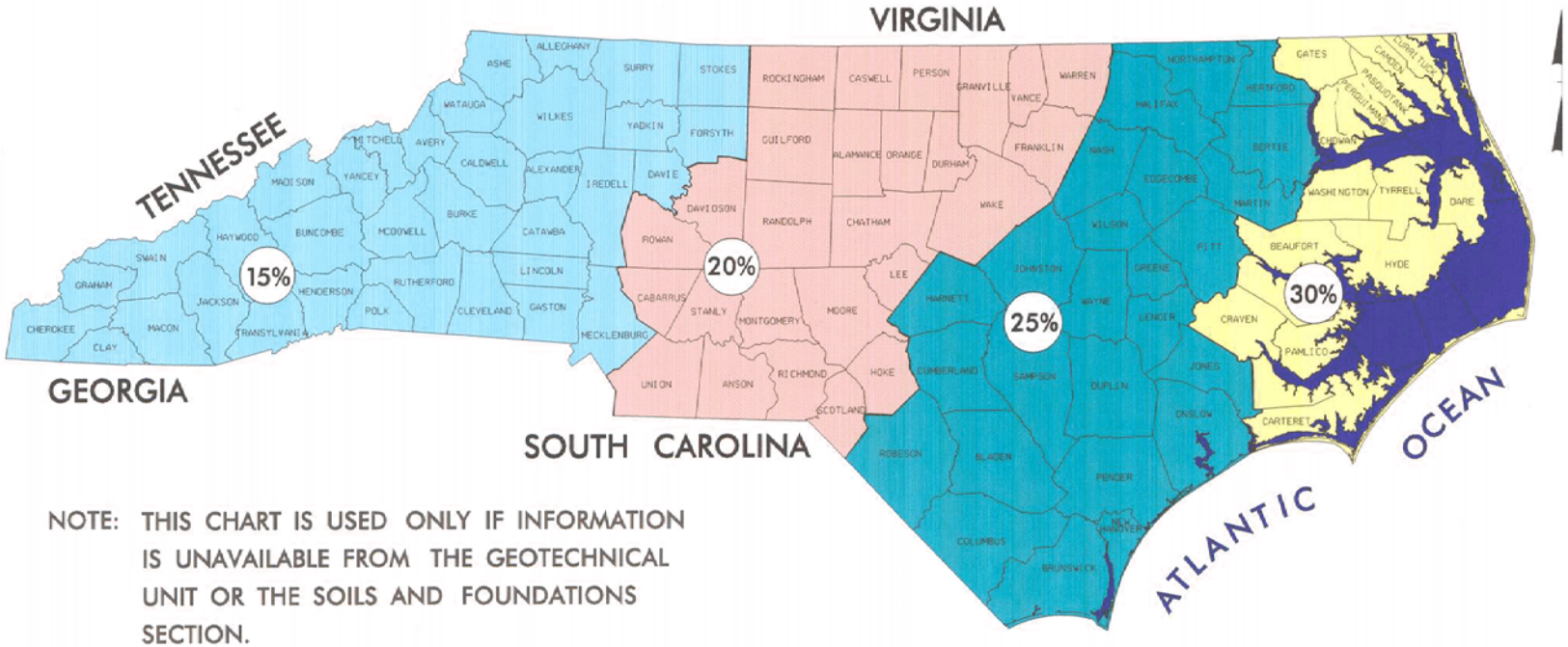
	2d Area (acres)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Total	54.22	603250.58	216819.42	386431.15<Cut>

* Value adjusted by cut or fill factor other than 1.0

REFERENCE 2

North Carolina Department of Transportation Soil Shrinkage Map

North Carolina
SHRINKAGE FACTORS
(FOR THE EARTH PORTION OF UNCLASSIFIED EXCAVATION USED TO CONSTRUCT EMBANKMENTS)



NOTE: THIS CHART IS USED ONLY IF INFORMATION IS UNAVAILABLE FROM THE GEOTECHNICAL UNIT OR THE SOILS AND FOUNDATIONS SECTION.

APPENDIX III

Calculations Addressing Stability

APPENDIX III-1

Seismic Coefficient Calculation

Calculation Title:
Seismic Coefficient Calculation

Summary:
The design seismic coefficient at the crest of the landfill is 0.31, the design seismic coefficient at the landfill subgrade is 0.12, and the design seismic coefficient at depths within the landfill is shown in Table 2.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal	Chris Jordan	Tryambak Kaushik	Cedric H. Ruhl

OBJECTIVE:

The objective of this calculation is to estimate the seismic coefficient for pseudo-static analyses.

METHOD:

The seismic coefficient for pseudo-static analyses was developed by estimating the bedrock acceleration for the design earthquake based on USGS hazard maps, utilizing amplification factors based on seismic site class to evaluate acceleration at the ground surface, utilizing published correlations to evaluate acceleration at the top of the waste mass, and utilizing published correlations to evaluate acceleration at depth within the waste mass. The seismic coefficient is the design seismic acceleration expressed as a percentage of gravity.

DEFINITION OF VARIABLES:

g = gravity;
h = height of the landfill;
k_s = design seismic coefficient;
M_w = moment magnitude;
PGA = peak ground acceleration;
R = distance from seismic event to site; and
y = depth of failure surface within the landfill.

CALCULATIONS:

1.0 Define design earthquake

The design earthquake was selected in accordance with North Carolina Solid Waste Rules 15A NCAC 13B .1622 for seismic impact zones [Ref. 1] and RCRA Subtitle D regulation Part 258.14 [Ref. 2] which describe a design earthquake as having an acceleration with a 90 percent or greater probability of not being exceeded within 250 years. The event with a 2 percent probability of exceedance in 50 years (i.e., a return period of 2475 years) was selected as the design earthquake and is commonly used to approximate the event with a 90 percent or greater probability of not being exceeded within 250 years.

2.0 Estimate design transverse crest acceleration

The design transverse crest acceleration is the acceleration at the crest of the landfill and was estimated based on the following steps:

1. Evaluate bedrock acceleration based on USGS hazard maps;
2. Estimate acceleration at the ground surface by using the seismic site class and published amplification/de-amplification factors; and
3. Estimate acceleration at the crest of the landfill by using published correlations.

The design transverse crest acceleration was previously estimated for the Dan River Steam Station as summarized in the following table:

Table 1: Estimate Design Transverse Crest Acceleration							
Event [Ref. 3]	Distance {R} (km) [Ref. 3]	Moment Magnitude {M_w} [Ref. 3]	Bedrock Acceleration {PGA_{rock}} (g) [Ref. 3]	Seismic Site Class [Ref. 3]	Amplification Factor [Ref. 3]	Acceleration at Ground Surface {PGA_{ground}} (g) [Ref. 3]	Peak Transverse Crest Acceleration {PGA_{crest}} (g) [Ref. 3]
Near-Field	33.8	5.03	0.053	D	1.6	0.085	0.309
Far-Field	280.0	7.39	0.036	D	1.6	0.058	0.231

The near-field event controls with a peak transverse crest acceleration of 0.309 g.

3.0 Estimate acceleration at depth within the waste mass

Correlations developed by Makdisi and Seed [Ref. 4] were used to estimate the acceleration at depth within the waste mass as shown in the following table:

Table 2: Acceleration at Depth			
Percent Depth from Crest (y/h)	Peak Transverse Crest Acceleration {PGA_{crest}} (g)	Ratio of Acceleration at Depth to Peak Transverse Crest Acceleration {k_s/PGA_{crest}}	Acceleration at Depth {k_s}
0.0	0.309	1.00	0.31
0.1	0.309	0.95	0.29
0.2	0.309	0.88	0.27
0.3	0.309	0.80	0.25
0.4	0.309	0.70	0.22
0.5	0.309	0.60	0.19
0.6	0.309	0.52	0.16
0.7	0.309	0.47	0.15
0.8	0.309	0.44	0.14
0.9	0.309	0.41	0.13
1.0	0.309	0.38	0.12

DISCUSSION:

The design seismic coefficient at the crest of the landfill is 0.31, the design seismic coefficient at the landfill subgrade is 0.12, and the design seismic coefficient at depths within the landfill is shown in Table 2.

REFERENCES:

1. North Carolina Solid Waste Rules 15A NCAC 13B .1622.
2. RCRA Subtitle D Regulation Part 258.14, July 1, 1996.
3. Amec Foster Wheeler. "Phase 2 Reconstitution of Ash Basin Design, Final Report Submittal, Revision A, Dan River Steam Station (Decommissioned)", January 30, 2015.
4. Makdisi, Faiz I. and H. Bolton Seed. "Simplified Procedure for Estimating Dam and Embankment Earthquake-Induced Deformations", Journal of the Geotechnical Engineering Division, July 1978.

REFERENCE 1

North Carolina Solid Waste Rules 15A NCAC 13B .1622.

(iii) The MSWLF unit will not cause or contribute to significant degradation of wetlands. The owner or operator shall demonstrate the integrity of the MSWLF unit and its ability to protect ecological resources by addressing the following factors:

(A) Erosion, stability, and migration potential of native wetland soils, muds and deposits used to support the MSWLF unit;

(B) Erosion, stability, and migration potential of dredged and fill materials used to support the MSWLF unit;

(C) The volume and chemical nature of the waste managed in the MSWLF unit;

(D) Impacts on fish, wildlife, and other aquatic resources and their habitat from release of the solid waste;

(E) The potential effects of catastrophic release of waste to the wetland and the resulting impacts on the environment; and

(F) Any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected.

(iv) To the extent required under Section 404 of the Clean Water Act or applicable State wetlands laws, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function) by first avoiding impacts to wetlands to the maximum extent practicable as required by Subitem (3)(a)(i) of this Rule, then minimizing unavoidable impacts to the maximum extent practicable, and finally offsetting remaining unavoidable wetland impacts through all appropriate and practicable compensatory mitigation actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands); and

(v) Sufficient information is available to make a reasonable determination with respect to these demonstrations.

(b) For purposes of this Item, wetlands means those areas that are defined in 40 CFR 232.2(r).

(4) Fault Areas.

(a) New MSWLF units and lateral expansions shall not be located within 200 feet (60 meters) of a fault that has had displacement in Holocene time unless the owner or operator demonstrates to the Division that an alternative setback distance of less than 200 feet (60 meters) will prevent damage to the structural integrity of the MSWLF unit and will be protective of human health and the environment.

(b) For the purposes of this Item:

(i) "Fault" means a fracture or a zone of fractures in any material along which strata on one side have been displaced with respect to that on the other side.

(ii) "Displacement" means the relative movement of any two sides of a fault measured in any direction.

(iii) "Holocene" means the most recent epoch of the Quaternary period, extending from the end of the Pleistocene Epoch to the present.

(5) Seismic Impact Zones.

(a) New MSWLF units and lateral expansions shall not be located in seismic impact zones, unless the owner or operator demonstrates to the Division that all containment structures, including liners, leachate collection systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site.

(b) For the purposes of this Item:

(i) "Seismic impact zone" means an area with a ten percent or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10g in 250 years.

(ii) "Maximum horizontal acceleration in lithified earth material" means the maximum expected horizontal acceleration depicted on a seismic hazard map, with a 90 percent or greater probability that the acceleration will not be exceeded in 250 years, or the maximum expected horizontal acceleration based on a site-specific seismic risk assessment.

(iii) "Lithified earth material" means all rock, including all naturally occurring and naturally formed aggregates or masses of minerals or small particles of older rock that formed by crystallization of magma or by induration of loose sediments. This term does not include

man-made materials, such as fill, concrete, and asphalt, or unconsolidated earth materials, soil, or regolith lying at or near the earth surface.

(6) Unstable Areas.

(a) Owners or operators of new MSWLF units, existing MSWLF units, and lateral expansions located in an unstable area shall demonstrate that engineering measures have been incorporated into the MSWLF unit's design to ensure that the integrity of the structural components of the MSWLF unit will not be disrupted. The owner or operator shall consider the following factors, at a minimum, when determining whether an area is unstable:

(i) On-site or local soil conditions that may result in significant differential settling;

(ii) On-site or local geologic or geomorphologic features; and

(iii) On-site or local human-made features or events (both surface and subsurface).

(b) For purposes of this Item:

(i) "Unstable area" means a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity of some or all of the landfill structural components responsible for preventing releases from a landfill. Unstable areas can include poor foundation conditions, areas susceptible to mass movements, and Karst terranes.

(ii) "Structural components" means liners, leachate collection systems, final covers, run-on or run-off systems, and any other component used in the construction and operation of the MSWLF that is necessary for protection of human health and the environment.

(iii) "Poor foundation conditions" means those areas where features exist which indicate that a natural or man-induced event may result in inadequate foundation support for the structural components of an MSWLF unit.

(iv) "Areas susceptible to mass movement" means those areas of influence (i.e., areas characterized as having an active or substantial possibility of mass movement) where the movement of earth material at, beneath, or adjacent to the MSWLF unit, because of natural or man-induced events, results in the downslope transport of soil and rock material by means of gravitational influence. Areas of mass movement include, but are not limited to, landslides, avalanches, debris slides and flows, soil fluction, blocksliding, and rock fall.

(v) "Karst terranes" means areas where karst topography, with its characteristic surface and subterranean features, is developed as the result of dissolution of limestone, dolomite, or other soluble rock. Characteristic physiographic features present in karst terranes include, but are not limited to, sinkholes, sinking streams, caves, large springs, and blind valleys.

(7) Cultural Resources. A new MSWLF unit or lateral expansion shall not damage or destroy an archaeological or historical property. The Department of Cultural Resources shall determine archeological or historical significance. To aid in making a determination as to whether the property is of archeological or historical significance, the Department of Cultural Resources may request the owner or operator to perform a site-specific survey which shall be included in the Site Study.

(8) State Nature and Historic Preserve. A new MSWLF unit or lateral expansion shall not have an adverse impact on any lands included in the State Nature and Historic Preserve.

(9) Water Supply Watersheds.

(a) A new MSWLF unit or lateral expansion shall not be located in the critical area of a watersupply watershed or in the watershed for a stream segment classified as WS-I, in accordance with the rules codified at 15A NCAC 2B .0200 - "Classifications and Water Quality Standards Applicable To Surface Waters Of North Carolina."

(b) Any new MSWLF unit or lateral expansion, which shall discharge leachate to surface waters at the landfill facility and must obtain a National Pollution Discharge Elimination System (NPDES) Permit from the Division of Environmental Management pursuant to Section 402 of the United States Clean Water Act, shall not be located within watersheds classified as WS-II or WS-III, in accordance with the rules codified at 15A NCAC 2B .0200 - "Classifications and Water Quality Standards Applicable To Surface Waters Of North Carolina."

REFERENCE 2

RCRA Subtitle D Regulation Part 258.14, July 1, 1996.

(1) *Fault* means a fracture or a zone of fractures in any material along which strata on one side have been displaced with respect to that on the other side.

(2) *Displacement* means the relative movement of any two sides of a fault measured in any direction.

(3) *Holocene* means the most recent epoch of the Quaternary period, extending from the end of the Pleistocene Epoch to the present.

§ 258.14 Seismic impact zones.

(a) New MSWLF units and lateral expansions shall not be located in seismic impact zones, unless the owner or operator demonstrates to the Director of an approved State/Tribe that all containment structures, including liners, leachate collection systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site. The owner or operator must place the demonstration in the operating record and notify the State Director that it has been placed in the operating record.

(b) For the purposes of this section:

(1) *Seismic impact zone* means an area with a ten percent or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10g in 250 years.

(2) *Maximum horizontal acceleration in lithified earth material* means the maximum expected horizontal acceleration depicted on a seismic hazard map, with a 90 percent or greater probability that the acceleration will not be exceeded in 250 years, or the maximum expected horizontal acceleration based on a site-specific seismic risk assessment.

(3) *Lithified earth material* means all rock, including all naturally occurring and naturally formed aggregates or masses of minerals or small particles of older rock that formed by crystallization of magma or by induration of loose sediments. This term does not include man-made materials, such as fill, concrete, and asphalt, or unconsolidated earth materials, soil, or regolith lying at or near the earth surface.

[56 FR 51016, Oct. 9, 1991; 57 FR 28627, June 26, 1992]

§ 258.15 Unstable areas.

(a) Owners or operators of new MSWLF units, existing MSWLF units, and lateral expansions located in an unstable area must demonstrate that engineering measures have been incorporated into the MSWLF unit's design to ensure that the integrity of the structural components of the MSWLF unit will not be disrupted. The owner or operator must place the demonstration in the operating record and notify the State Director that it has been placed in the operating record. The owner or operator must consider the following factors, at a minimum, when determining whether an area is unstable:

(1) On-site or local soil conditions that may result in significant differential settling;

(2) On-site or local geologic or geomorphologic features; and

(3) On-site or local human-made features or events (both surface and subsurface).

(b) For purposes of this section:

(1) *Unstable area* means a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity of some or all of the landfill structural components responsible for preventing releases from a landfill. Unstable areas can include poor foundation conditions, areas susceptible to mass movements, and Karst terranes.

(2) *Structural components* means liners, leachate collection systems, final covers, run-on/run-off systems, and any other component used in the construction and operation of the MSWLF that is necessary for protection of human health and the environment.

(3) *Poor foundation conditions* means those areas where features exist which indicate that a natural or man-induced event may result in inadequate foundation support for the structural components of an MSWLF unit.

(4) *Areas susceptible to mass movement* means those areas of influence (i.e., areas characterized as having an active

REFERENCE 3

Amec Foster Wheeler. “Phase 2 Reconstitution of Ash Basin Design, Final Report Submittal, Revision A, Dan River Steam Station (Decommissioned)”, January 30, 2015.

The shear wave velocities from the seismic CPTs were also evaluated. The seismic velocity below CPT terminated depth is assumed to be the same as the recorded seismic velocity at the terminated depth of the CPT sounding. This assumption is conservative, since the CPTs were terminated in soils, and did not measure seismic velocity in the rock, which would be significantly higher than the seismic velocity in the soil.

The analyses of sixteen borings using both the SPTs and seismic CPTs are attached and the results are summarized in **Table 1.**

4.1 Ground Acceleration Determination

The resulting Site Class for the upper 100 ft (30m) of soil, weathered rock, and rock below the foundation level beneath the site is used to determine the amplification factor to apply to the PGA_{rock}, and then to determine the PGA_{design} at the original ground surface. The calculation for PGA_{rock} and the associated earthquake magnitude is contained in Calculation Package G-001.

The table of amplification ratios from the seismic hazard calculation is included in **Table 2**.
Using Amplification Factor of 1.6 for Site Class D, we have:

- Near-Field Earthquake, M_W = 5.03, PGA_{rock} = 0.053 g, PGA_{design} = 0.085 g
- Far-Field Earthquake, M_w = 7.39, PGA_{rock} = 0.036 g , PGA_{design} = 0.058 g

Table 1 – Seismic Site Class Evaluation Results

Boring ID	Boring Ground Elev. (ft)	Depth from Boring Ground to Last SPT/CPT reading (ft)	Depth from Foundation to Last SPT/CPT reading (ft)	Blow Count Weighted Avg. to 100-ft (blows/ft)	Velocity Weighted Avg. to 100-ft (ft/s)	Seismic Site Class
SPT DR-1	528.6	46.0	19.0	31.6		D
SPT DR-2	529.1	46.0	19.0	31.5		D
SPT DR-3	529.3	44.1	12.1	38.8		D
CPT-2	529.3	41.6	9.6		1243	C
SPT DR-4	529.6	50.5	18.5	34.1		D
SPT DR-5	529.4	61.5	34.5	18.8		D
SPT DR-6	529.5	53.7	21.7	12.8		E
SPT DR-7	539.6	68.5	31.5	17.8		D
SPT DR-8	539.4	64.1	27.1	15.4		D
CPT-8	496.4	18.9	13.9		752	D
SPT DR-15	496.3	24.1	19.1	9.8		E
SPT DR-13	539.5	68.0	31.0	15.9		D
CPT-6	539.4	57.9	15.9		1272	C
SPT DR-12	539.9	68.0	26.0	22.3		D
SPT DR-11	539.7	73.5	36.5	22.2		D
SPT DR-14	539.5	63.5	23.5	16.2		D

Table 2 – Amplification Ratios from PGA_{rock} to PGA_{design}

Site Class	Peak Ground Acceleration Values at site (PGA_{design})/Peak Ground Acceleration at base rock layer (PGA_{rock})				
	$PGA_{rock} \leq 0.1g$	$PGA_{rock} = 0.2g$	$PGA_{rock} = 0.3g$	$PGA_{rock} = 0.4g$	PGA_{rock} ñ 0.5g
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	*	*	*	*	*

* Site-specific geotechnical investigation and dynamic site response analysis is warranted to develop appropriate values.

For the embankment fill, peak ground acceleration at the crest of the dam (PGA_{crest}) was estimated as 0.309g (Near-Field) and 0.231g (Far-Field) using the chart developed by Harder (1991) that compares recorded base and peak crest accelerations at earth dams in several earthquakes (**Figure 1**).

This PGA_{crest} value is considered potentially conservative due to the Harder curve representing the upper bound for observed motions.

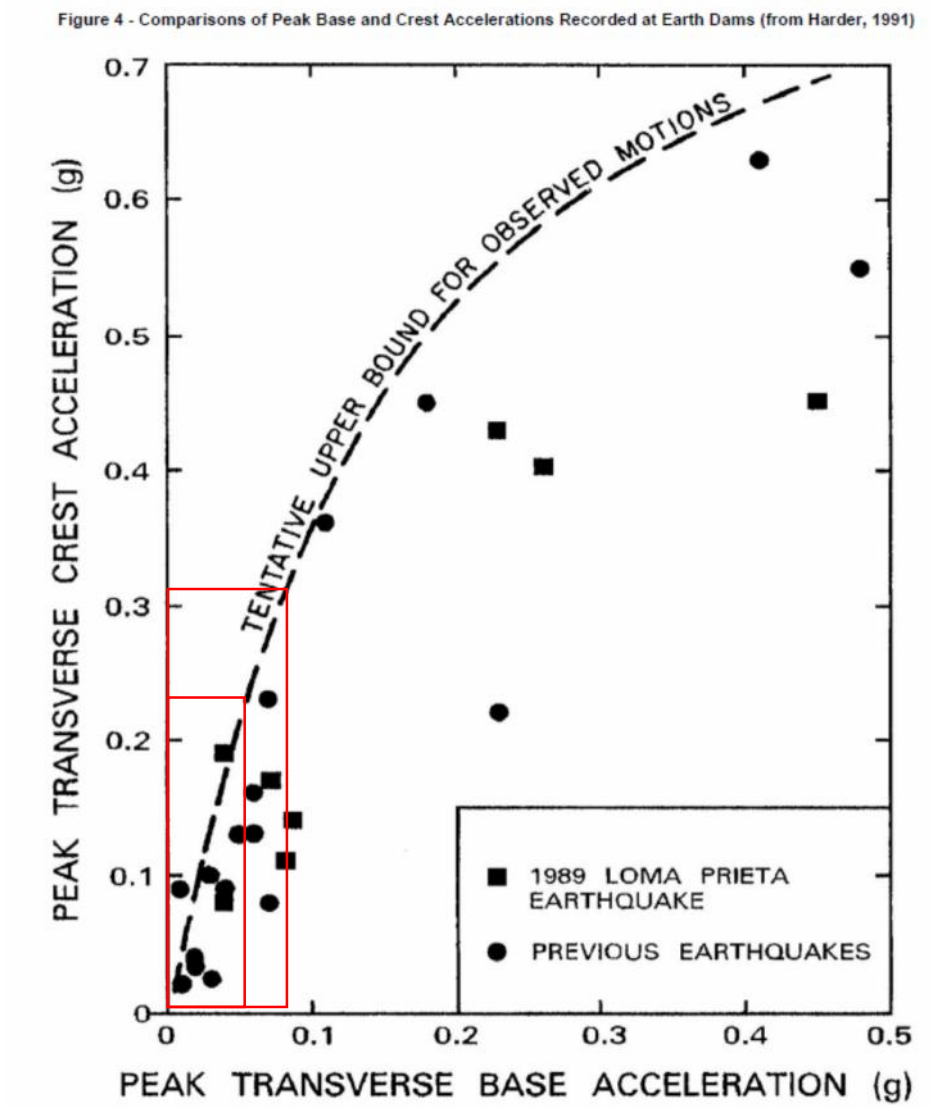


Figure 1 – Base crest peak accelerations of earth dams (Harder, 1991)

For evaluation of the foundation soils under the embankment in borings performed at the crest, PGA_{design} is adjusted using the stress reduction coefficient (r_d) based on the embankment fill thickness: $PGA_{adjusted} = PGA_{design} / r_d$. The stress reduction coefficient is computed using the equation below.

$$r_d = exp\left(-1.012 - 1.126\sin\left(\frac{z}{11.73} + 5.133\right) + \left(0.106 + 0.118\sin\left(\frac{z}{11.28} + 5.142\right)\right)M\right)$$

where: z = depth from the crest to the top of the foundation in meters.

This method applies the PGA_{design} at the top of foundation soils below the embankment when using the spreadsheet from the crest. Peak ground accelerations adjusted for embankment fill thickness are summarized in **Table 3.**

REFERENCE 4

Makdisi, Faiz I. and H. Bolton Seed. “Simplified Procedure for Estimating Dam and Embankment Earthquake-Induced Deformations”, Journal of the Geotechnical Engineering Division, July 1978.

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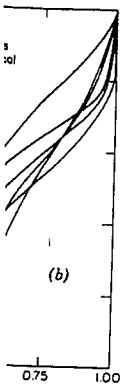

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the average acceleration histories for various levels were computed for embankments subjected to ground accelerations recorded in the El Centro earthquake of 1940. The variation of the maximum average acceleration, k_{max}, with depth for these embankments with natural periods ranging between 0.26 sec–5.22 sec is presented in Fig. 5(a). The maximum average acceleration in Fig. 5(a) is normalized with respect to the maximum crest acceleration and the ratio, $k_{max}/\ddot{u}_{max}$, plotted as a function of the depth of the sliding mass is presented in Fig. 5(b).

Ambraseys and Sarma (1) used essentially the same method reported by Seed and Martin (26) and calculated the response of embankments with natural periods ranging between 0.25 sec and 3.0 sec. They presented their results in terms of average response for eight strong motion records. The variation of maximum average acceleration with depth based on the results reported by Ambraseys and Sarma (1) is shown in Fig. 6(a) and that for the maximum acceleration ratio, $k_{max}/\ddot{u}_{max}$, is shown in Fig. 6(b). A summary of the results obtained

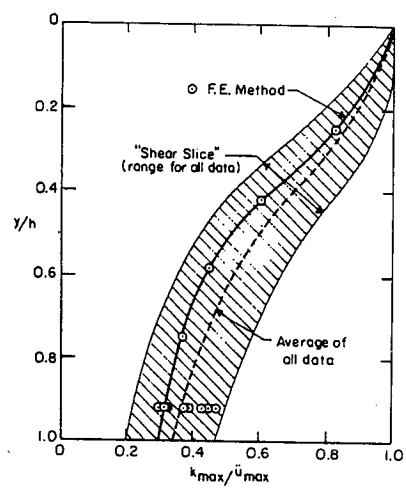

FIG. 7.—Variation of Maximum Acceleration Ratio with Depth of Sliding Mass

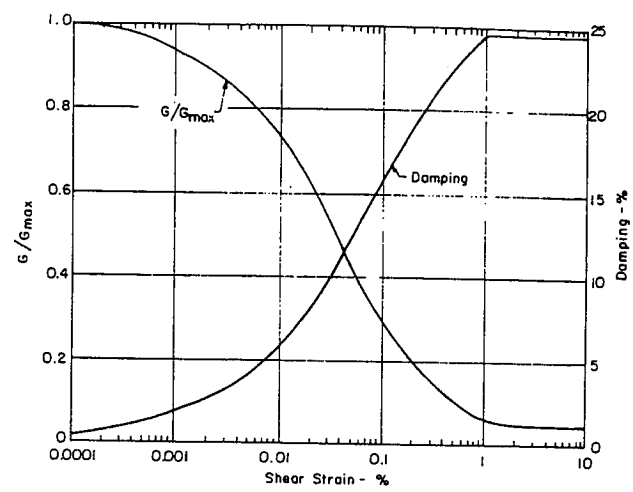

FIG. 8.—Shear Modulus and Damping Characteristics Used in Response Computations

from the different shear slice response calculations mentioned previously is presented in Fig. 7 together with results obtained from finite element calculations made in the present study. As can be seen from Fig. 7 the shape of the curves obtained using the shear slice method and the finite element method are very similar. The dashed curve in Fig. 7 is an average relationship of all data considered. The maximum difference between the envelope of all data and the average relationship ranges from ±10% to ±20% for the upper portion of the embankment and from ±20% to ±30% for the lower portion of the embankment.

Considering the approximate nature of the proposed method of analysis, the use of the average relationship shown in Fig. 7 for determining the maximum average acceleration for a potential sliding mass based on the maximum crest acceleration is considered accurate enough for practical purposes. For design computations where a conservative estimate of the accelerations is desired the upper bound curve shown in Fig. 7 may be used leading to values that are 10%–30% higher than those estimated using the average relationship.

APPENDIX III-2

Slope Stability Calculation

Calculation Title:
Slope Stability Calculation

Summary:
Four cross-sections of the proposed landfill were identified to represent critical slope stability scenarios in different parts of the landfill. The cross-sections were analysed for static and pseudo-static conditions. The analyses indicated that the factors of safety for the specified analyses of each cross-section meet or exceed the minimum design criteria.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal			
		Tryambak Kaushik	**C. Lee Eaves**	**Cedric Ruhl**

OBJECTIVE:

This calculation evaluates global, shallow and liner interface slope stability of the proposed Dan River Landfill.

METHOD:

An on-site landfill is proposed for CCR material at Dan River Steam Station. Deep, shallow and liner interface slope failure modes were analyzed at four cross-sections of the proposed landfill.

Slope stability was evaluated for both the post-construction static and the post-construction pseudo-static cases. Geostudio's SLOPE/W computer program was used to evaluate slope stability [Ref. 4]. All slope stability analyses presented here assumed plane strain conditions (i.e., 2-dimensional cross-sections which ignore 3-dimensional strain effects).

DEFINITION OF VARIABLES:

CU = consolidated undrained;
w = gravimetric water content;
w_{OMC} = optimum gravimetric water content from standard proctor test;
γ_{design} = design unit weight of soil used in slope stability analysis (lb/ft^3);
γ_{dry} = dry unit weight of soil (lb/ft^3);
γ_{dry_max} = maximum dry unit weight of soil (lb/ft^3);
γ_{moist} = moist unit weight of soil (lb/ft^3);
$\gamma_{moist_95,OMC}$ = moist unit weight of soil compacted at 95% maximum dry density and optimum moisture content of standard proctor (lb/ft^3);
$\gamma_{moist_95,5}$ = moist unit weight of soil compacted at 95% maximum dry density and 5% wet of optimum moisture content of standard proctor (lb/ft^3);
φ' = drained friction angle of soil;
c' = drained cohesion of soil (lb/ft^2);
φ = undrained friction angle of soil;
c = undrained cohesion of soil (lb/ft^2).

CALCULATIONS:

1.0 Define Target Safety Factors

A target factor of safety of 1.5 for the post-construction static slope stability was chosen as per USACE (2003) [Ref. 1]. For the post-construction pseudo-static case, a target factor of safety of 1.0 was selected for slope stability as per USEPA's "Seismic Design Guidance for Municipal Solid Waste Landfill Facilities" [Ref. 2].

2.0 Describe Critical Cross-Sections

Ash fill, landfill liner, residuum, structural fill, and bed rock constitute the different material layers of the landfill. Four cross-sections (sections 1 through 4) were assumed to represent all possible critical slope failure scenarios for the landfill (Figure 1 and Figure 2).

The cross-sections were chosen based on the possible critical slope failure of the proposed impounded ash, proposed subgrade, and existing grade (Figure 1 and Figure 2). Cross-sections 1 and 2 were selected to represent critical slope failure surfaces at the south section of the landfill. Cross-section 3 represents critical slope failure for the west portion of the landfill and cross-section 4 was selected to represent slope failure in the northern part of the landfill.

3.0 Describe Materials

Geotechnical parameters were developed for bedrock, residuum, structural fill, landfill liner, and waste/ash fill materials.

3.1 Bedrock

Bedrock material was generally defined as auger refusal material identified during subsurface exploration [Ref. 3].

3.2 Residuum

Residuum material consists of existing soils that remain undisturbed. Based on the samples obtained from the subsurface exploration, residuum generally consists of silty clay and weathered rock [Ref. 3].

3.3 Structural Fill

Fill material will consist of re-compacted residual materials placed to achieve the design grades for the landfill subgrade, perimeter roads and channels, and other landfill features.

3.4 Landfill Liner Fill

The landfill liner system (located below the waste material) is anticipated to consist of the following components, from top to bottom:

- 24-inch thick protective cover;
- Geocomposite drainage layer;
- Primary 60-mil HDPE geomembrane;
- Geocomposite leak detection layer;
- Secondary 60-mil HDPE geomembrane;
- Geosynthetic clay liner (EPA rules); and
- 12-inch thick compacted soil liner.

The landfill liner system was characterized as one material type and the strength parameters were defined to approximate the estimated lower bound of the combined strength parameters of the liner system based on engineering judgment from previous experience. Prior to construction of the landfill, interface shear strength testing will be required to verify that the minimum interface shear strength values are achieved for project-specific geosynthetic materials and site specific soil materials.

3.5 Waste/Ash Fill

Landfilled waste material and existing Ash Fill 1 ash material was assumed to primarily consist of compacted ash fill from coal combustion generated at Dan River Steam Station.

4.0 Define Material Parameters and Conditions for Stability Analyses

For the long term post-construction static condition it was assumed that the waste fill has been placed and excess pore water pressures, if any, have dissipated. Strength parameters based on drained shear strength were used for this condition. The target safety factor is 1.5 for both the global and liner interface post-construction static cases, as discussed in section 1 of this calculation.

For the post-construction pseudo-static condition, it was conservatively assumed that the critical seismic event generates a horizontal acceleration of 0.12 and a vertical acceleration of 0.08 with respect to gravity, based on “Seismic Coefficient Calculation”. Seismic forces were assumed to cause a temporary increase in inertial forces, thereby de-stabilizing the landfill slope. A target safety factor of 1.0 was selected for the post-construction pseudo-static cases, as discussed in section 1 of this calculation.

The material properties of residuum, structural fill and ash were based on soil exploration and laboratory test as presented in the report by Amec Foster Wheeler [Ref. 3]. Standard Proctor tests and consolidated undrained (CU) triaxial tests were conducted on the undisturbed and remolded samples to determine geotechnical properties of different soil layers. The shear strength failure envelope was developed using CU test results to evaluate drained and undrained shear strength parameters of the soil materials. The drained shear strength failure envelope was based on the maximum principal stress ratio failure criteria and was used to evaluate static slope stability while the undrained shear strength failure envelope was based on the maximum deviator stress ratio failure criteria and was used to evaluate pseudo-static slope stability.

For a given cross-section, the phreatic surface was conservatively extrapolated at the same elevation head beyond the limit of observation to the limit of cross-section in slope stability analysis. Similarly, the extents of residuum and bedrock layers were also limited by the available subsurface exploration data and were extrapolated for the completeness of cross-section definition in the slope stability analysis.

4.1 Pore Water Pressures

The phreatic surfaces used in the slope stability models were developed using groundwater data collected from onsite monitoring wells on May 27, 2015 [Ref. 3].

4.2 Material Parameters for Residuum and Structural Fill

Three relatively undisturbed samples of residuum collected during the subsurface exploration were tested for geotechnical engineering properties. The residuum soil was evaluated to have an average moist density of 122.7 pcf (Table 1). Drained shear strength of residuum was estimated to have a cohesion of 150 pcf and friction angle of 32° (Figure 1) while undrained shear

strength of residuum was estimated to have a cohesion of 800 pcf and friction angle of 15° (Figure 2).

Table 1: Undisturbed Sample Laboratory Test Results - Residuum

Sample No.	Sample [Ref. 3]	Depth (feet) [Ref. 3]	Water Content {w} (%) [Ref. 3]	Dry Unit Weight {γ_{dry}} (pcf) [Ref. 3]	Moist Unit Weight {γ_{moist}} (pcf) [Ref. 3]
1	OW-406D	2-4	31.3	89.8	117.9
2	OW-407D	43.5-45.5	24.9	96.7	120.8
3	OW-417D	2-4	26.5	102.4	129.5
				Average =	122.7

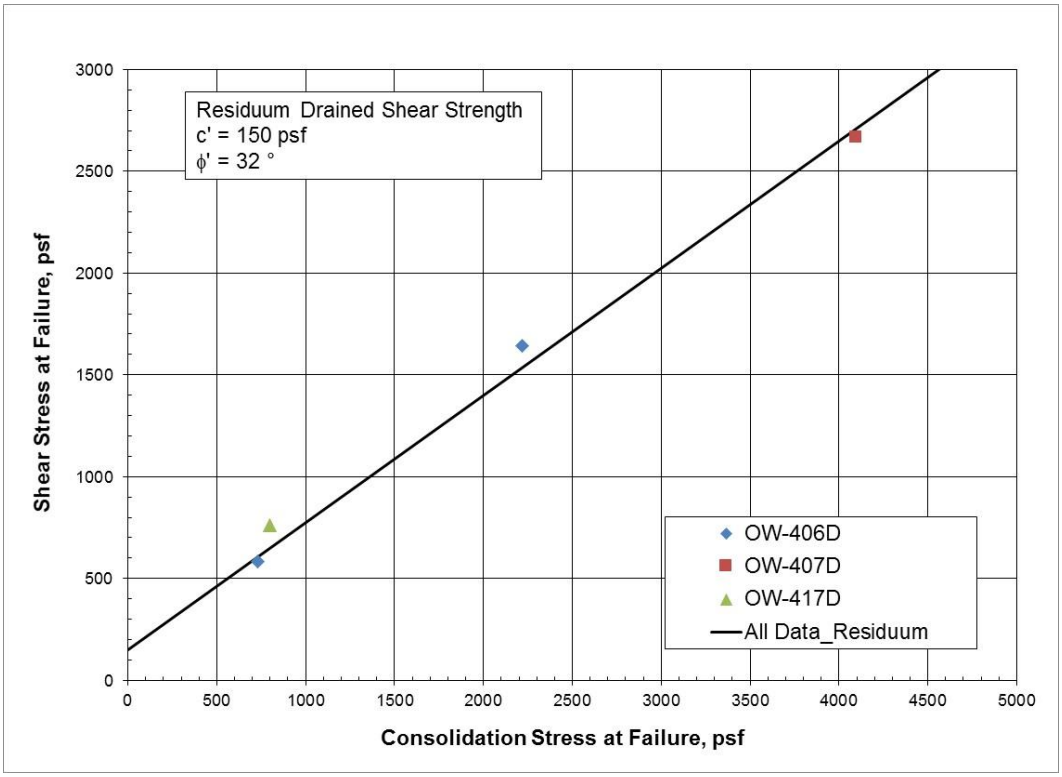

Figure 1: Drained shear strength parameters for residuum soil

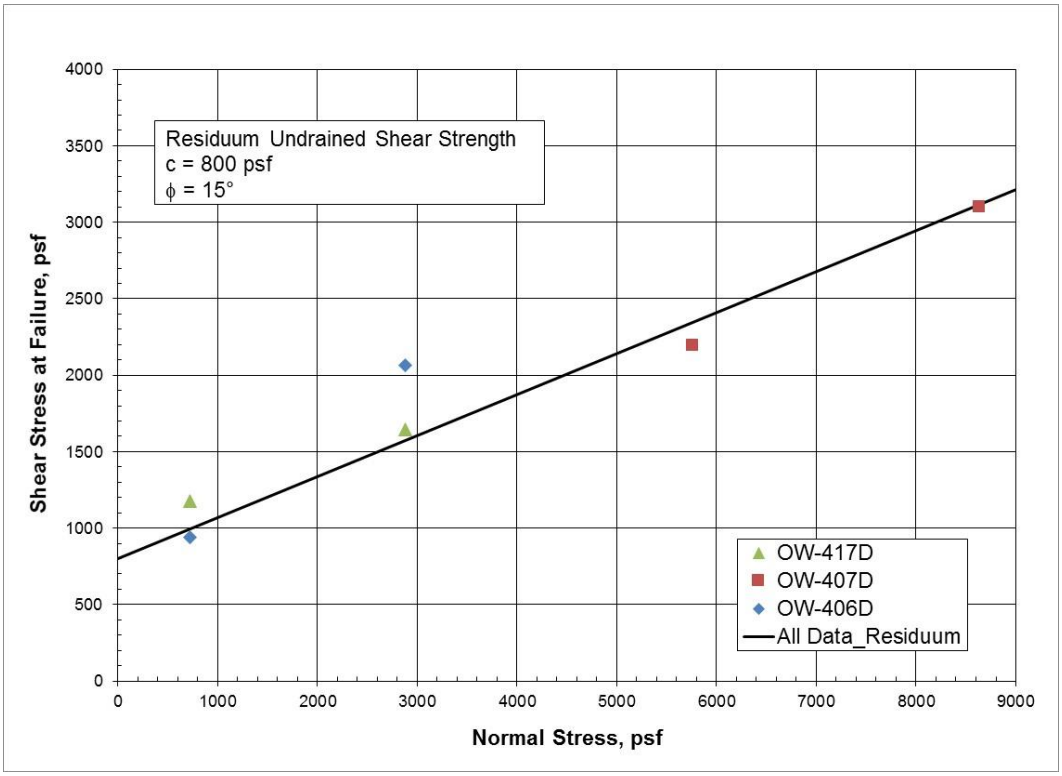

Figure 2: Undrained shear strength parameters for residuum soil

Similarly, the structural fill soil was evaluated to have an average moist density of 117.8 pcf based on four subsurface exploration and laboratory testing samples (Table 2). Drained shear strength of structural fill was estimated to have a cohesion of 200 pcf and a friction angle of 27° (Figure 3) while undrained shear strength of structural fill was estimated to have a cohesion of 700 pcf and a friction angle of 20° (Figure 4).

Table 2: Standard Proctor Test Results - Structural Fill

Sample No.	Sample [Ref. 3]	Depth (feet) [Ref. 3]	Optimum Water Content {w_{OMC}} (%) [Ref. 3]	Maximum Dry Unit Weight {γ_{dry_max}} (pcf) [Ref. 3]	Moist Unit Weight {γ_{moist}} (pcf) [Ref. 3]	Moist Unit Weight @ 95% {$\gamma_{moist_95,OMC}$} (pcf) [Ref. 3]
1	B452	0-10	24.9	96.5	120.5	114.5
2	B453	0-10	23.5	97.7	120.7	114.6
3	B463	0-10	21.8	100.9	122.9	116.8
4	OW-412S	10-20	15.2	114.5	131.9	125.3
				Average =	124.0	117.8

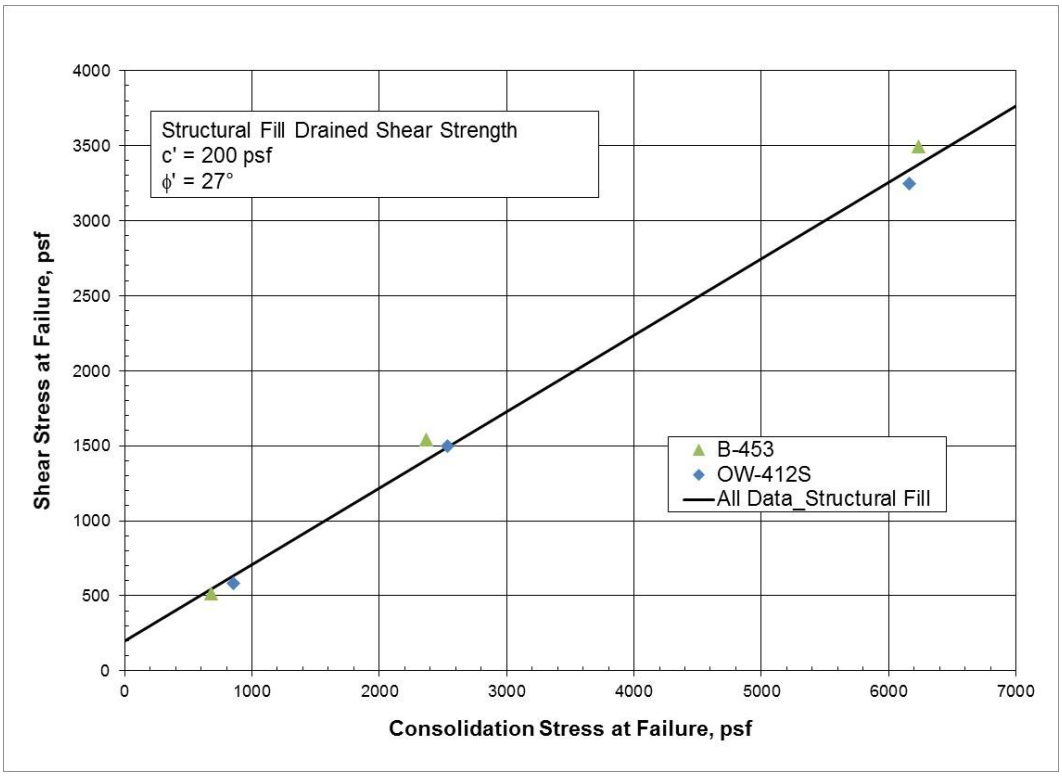

Figure 3: Drained shear strength parameters for structural fill soil

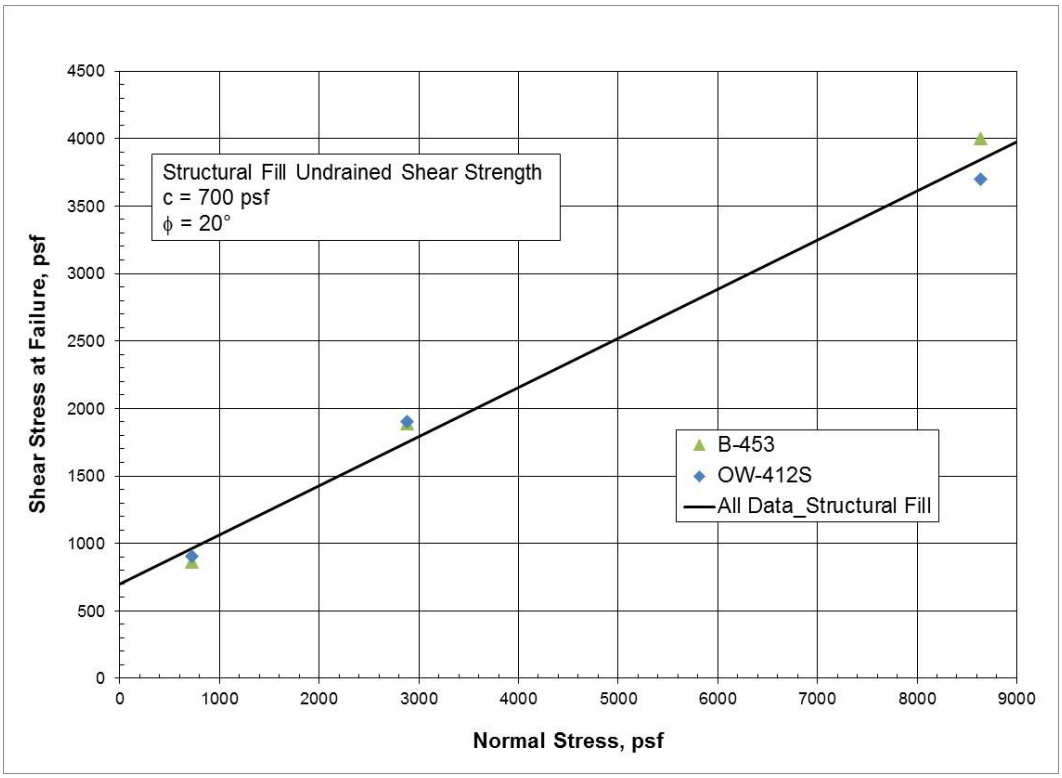

Figure 4: Undrained shear strength parameters for structural fill soil

4.3 Material Parameters for Ash

Ash was conservatively assumed to be compacted to 95% of the maximum dry density at 5% wet of optimum moisture content. Thus, the ash fill material in the landfill was evaluated to have an average moist density of 101.1 pcf (Table 3). Drained shear strength of ash material was estimated to have a cohesion of 0 pcf and a friction angle of 33° (Figure 5). Undrained shear strength of ash material was estimated to have a cohesion of 440 pcf and a friction angle of 29° (Figure 6).

Table 3: Standard Proctor Test Results - Ash

Sample No.	Sample [Ref. 3]	Depth (feet) [Ref. 3]	Optimum Water Content $\{w_{OMC}\}$ (%) [Ref. 3]	Maximum Dry Unit Weight $\{\gamma_{dry_max}\}$ (pcf) [Ref. 3]	Moist Unit Weight @ 95% at 5% wet of OMC $\{\gamma_{moist_95,5}\}$ (pcf) [Ref. 3]
1	B319	10-20	28.9	74.9	95.3
2	B322	38.5-48.5	23.2	87.5	106.6
3	B322	48.6-58.5	22.8	88.9	107.9
4	B324	25-35	31.75	73.0	94.8
				Average =	101.1

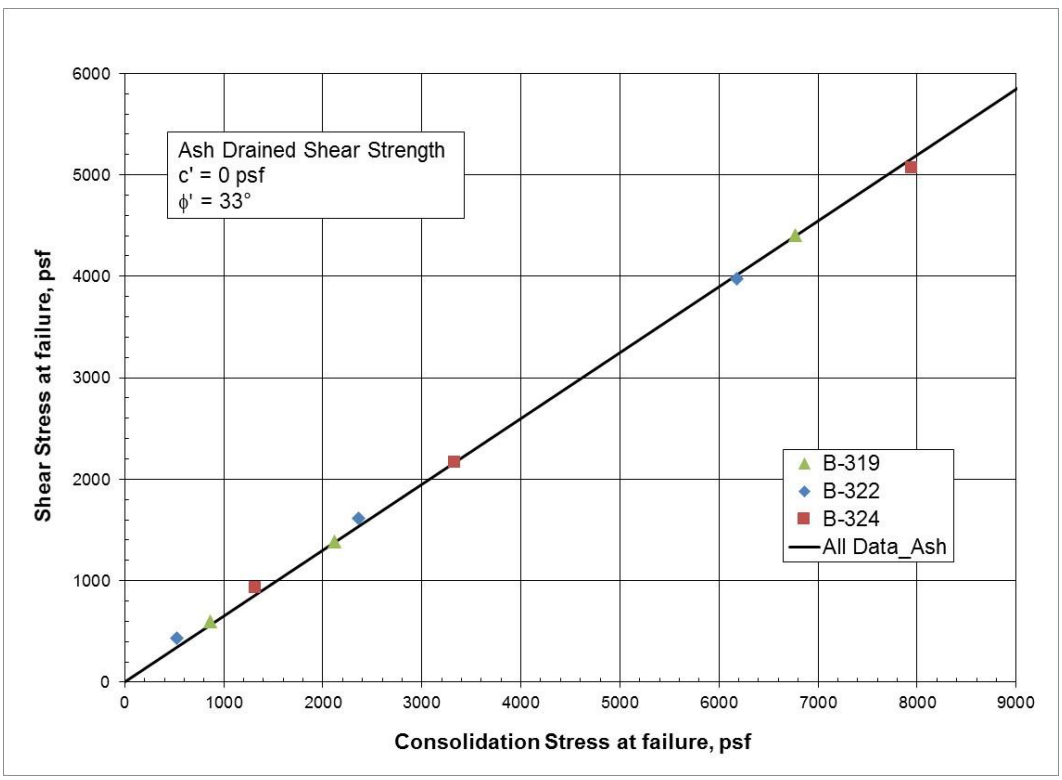

Figure 5: Drained shear strength parameters for ash fill soil

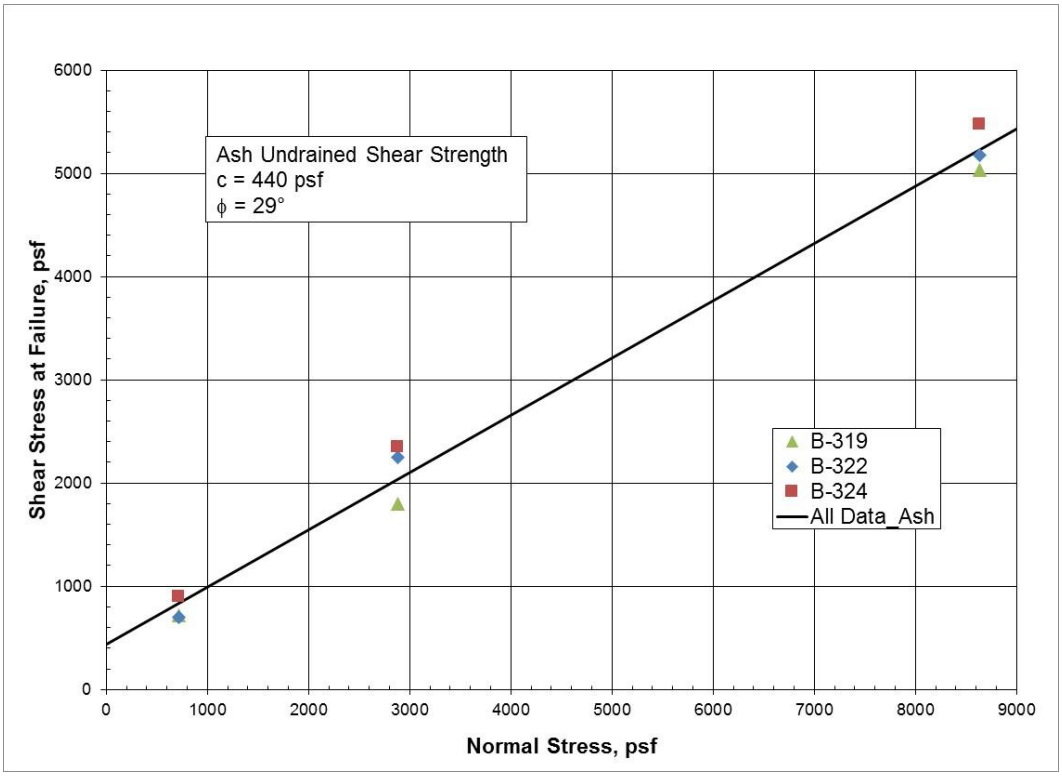

Figure 6: Undrained shear strength parameters for ash fill soil

4.4 Material Parameters for Liner System

The shear strength parameters of the liner system were based on the engineering judgment of the geotechnical engineer. The liner system was conservatively assumed to have the uniform total unit weight of 117.8 pcf which was same as the structural fill. The liner material was assumed to behave as cohesionless material with a friction angle of 16.5° for both drained and undrained conditions.

4.5 Material Parameters for Bedrock

The bottom-most layer was assumed to be bedrock and assigned the default bedrock parameters in Slope/W. These assigned parameters make the bedrock "impenetrable" and do not allow the critical slip surface to pass through this material.

A summary of material parameters used in the slope stability analyses is presented in the following Table 4.

Table 4: Summary of Material Parameters						
S.No.	Material	Design Unit Weight {γ_{design}} (pcf)	Measured Effective Cohesion {c'} (psf)	Measured Effective Friction Angle {ϕ'} (degrees)	Measured Total Cohesion {c} (psf)	Measured Total Friction Angle {ϕ} (degrees)
1	Ash Fill	101.1	0	33	440	29
2	Liner	117.8	0	16.5	0	16.5
3	Structural Fill	117.8	200	27	700	20
4	Residuum	122.7	150	32	800	15
5	Bedrock	Default Slope/W properties				

5.0 Slope Stability Analyses Results

Spencer's method and grid and radius search parameters were used in Geostudio SLOPE/W version 8.14.1.10087 program for the slope stability analyses of Dan River landfill. The critical surface was defined as the slip surface with the minimum factor of safety against slope failure. Only the critical slope failures are reported herein for the brevity of presentation.

5.1 Shallow Failure Slope Stability

A shallow failure surface was defined as the slope failure surface having a depth of less than 10 feet below the ground surface. A minimum safety factor of 1.77 was evaluated for static slope failure cases among all cross-sections for the allowable static factor of safety of 1.5, while the minimum safety factor was 1.14 for pseudo-static failure cases among all cross-sections for an allowable factor of safety of 1.0 [Table 5]. Hence, all sections were safe in shallow slope stability for both static and pseudo-static analysis.

5.2 Deep Failure Slope Stability

A deep failure surface was defined as the slip surface having a depth of greater than 10 feet below the ground surface. All sections were safe in deep slope stability for both pseudo-static and static analyses with the predicted minimum factors of safety of 1.15 and 1.79, respectively [Table 5].

5.3 Liner Interface Stability

Liner interface stability was modeled by assuming a block-type failure along the liner interface. The liner interface was modeled as a single material having no cohesion. For the liner interface stability analyses, the liner strength (interface friction angle) was assumed to be 16.5° while the unit weight was assumed to be same as structural fill. All cross-sections passed in liner interface slope stability for pseudo-static cases with a minimum value of 1.12 which is greater than the minimum allowable value of 1.0. Similarly, the predicted minimum factor of safety for the static case was 1.53 which is greater than minimum allowable factor of safety of 1.5. Hence, it is recommended to ensure a minimum value of liner interface friction angle of 16.5°.

5.4 Proposed Slope Stability

A small embankment slope is proposed in the north part of the landfill to tie into existing grades. This small embankment was independently evaluated for static and pseudo-static slope failure criteria. The proposed slope had a predicted factor of safety of 1.97 for pseudo-static condition

and a predicted factor of safety of 2.04 for static conditions for the corresponding allowable factor of safety of 1.0 and 1.5. Hence, the proposed slope is safe in static and pseudo-static conditions.

Table 5: Summary of Slope Stability Results

Section	Analysis No.	Failure Type	Condition	Estimated Safety Factor	Minimum Required Safety Factor	Estimated Safety Factor > Minimum Required Safety Factor
1	1	Deep	Pseudo-Static	1.37	1.0	YES
	2		Static	1.79	1.5	YES
	3	Liner	Pseudo-Static	1.12	1.0	YES
	4		Static	1.53	1.5	YES
	5	Shallow	Pseudo-Static	1.19	1.0	YES
	6		Static	1.77	1.5	YES
2	7	Deep	Pseudo-Static	1.20	1.0	YES
	8		Static	1.86	1.5	YES
	9	Liner	Pseudo-Static	1.17	1.0	YES
	10		Static	1.59	1.5	YES
	11	Shallow	Pseudo-Static	1.20	1.0	YES
	12		Static	1.86	1.5	YES
3	13	Deep	Pseudo-Static	1.15	1.0	YES
	14		Static	1.97	1.5	YES
	15	Liner	Pseudo-Static	1.19	1.0	YES
	16		Static	1.63	1.5	YES
	17	Shallow	Pseudo-Static	1.14	1.0	YES
	18		Static	1.95	1.5	YES
4	19	Deep	Pseudo-Static	1.61	1.0	YES
	20		Static	2.04	1.5	YES
	21	Liner	Pseudo-Static	1.49	1.0	YES
	22		Static	1.84	1.5	YES
	23	Shallow	Pseudo-Static	1.54	1.0	YES
	24		Static	1.80	1.5	YES
	25	Slope	Pseudo-Static	1.97	1.0	YES
	26		Static	2.04	1.5	YES

6.0 Discussion

All sections had a higher estimated factor of safety than the minimum allowable factor of safety for all load cases analyzed. Site specific interface material strength testing must be performed using the site specific construction materials (geosynthetics and soil) to achieve the minimum friction angle (16.5°) requirements as identified in this calculation. Specifically, the following interfaces should be tested using ASTM D5321 or other approved procedures:

- Compacted soil liner (CSL) against geosynthetic clay liner (GCL);
- GCL against geomembrane;
- Geomembrane against geocomposite; and
- Geocomposite against protective cover soil.

Geosynthetic clay liners, geomembranes, or geocomposites can have different texturing on two sides and hence all possible interfaces should undergo interface friction testing (e.g., a geomembrane with short calendaring on one side and long calendaring on the other side should

be tested for both textures on each interface). Any of these interface combinations may result in the most critical interface strength condition which requires each condition should be properly tested and evaluated.

The normal loads used during friction testing should be representative of the normal loads that the liner system is expected to sustain. For example, if 150 feet of ash waste fill with a moist unit weight of 101.1 pcf will be placed on top of the liner system, the anticipated normal load will be on the order of 15,000 psf. In this situation, interface friction testing normal loads on the order of 1,000 psf, 4,000 psf, 8,000 psf, and 16,000 psf will likely provide interface friction information within the range of normal loads that will be imposed on the cover system. Maximum interface friction testing normal loads may be limited by the testing equipment.

A valid interpretation of interface friction testing results is very important. One method of reviewing interface friction testing results is to superimpose a line with a slope angle equal to the required interface friction angle and a y-intercept of 0. The interfaces are expected to be stable for interface stability for those normal loads where the reported peak interface friction envelope is higher than the superimposed line. Based on the current slope stability calculations, the minimum peak interface friction angle for all material interfaces or combinations thereof that make up the liner system should have a minimum equivalent interface friction greater than 16.5°, based on a zero cohesion intercept over the anticipated range of normal loads.

FIGURES:

1. Slope stability calculations cross-sections locations landfill subgrade
2. Slope stability calculations cross-sections locations landfill final cover

REFERENCES:

1. "USACE, Engineering and Design – Slope Stability," EM 1110-2-1902, October 31, 2003.
2. USEPA, "*RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities*", Office of Research and Development, EPA/600/R-95/051, April 1995.
3. "Hydrogeologic Study – Dan River Landfill", Amec Foster Wheeler, July 15, 2015.
4. GEOSLOPE International (2013). GeoStudio 2012, Version 8.14.1.10087, December 2014 Release.

FIGURES

Amec Foster Wheeler Environment & Infrastructure, Inc.
2801 YORKMONT ROAD, SUITE 100
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LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

CLIENT LOGO

CLIENT
DUKE ENERGY CAROLINAS
ROCKINGHAM COUNTY, NC

PROJECT: DAN RIVER LANDFILL	DWN BY: TK	DATUM: NAD99	DATE: 08/17/2015
TITLE: SLOPE STABILITY CALCULATIONS CROSS SECTION LOCATIONS PROPOSED LANDFILL SUBGRADE	CHK'D BY: CHR	REV. NO.: A	PROJECT NO: 7810-14-0065
	PROJECTION: UTM Zone 0	SCALE: AS SHOWN	FIGURE No. FIGURE 1

Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Work\TK\Landfill\2015-0805-SlopeStabilitySections.dwg - 8.5x11_Subgrade - Aug. 08, 2015 7:21pm - tryambak.kaushik

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ROCKINGHAM COUNTY, NC

PROJECT: DAN RIVER LANDFILL	DWN BY: TK	DATUM: NAD99	DATE: 08/17/2015
TITLE: SLOPE STABILITY CALCULATIONS CROSS SECTION LOCATIONS PROPOSED LANDFILL TOP OF FINAL COVER	CHK'D BY: CHR	REV. NO.: A	PROJECT NO: 7810-14-0065
	PROJECTION: UTM Zone 0	SCALE: AS SHOWN	FIGURE No. FIGURE 2

Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Work\TK\Landfill\2015-0805-SlopeStabilitySections.dwg - 8.5x11_TopCover - Aug. 08, 2015 7:20pm - tryambak.kaushik

REFERENCE 1

“USACE, Engineering and Design – Slope Stability,” EM 1110-2-1902, October 31, 2003.

Table 3-1
Minimum Required Factors of Safety: New Earth and Rock-Fill Dams

Analysis Condition[1]	Required Minimum Factor of Safety	Slope
End-of-Construction (including staged construction)[2]	1.3	Upstream and Downstream
Long-term (Steady seepage, maximum storage pool, spillway crest or top of gates)	1.5	Downstream
Maximum surcharge pool[3]	1.4	Downstream
Rapid drawdown	1.1-1.3[4,5]	Upstream

[1] For earthquake loading, see ER 1110-2-1806 for guidance. An Engineer Circular, "Dynamic Analysis of Embankment Dams," is still in preparation.

[2] For embankments over 50 feet high on soft foundations and for embankments that will be subjected to pool loading during construction, a higher minimum end-of-construction factor of safety may be appropriate.

[3] Pool thrust from maximum surcharge level. Pore pressures are usually taken as those developed under steady-state seepage at maximum storage pool. However, for pervious foundations with no positive cutoff steady-state seepage may develop under maximum surcharge pool.

[4] Factor of safety (FS) to be used with improved method of analysis described in Appendix G.

[5] FS = 1.1 applies to drawdown from maximum surcharge pool; FS = 1.3 applies to drawdown from maximum storage pool.

For dams used in pump storage schemes or similar applications where rapid drawdown is a routine operating condition, higher factors of safety, e.g., 1.4-1.5, are appropriate. If consequences of an upstream failure are great, such as blockage of the outlet works resulting in a potential catastrophic failure, higher factors of safety should be considered.

(1) During construction of embankments, materials should be examined to ensure that they are consistent with the materials on which the design was based. Records of compaction, moisture, and density for fill materials should be compared with the compaction conditions on which the undrained shear strengths used in stability analyses were based.

(2) Particular attention should be given to determining if field compaction moisture contents of cohesive materials are significantly higher or dry unit weights are significantly lower than values on which design strengths were based. If so, undrained (UU, Q) shear strengths may be lower than the values used for design, and end-of-construction stability should be reevaluated. Undisturbed samples of cohesive materials should be taken during construction and unconsolidated-undrained (UU, Q) tests should be performed to verify end-of-construction stability.

d. Pore water pressure. Seepage analyses (flow nets or numerical analyses) should be performed to estimate pore water pressures for use in long-term stability computations. During operation of the reservoir, especially during initial filling and as each new record pool is experienced, an appropriate monitoring and evaluation program must be carried out. This is imperative to identify unexpected seepage conditions, abnormally high piezometric levels, and unexpected deformations or rates of deformations. As the reservoir is brought up and as higher pools are experienced, trends of piezometric levels versus reservoir stage can be used to project piezometric levels for maximum storage and maximum surcharge pool levels. This allows comparison of anticipated actual performance to the piezometric levels assumed during original design studies and analysis. These projections provide a firm basis to assess the stability of the downstream slope of the dam for future maximum loading conditions. If this process indicates that pore water pressures will be higher than those used in design stability analyses, additional analyses should be performed to verify long-term stability.

e. Loads on slopes. Loads imposed on slopes, such as those resulting from structures, vehicles, stored materials, etc. should be accounted for in stability analyses.

REFERENCE 2

USEPA, "*RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities*", Office of Research and Development, EPA/600/R-95/051, April 1995.

Observations of the satisfactory performance of landfill slopes in major earthquakes indicates that the dynamic shear strength of MSW may be significantly greater than the static shear strength. Figure 6.4 (Siegel et al., 1990) shows combinations of cohesion, friction angle, and yield acceleration that resulted a pseudo-static factor of safety of 1.0 in back analyses of the satisfactory performance of the slopes of the OII landfill in a major earthquake.

6.1.6 Sensitivity Studies

It is strongly recommended that all stability analyses of MSW landfills be performed using parametric studies to clearly identify the sensitivity of the performance of the landfill to the material properties used in the analysis. If performance depends significantly on a given parameter, then additional laboratory or field testing may be required to better define appropriate properties for design.

6.2 Seismic Stability and Deformation Analysis

A prerequisite for performing a seismic slope stability and deformation analysis is performance of a static slope stability analysis. The seismic stability and deformation analysis is carried out using the same basic model(s) of landfill (waste mass and foundation) and containment system used in the static analysis. The following steps are used in a typical seismic slope stability and deformation analysis:

Step 1: Reinterpret the cross-sections analyzed in the static stability analysis and assign appropriate dynamic strength parameters. In cases where it is not clear whether drained or undrained shear strength parameters are appropriate for the dynamic analysis, follow guidelines presented in Duncan (1992).

Step 2: Evaluate the seismic coefficient, k_s. There are many different views on how to define k_s (e.g., Seed and Martin, 1966; Seed, 1979; Marcuson, 1981; Hynes and Franklin, 1984). The most reasonable definition appears to be one that regards the seismic coefficient as an empirical factor. This definition recognizes the limitations of the pseudo-static slope stability analysis in representing the actual effects of an earthquake on the slope. Unfortunately, this definition provides no guidance to selection of an appropriate value of k_s. Seed (1979) reports that slopes and embankments designed with a minimum pseudo-static factor of safety of 1.15 using a seismic coefficient of 0.15 have experienced "acceptable" deformations in earthquakes of magnitude less than 7.5 and intensity less than

0.75 g. However, Seed's definition of acceptable deformations appears to include deformations of over one meter in some cases.

Figure 6.5 shows the results of Newmark seismic deformation analyses performed by Hynes and Franklin (1984) using 387 strong motion records and 6 artificial accelerograms. Based upon this data and their experience with seismic response analyses of slopes and embankments, Hynes and Franklin (1984) concluded that slopes and embankments with a yield acceleration equal to half the peak ground acceleration would experience permanent seismic deformations of less than one 0.3 meters (1.0 foot) in any earthquake, even for embankments where amplification of motions occurs. In the absence of amplification, the Hynes and Franklin data suggest that deformations may remain small for yield accelerations less than one-third the peak ground acceleration. Based upon the work of Hynes and Franklin, it appears that the maximum value of k_s may be safely determined as $k_s = 0.5 \cdot a_{max}/g$, where a_{max} is peak horizontal acceleration at the ground surface for analyses of the liner system and at the top of the landfill for analyses of the cover system. a_{max} can be estimated either using the simplified methods presented in Section 4 of this guidance document or from the results of a seismic response analysis.

Step 3: Perform the pseudo-static stability analysis. If the minimum factor of safety, FS_{min}, exceeds 1.0, the seismic stability analysis is completed.

Step 4: If the pseudo-static factor of safety is less than 1.0, perform a Newmark deformation analysis. This is done with the following three steps:

1) Calculate the yield acceleration, k_y. The yield acceleration is usually calculated in pseudo-static analyses using a trial and error procedure in which the seismic coefficient is varied until $FS_{min} = 1.0$ is obtained.

2) Calculate the permanent seismic deformation. The permanent seismic deformation may be calculated using either simplified design charts (e.g., Hynes and Franklin, 1984; Makdisi and Seed, 1978) or a formal time-history analysis in which the excursions of the average acceleration time history above the yield acceleration are double integrated.

3) Compare the calculated permanent seismic deformation to the allowable maximum permanent displacement, u_{max}. Seed and Bonaparte (1992) report that u_{max} values of 0.15 to 0.3 meters (0.5 to 1.0 feet) are typically used in practice for design of geosynthetic liner systems. For cover systems, where permanent seismic deformations may be observed in post-earthquake inspections and damage to components can be repaired, larger permanent deformations may be considered acceptable. In fact, some regulatory agencies consider seismic deformations of the landfill cover system primarily a maintenance problem.

Several investigators have presented simplified charts based upon the results of Newmark deformation analyses for estimating permanent seismic deformations. Makdisi and Seed (1978) developed the chart shown in Figure 6.6 from the results of two-dimensional finite element analyses of embankments. This chart includes the effect of amplification of seismic motions by an embankment and provides upper and lower bounds on the permanent deformation as a function of magnitude. Hynes and Franklin (1984) developed the chart shown in Figure 6.5 from classical Newmark "sliding block on a plane" analyses. The Hynes and Franklin chart does not consider amplification or magnitude effects. Due to the uncertainties in using a simplified design chart and the characteristics and limitations discussed above, the use of the upper bound curves from Makdisi and Seed (Figure 6.6) for simplified analysis of the permanent seismic deformation potential of the waste mass and liner system. The *mean* + σ curve from Hynes and Franklin (Figure 6.5) is recommended for simplified permanent seismic deformation analysis of the cover system.

If a seismic response analysis has been performed, a formal Newmark seismic deformation analysis can be performed by using the acceleration or shear stress time histories from the response analysis. Jibson (1993) describes the analytical procedure for performing such an analysis. To evaluate the permanent displacement of the landfill mass, the average acceleration time history of mass above the critical failure plane (the failure surface with the lowest yield acceleration) should be used. The average acceleration time history may be calculated as the average of the acceleration time history of each layer above the interface weighted according to the unit weight and thickness of each layer. Alternatively, the average acceleration time history may be calculated from the shear stress at the interface divided by the total vertical stress above the interface, as described by Repetto et al. (1993). To calculate the permanent deformation of the landfill final cover, either the average acceleration time history of the cover or the shear stress time history at the cover-waste interface divided by the total vertical stress at the interface should be used in the Newmark analysis. Particularly for landfills in the eastern United States, where the earthquake acceleration time history may contain relatively enriched high frequencies,

REFERENCE 3

“Hydrogeologic Study – Dan River Landfill”, Amec Foster Wheeler, July 15, 2015.

geotechnics
geotechnical & geosynthetic testing

MOISTURE CONTENT

ASTM D 2216-10

Client: AMEC FOSTER WHEELER
Client Reference: Dan River Steam Station Ash Removal
Project No.: 2015-616-02

Lab ID:	-01	-02	-03	-04	-05
Boring No.:	OW-406D	OW-407D	OW-417D	B-453	B-463
Depth (ft):	2.0-4.0	43.5-45.5	2.0-4.0	0.0-10.0	0.0-10.0
Sample No.:	UD	UD	UD	BULK	BULK
Tare Number	814	812	810	317	303
Wt. of Tare & Wet Sample (g)	298.13	335.16	374.94	461.62	473.20
Wt. of Tare & Dry Sample (g)	253.25	289.50	320.11	380.92	399.91
Weight of Tare (g)	109.97	106.00	112.89	83.98	110.70
Weight of Water (g)	44.88	45.66	54.83	80.70	73.29
Weight of Dry Sample (g)	143.28	183.50	207.22	296.94	289.21
Water Content (%)	**31.3**	**24.9**	**26.5**	**27.2**	**25.3**

Lab ID	-06
Boring No.	OW-412S
Depth (ft)	10.0-20.0
Sample No.	BULK
Tare Number	835
Wt. of Tare & Wet Sample (g)	825.17
Wt. of Tare & Dry Sample (g)	760.40
Weight of Tare (g)	255.40
Weight of Water (g)	64.77
Weight of Dry Sample (g)	505.00
Water Content (%)	**12.8**

Notes :

Tested By *SFS* *Date* *5/15/15* *Checked By* *GEM* *Date* *5/19/15*

DCN: CT-S1 DATE: 3/18/13 REVISION: 4

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MOISTURE DENSITY TEST DATA

5/26/2015

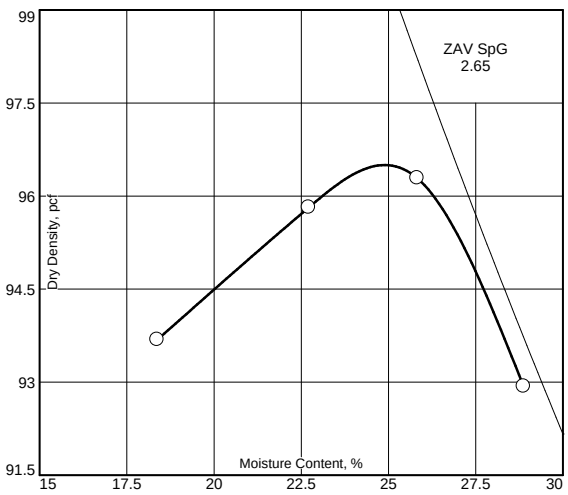
Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B452
Depth: 0 - 10' (Bulk)
Sample Number: Bulk
Description: Orange Fat Clay with Sand
USCS Classification: CH
AASHTO Classification: A-7-6(34)
Natural Moisture: 22.4
Liquid Limit: 63
Plasticity Index: 37
Tested by: A. Kottenstette
Checked by: G. Williams
Percent passing #4 sieve: 96.2

Test Data and Results For Curve 1

Test Specification:

Type of Test: ASTM D 698-07 Method A Standard

Mold Dia: 4.00 **Hammer Wt.:** 5.5 lb. **Drop:** 12 in. **Layers:** three **Blows per Layer:** 25



Point No.	1	2	3	4	5
Wt. M+S	6124.0	6168.0	6189.0	6135.0	6034.0
Wt. M	4359.0	4359.0	4359.0	4359.0	4359.0
Wt. W+T	500.3	462.5	486.9	412.1	644.6
Wt. D+T	411.8	390.2	417.3	355.2	603.3
Tare	139.0	139.8	147.8	104.7	378.5
Moist.	32.4	28.9	25.8	22.7	18.4
Dry Den.	88.2	92.9	96.3	95.8	93.7

Test Results: **Max. Dry Den.=** 96.5 pcf **Opt. Moist.=** 24.9%

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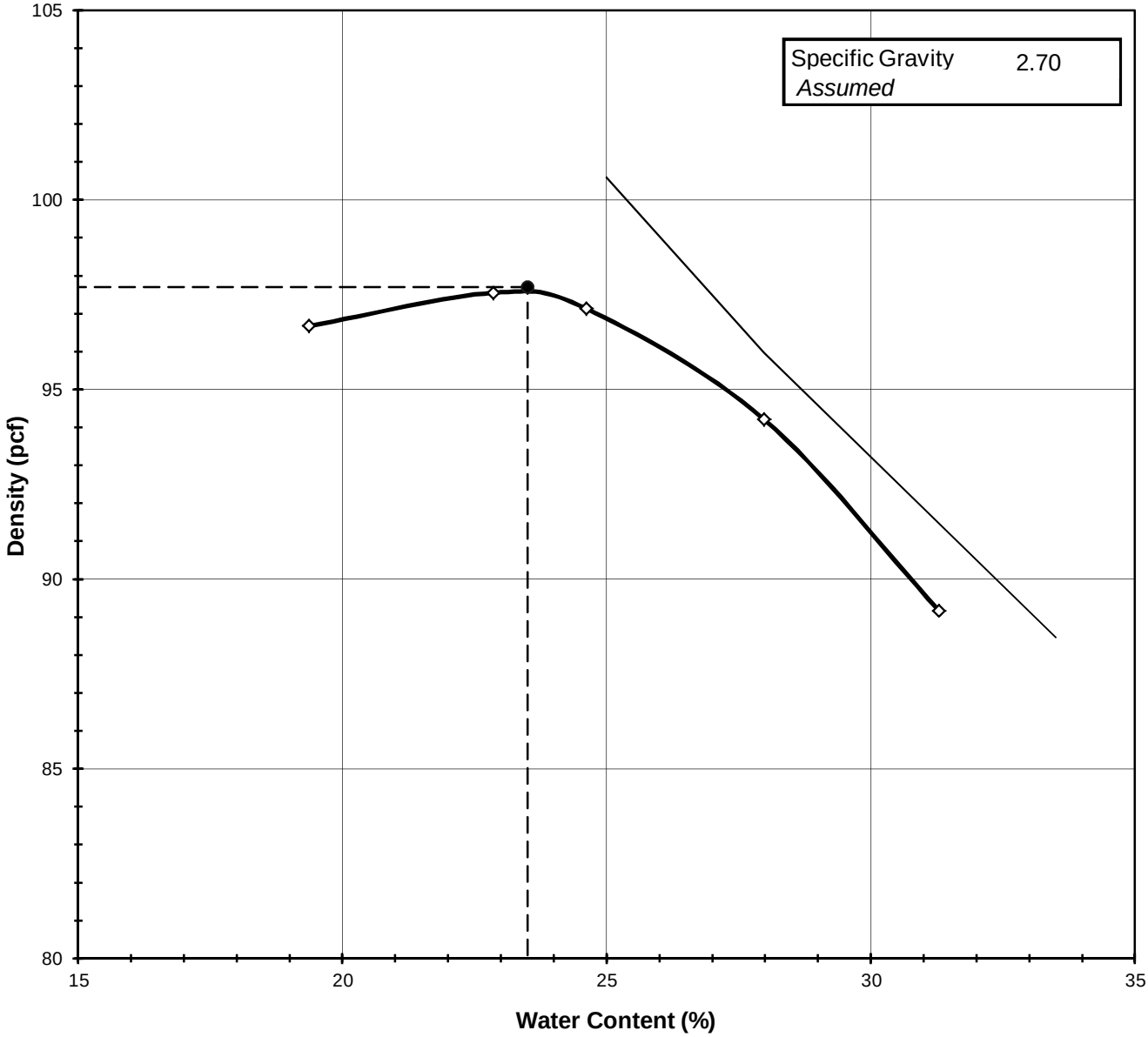
MOISTURE DENSITY RELATIONSHIP

ASTM D698-12

Client:	AMEC FOSTER WHEELER	Boring No.:	B-453
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	0.0-10.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-04	Test Method	**STANDARD**

Visual Description: YELLOW-BROWN FAT CLAY WITH SAND

Optimum Water Content	**23.5**
Maximum Dry Density	**97.7**



Tested By *BT* *Date* *5/15/15* *Checked By* *SFS* *Date* 6/4/15

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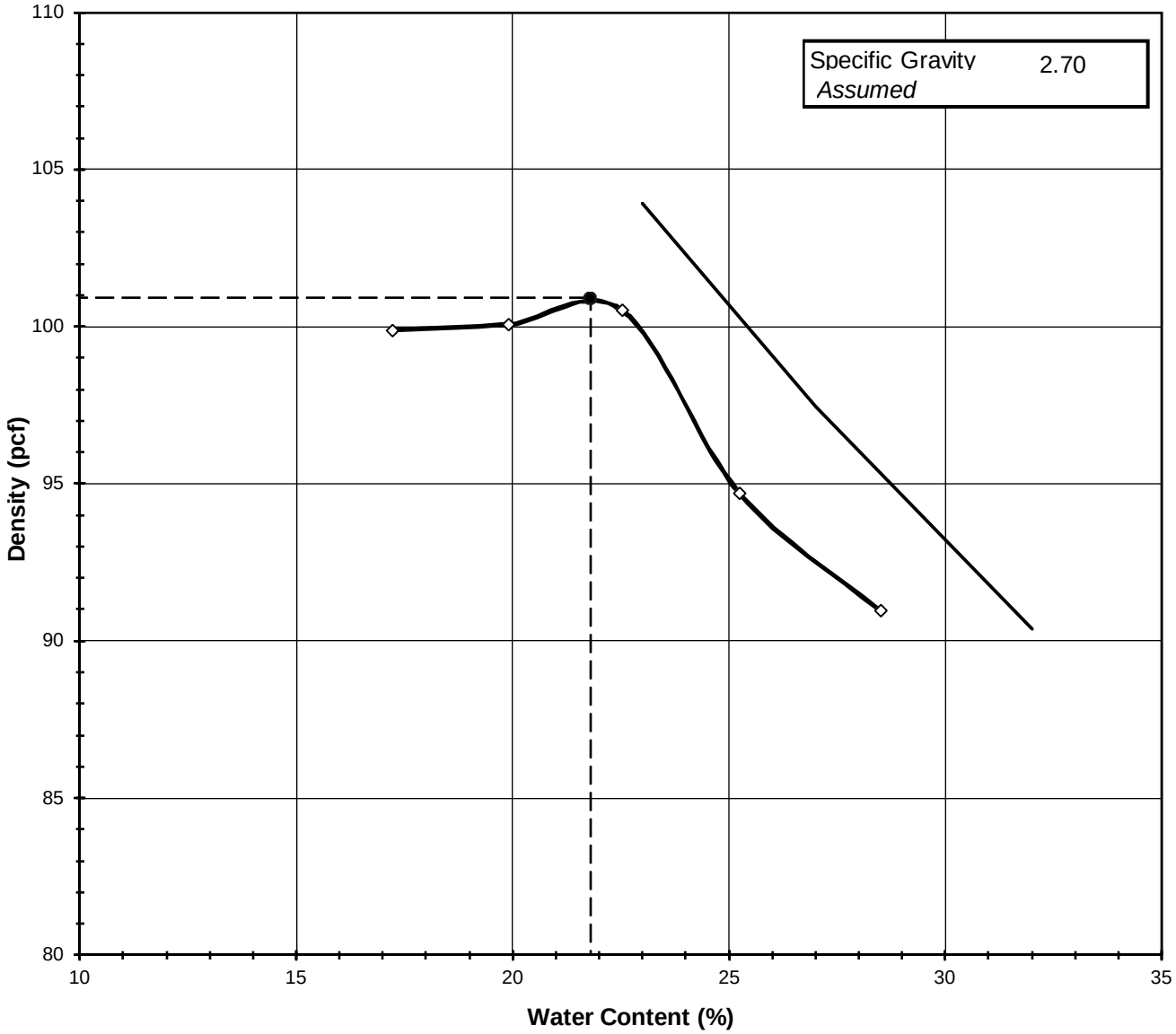
MOISTURE DENSITY RELATIONSHIP

ASTM D698-12

Client:	Amec Foster Wheeler	Boring No.:	B-463
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	0.0-10.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-05	Test Method	**STANDARD**

Visual Description: YELLOW RED TO RED BROWN LEAN CLAY WITH SAND

Optimum Water Content	**21.8**
Maximum Dry Density	**100.9**



Tested By *BT* *Date* *5/8/15* *Checked By* *SFS* *Date* 6/4/15

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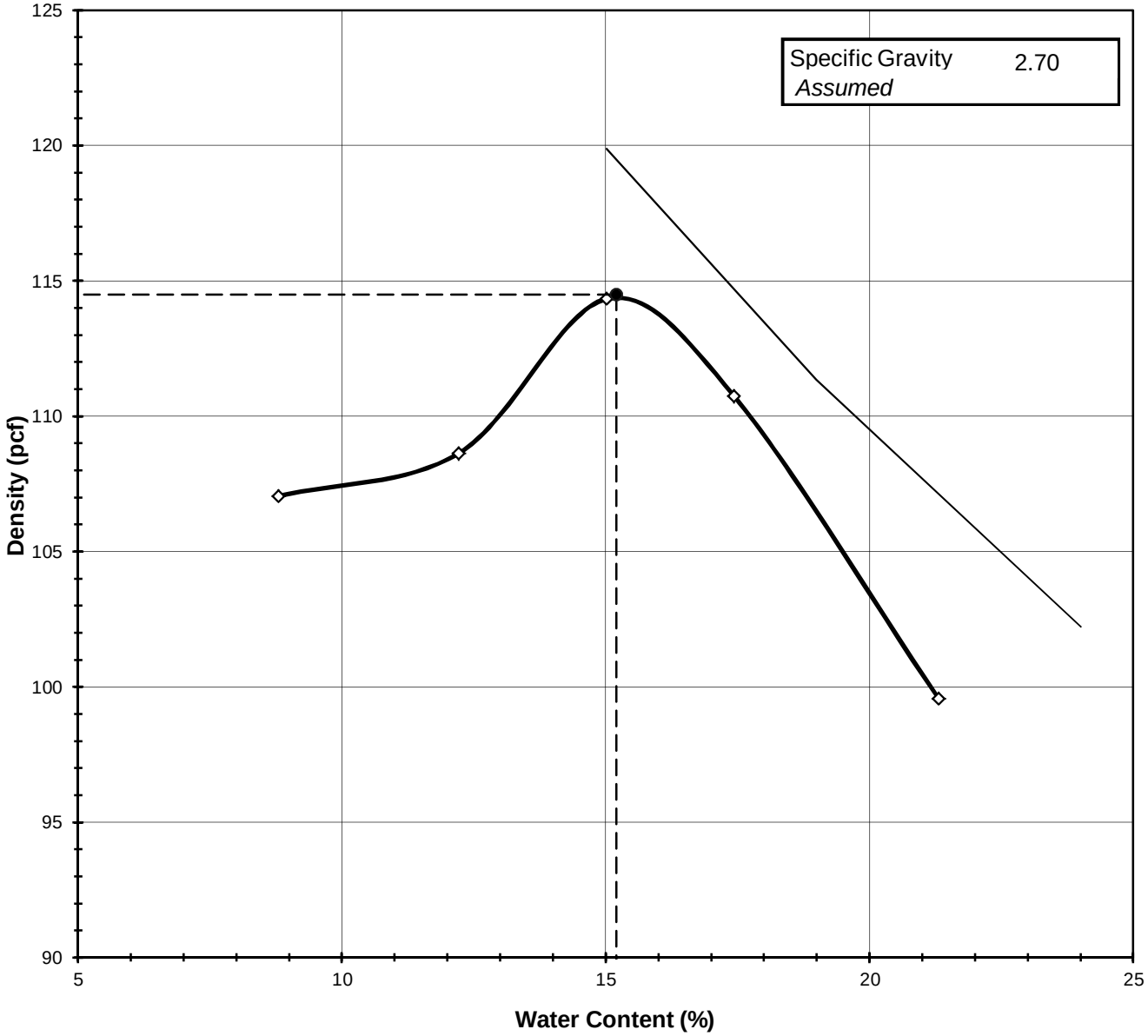
MOISTURE DENSITY RELATIONSHIP

ASTM D698-12

Client:	Amec Foster Wheeler	Boring No.:	OW-412S
Client Reference:	Dan River Steam Statin Ash Removal	Depth (ft):	10.0-20.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-06	Test Method	**STANDARD**

Visual Description: YELLOW & YELLOW BROWN SANDY LEAN CLAY

Optimum Water Content	**15.2**
Maximum Dry Density	**114.5**



Tested By *BT* *Date* *5/5/15* *Checked By* *SFS* *Date* 6/4/15

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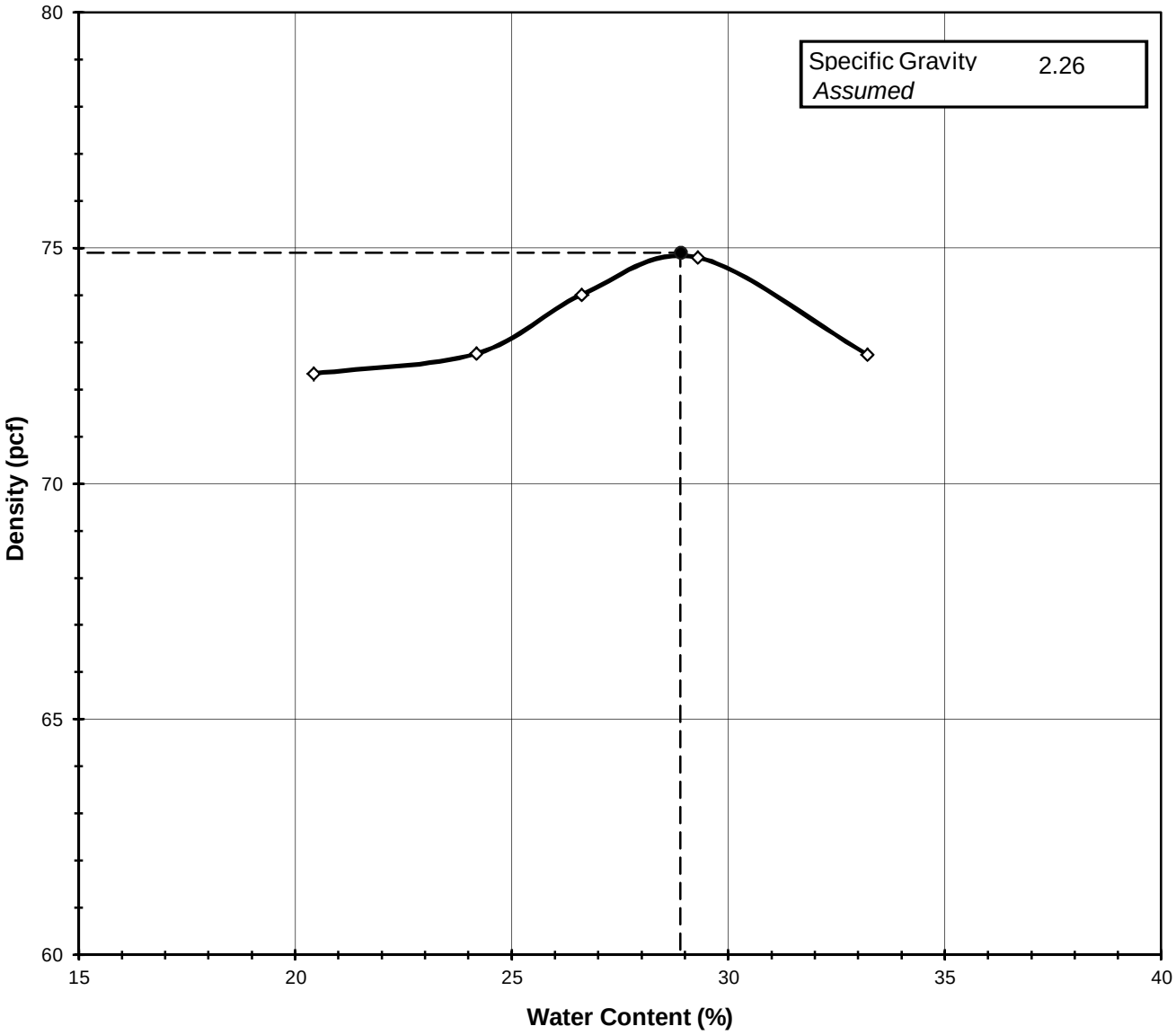
MOISTURE DENSITY RELATIONSHIP

ASTM D698-12

Client:	AMEC FOSTER WHEELER	Boring No.:	B319
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10-20
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-01	Test Method	**STANDARD**

Visual Description: DARK GRAY SILT

Optimum Water Content	**28.9**
Maximum Dry Density	**74.9**



Tested By *BW* *Date* *12/12/14* *Checked By* *GEM* *Date* 6/3/15

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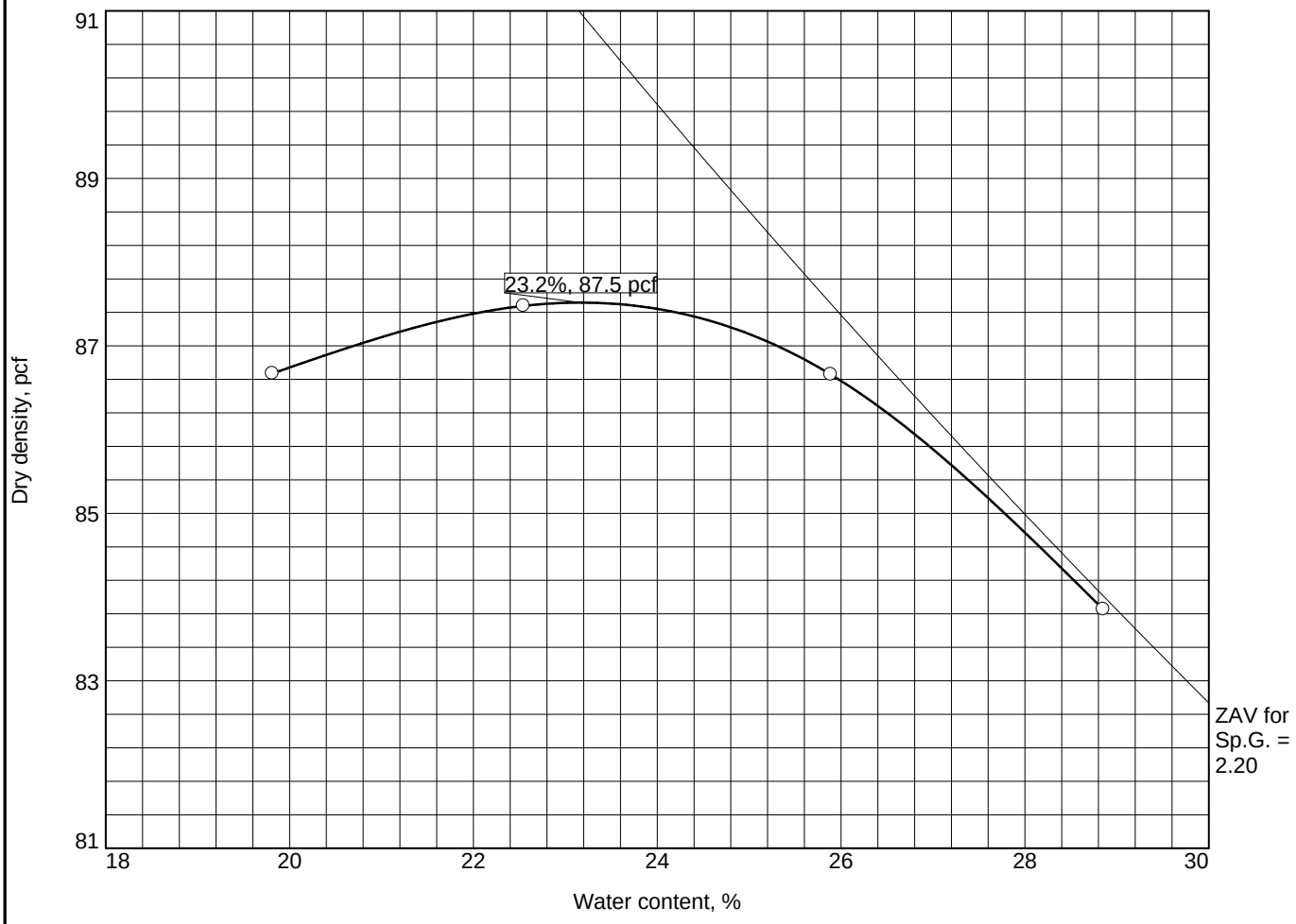
COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
38.5 - 48.5	ML	A-4(6)	NR	2.412	38	9	1.6	69.1

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 87.5 pcf Optimum moisture = 23.2 %	Dark Gray CCR Material
Project No. 7810140065 **Client:** Duke Energy **Project:** Dan River Steam Station Ash Removal ○**Source of Sample:** B322 **Sample Number:** B322	**Remarks:** Ash from Ash Fill 2 Specific Gravity = 2.412
amec	**Figure**

Tested By: M. Hamilton **Checked By:** D. Kopitsky

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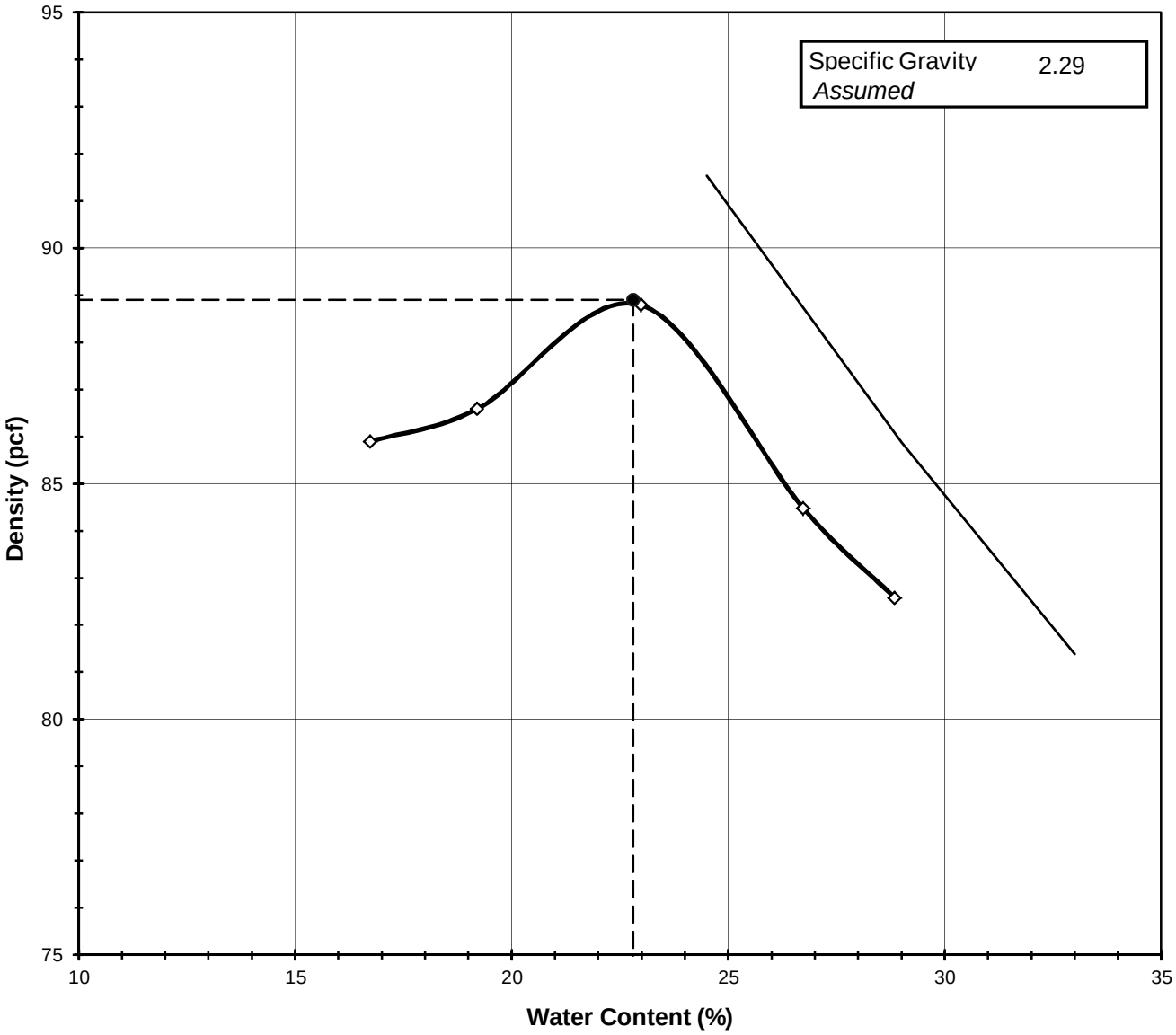
MOISTURE DENSITY RELATIONSHIP

ASTM D698-12

Client:	AMEC FOSTER WHEELER	Boring No.:	B322
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	48.6-58.5
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-02	Test Method	**STANDARD**

Visual Description: DARK GRAY SILT WITH SAND

Optimum Water Content	**22.8**
Maximum Dry Density	**88.9**



Tested By *BW* *Date* *12/15/14* *Checked By* *GEM* *Date* 6/3/15

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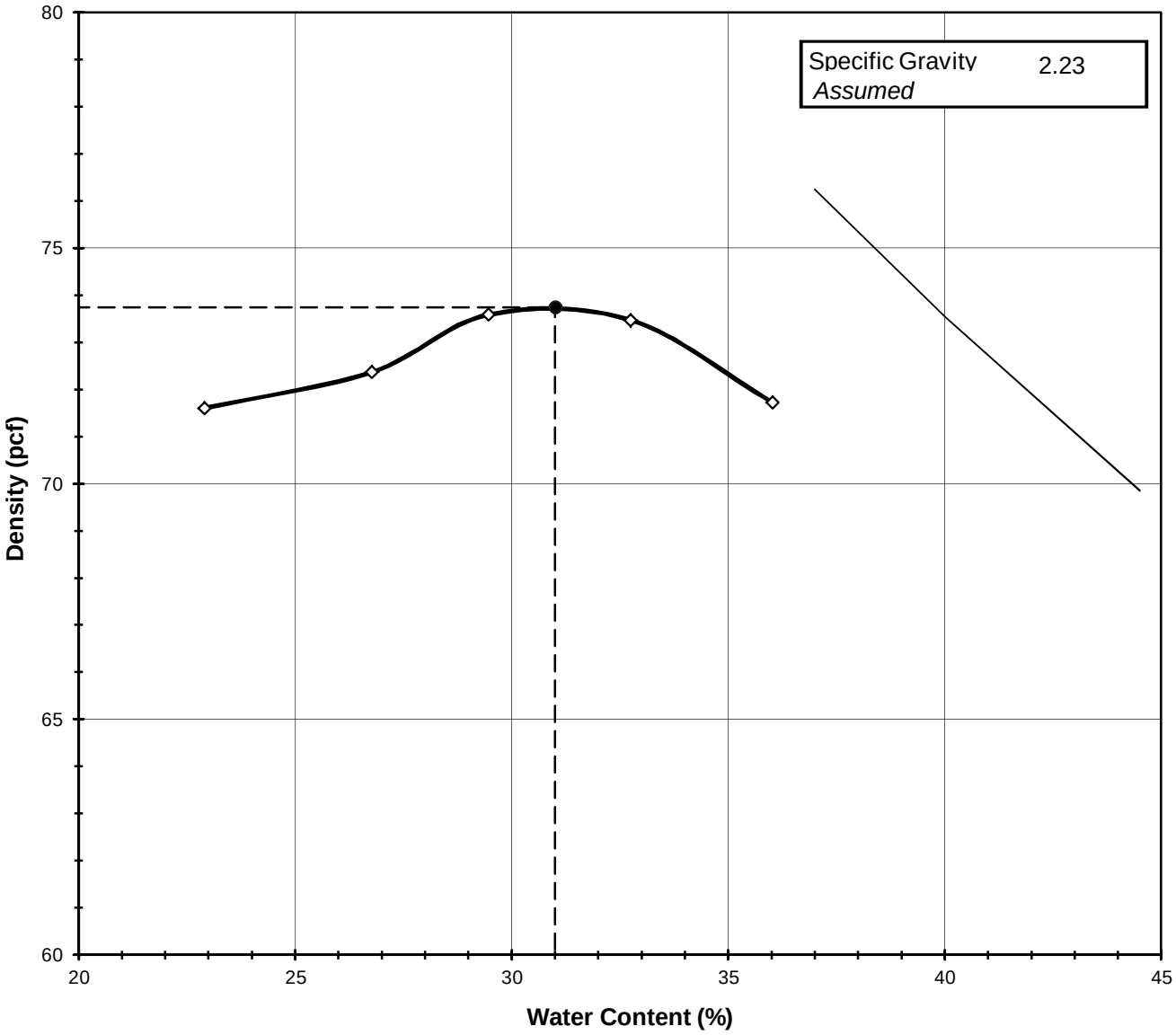
MOISTURE DENSITY RELATIONSHIP

ASTM D698-12

Client:	AMEC FOSTER WHEELER	Boring No.:	B324
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	25-35
Project No.:	2014-813-02	Sample No.:	BULK
Lab ID:	2014-813-02-01	Test Method	**STANDARD**

Visual Description: DARK GRAY SILT

Optimum Water Content	**31.0**
Maximum Dry Density	**73.7**



Tested By *BW* *Date* *1/9/15* *Checked By* *GEM* *Date* 6/3/15

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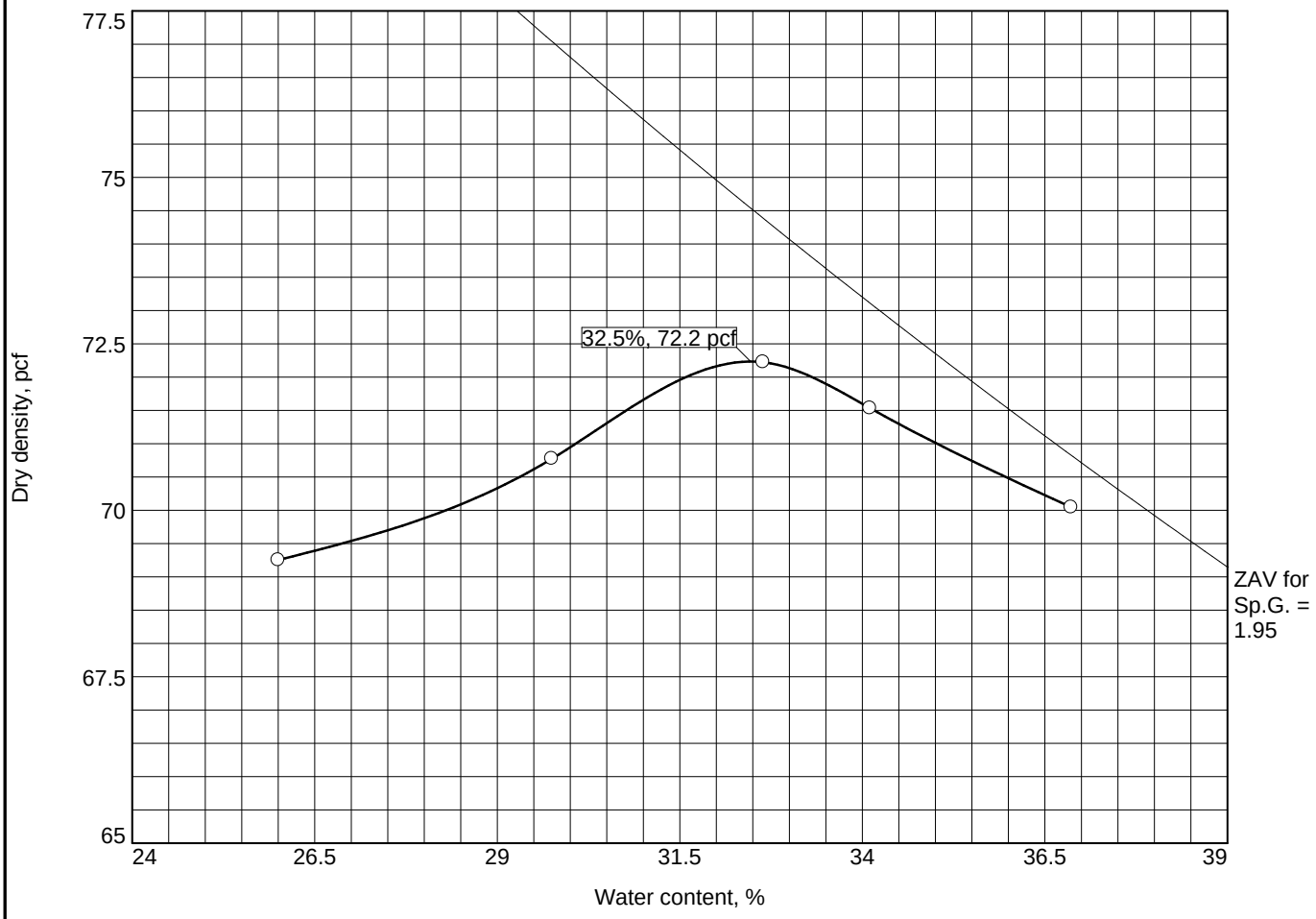
COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
25 - 35	ML	A-4(0)	NR	2.226	NV	NP	0.2	83.5

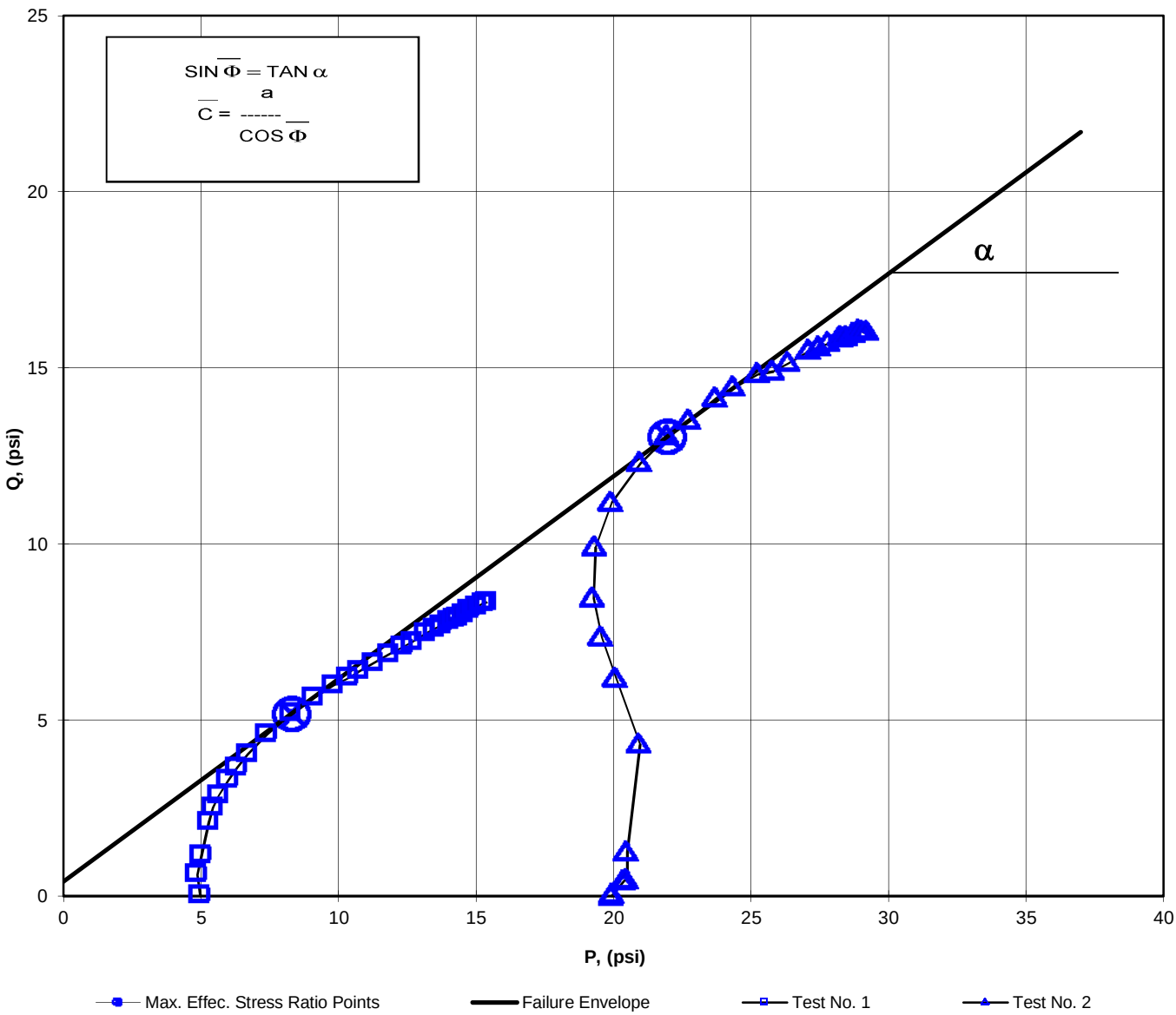
TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 72.2 pcf Optimum moisture = 32.5 %	Dark Gray CCR Material
Project No. 7810140065 **Client:** Duke Energy **Project:** Dan River Steam Station Ash Removal ○**Source of Sample:** B324 **Sample Number:** Bulk	**Remarks:** Ash from Ash Fill 1 Specific Gravity = 2.226
amec	**Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-406D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	2.7-3.7
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-01		

Consolidated Undrained Triaxial Test with Pore Pressure



a	=	**0.42**	$\overline{\mathbf{C}}$	=	**0.51**
α	=	**29.9**	$\overline{\Phi}$	=	**35.10**

Tested By: SFS Date: 4/30/15 Approved By: MPS Date: 6/4/15

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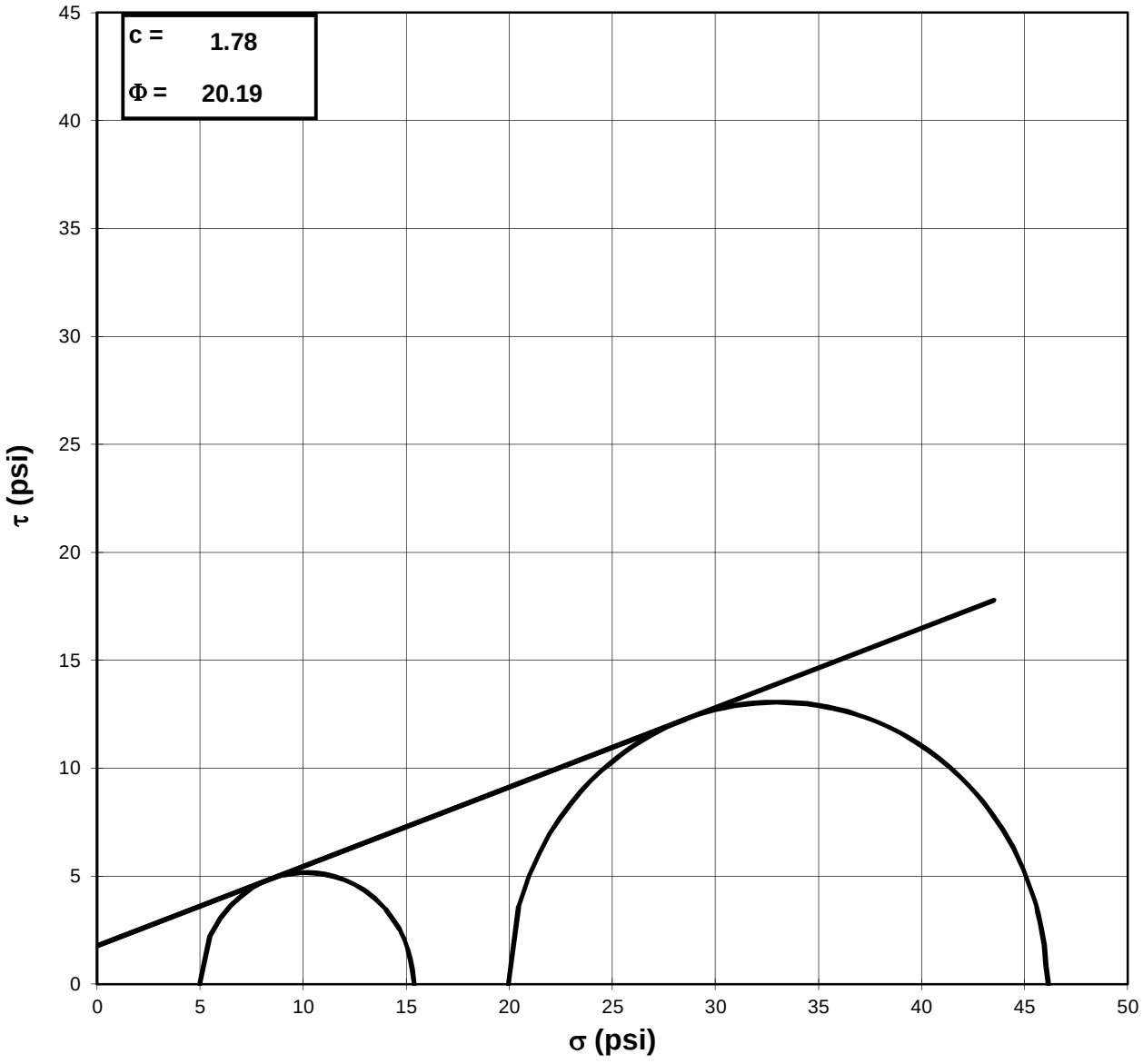
MOHR TOTAL STRENGTH ENVELOPE

ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-406D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	2.7-3.7
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-01		
Visual Description:	GRAY-BROWN SANDY ELASTIC SILT (UNDISTURBED)		



Failure Based on Maximum Effective Principal Stress Ratio

NOTE: GRAPH NOT TO SCALE

Tested By: SFS *Date:* 4/30/15 *Approved By:* MPS *Date:* 6/4/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-406D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	3.2-3.7
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-01		

Visual Description: GRAY-BROWN SANDY ELASTIC SILT (UNDISTURBED)

Stage No.	1
Test No.	1

PRESSURES (psi)

Cell Pressure (psi)	55.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	5.0
Pore Pressure Response (%)	98

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	8.27
Q	=	5.17

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	6.140	Diameter 1:	2.848
Length 2:	6.164	Diameter 2:	2.849
Length 3:	6.122	Diameter 3:	2.839
Avg. Length:	6.142	*Avg. Diam.:*	2.845

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	17.4
Final Change (ml)	6.6

Initial Dial Reading (mil)	58
Dial Reading After Saturation (mil)	81
Dial Reading After Consolidation (mil)	103

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
9.9	0.000	50.0
17.5	0.000	50.7
24.5	0.002	51.1
36.1	0.008	51.8
41.5	0.013	52.1
45.8	0.020	52.2
51.3	0.029	52.3
55.8	0.038	52.3
60.8	0.051	52.3
68.2	0.072	52.2
75.9	0.102	51.9
81.9	0.138	51.5
87.1	0.176	51.2
90.3	0.218	50.8
93.1	0.249	50.6
97.0	0.292	50.4
101.2	0.349	50.0
104.9	0.411	49.7
107.6	0.456	49.5
111.9	0.518	49.3
114.7	0.563	49.1
116.9	0.609	48.9
119.3	0.655	48.8
121.1	0.686	48.7
122.0	0.716	48.6
124.0	0.746	48.4
126.4	0.777	48.3
128.9	0.822	48.2
131.4	0.868	48.1
132.5	0.899	48.0
134.1	0.930	47.9

Tested By: SFS Date: 4/30/15 Input Checked By: GEM Date: 6/4/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-406D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	3.2-3.7
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-01		

Visual Description: GRAY-BROWN SANDY ELASTIC SILT (UNDISTURBED)

Effective Confining Pressure (psi)	5.0	*Stage No.*	1
		Test No	1

INITIAL DIMENSIONS

Initial Sample Length (in)	6.14
Initial Sample Diameter (in)	2.85
Initial Sample Area (in^2)	6.36
Initial Sample Volume (in^3)	39.05

VOLUME CHANGE

Volume After Consolidation (in^3)	38.21
Length After Consolidation (in)	6.10
Area After Consolidation (in^2)	6.267

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.01	1.20	0.73	5.46	4.3	1.282	0.62	4.86	0.60
0.04	2.32	1.12	6.19	3.9	1.599	0.49	5.03	1.16
0.14	4.18	1.79	7.37	3.2	2.308	0.44	5.28	2.09
0.22	5.03	2.05	7.96	2.9	2.711	0.42	5.45	2.51
0.33	5.71	2.19	8.51	2.8	3.039	0.39	5.65	2.85
0.47	6.57	2.29	9.27	2.7	3.434	0.36	5.98	3.28
0.63	7.28	2.32	9.95	2.7	3.731	0.33	6.31	3.64
0.83	8.05	2.31	10.73	2.7	4.003	0.29	6.71	4.03
1.18	9.19	2.19	11.99	2.8	4.282	0.24	7.40	4.60
1.67	10.35	1.89	13.44	3.1	4.344	0.19	8.27	5.17
2.27	11.23	1.51	14.70	3.5	4.229	0.14	9.09	5.61
2.88	11.95	1.16	15.78	3.8	4.121	0.10	9.81	5.98
3.57	12.37	0.81	16.55	4.2	3.962	0.07	10.36	6.19
4.08	12.74	0.60	17.12	4.4	3.907	0.05	10.75	6.37
4.79	13.23	0.34	17.87	4.6	3.846	0.03	11.26	6.61
5.73	13.73	0.01	18.71	5.0	3.756	0.00	11.84	6.86
6.74	14.14	-0.29	19.41	5.3	3.682	-0.02	12.34	7.07
7.48	14.41	-0.49	19.89	5.5	3.632	-0.03	12.68	7.21
8.49	14.88	-0.75	20.62	5.7	3.597	-0.05	13.17	7.44
9.24	15.17	-0.92	21.08	5.9	3.569	-0.06	13.49	7.59
9.99	15.37	-1.09	21.45	6.1	3.529	-0.07	13.76	7.68
10.74	15.58	-1.25	21.82	6.2	3.496	-0.08	14.03	7.79
11.24	15.74	-1.36	22.09	6.3	3.479	-0.09	14.22	7.87
11.74	15.79	-1.47	22.24	6.5	3.447	-0.09	14.34	7.89
12.24	15.98	-1.57	22.53	6.6	3.437	-0.10	14.54	7.99
12.74	16.22	-1.67	22.88	6.7	3.436	-0.11	14.77	8.11
13.49	16.43	-1.82	23.23	6.8	3.413	-0.11	15.02	8.21
14.24	16.62	-1.97	23.57	7.0	3.390	-0.12	15.26	8.31
14.74	16.67	-2.06	23.72	7.0	3.365	-0.13	15.39	8.34
15.25	16.80	-2.16	23.94	7.1	3.350	-0.13	15.54	8.40

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-406D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	2.7-3.2
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-01		

Visual Description: GRAY-BROWN SANDY ELASTIC SILT (UNDISTURBED)

Stage No.	1
Test No.	2

PRESSURES (psi)

Cell Pressure (psi)	70.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	20.0
Pore Pressure Response (%)	100

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	21.99
Q	=	13.06

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.838	Diameter 1:	2.849
Length 2:	5.852	Diameter 2:	2.843
Length 3:	5.843	Diameter 3:	2.852
Avg. Length:	5.844	*Avg. Diam.:*	2.848

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	8.0
Final Change (ml)	16.0

Initial Dial Reading (mil)	70
Dial Reading After Saturation (mil)	112
Dial Reading After Consolidation (mil)	164

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
9.3	0.000	50.0
9.9	0.000	50.0
14.6	0.002	50.0
15.0	0.008	49.9
24.7	0.013	50.7
62.6	0.020	53.3
86.0	0.029	56.1
100.7	0.038	57.8
114.5	0.051	59.2
133.0	0.072	60.5
149.6	0.102	61.2
164.6	0.138	61.3
175.5	0.176	61.1
182.5	0.218	60.7
191.5	0.249	60.4
197.0	0.292	60.0
203.8	0.349	59.5
207.1	0.411	59.1
211.9	0.456	58.7
219.1	0.518	58.3
222.3	0.563	58.1
225.8	0.609	57.8
230.3	0.655	57.6
230.9	0.686	57.5
232.9	0.716	57.4
235.5	0.746	57.2
238.3	0.777	57.1
239.8	0.822	56.9
241.9	0.868	56.7

Tested By: SFS Date: 4/30/15 Input Checked By: GEM Date: 6/4/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-406D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	2.7-3.2
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-01		

Visual Description: GRAY-BROWN SANDY ELASTIC SILT (UNDISTURBED)

Effective Confining Pressure (psi)	20.0	*Stage No.*	1
		Test No	2

INITIAL DIMENSIONS

Initial Sample Length (in)	5.84
Initial Sample Diameter (in)	2.85
Initial Sample Area (in^2)	6.37
Initial Sample Volume (in^3)	37.23

VOLUME CHANGE

Volume After Consolidation (in^3)	35.45
Length After Consolidation (in)	5.75
Area After Consolidation (in^2)	6.165

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.01	0.08	0.02	20.02	19.9	1.004	0.23	19.98	0.04
0.04	0.85	-0.01	20.82	20.0	1.043	-0.01	20.39	0.43
0.14	0.91	-0.10	20.97	20.1	1.045	-0.11	20.51	0.46
0.23	2.49	0.69	21.76	19.3	1.129	0.28	20.51	1.25
0.35	8.61	3.29	25.27	16.7	1.516	0.38	20.97	4.30
0.50	12.37	6.04	26.29	13.9	1.889	0.49	20.11	6.19
0.67	14.72	7.75	26.93	12.2	2.205	0.53	19.57	7.36
0.88	16.91	9.13	27.73	10.8	2.562	0.54	19.28	8.45
1.25	19.81	10.51	29.26	9.5	3.096	0.53	19.36	9.91
1.77	22.35	11.20	31.11	8.8	3.551	0.50	19.94	11.18
2.41	24.58	11.25	33.28	8.7	3.825	0.46	20.99	12.29
3.06	26.13	11.03	35.05	8.9	3.927	0.42	21.99	13.06
3.78	27.02	10.70	36.28	9.3	3.920	0.40	22.77	13.51
4.32	28.27	10.35	37.88	9.6	3.943	0.37	23.74	14.14
5.08	28.89	10.01	38.84	9.9	3.904	0.35	24.39	14.45
6.08	29.63	9.50	40.09	10.5	3.834	0.32	25.27	14.82
7.14	29.78	9.03	40.71	10.9	3.726	0.30	25.82	14.89
7.94	30.25	8.70	41.50	11.3	3.688	0.29	26.38	15.13
9.00	30.96	8.31	42.61	11.6	3.658	0.27	27.13	15.48
9.80	31.16	8.03	43.09	11.9	3.613	0.26	27.51	15.58
10.59	31.39	7.81	43.54	12.1	3.585	0.25	27.84	15.70
11.39	31.75	7.54	44.16	12.4	3.558	0.24	28.29	15.88
11.92	31.65	7.45	44.16	12.5	3.531	0.24	28.33	15.83
12.45	31.74	7.33	44.37	12.6	3.515	0.23	28.50	15.87
12.97	31.92	7.17	44.71	12.8	3.496	0.22	28.75	15.96
13.51	32.12	7.06	45.02	12.9	3.490	0.22	28.96	16.06
14.30	32.04	6.89	45.10	13.1	3.453	0.22	29.08	16.02
15.10	32.03	6.72	45.27	13.2	3.419	0.21	29.26	16.02

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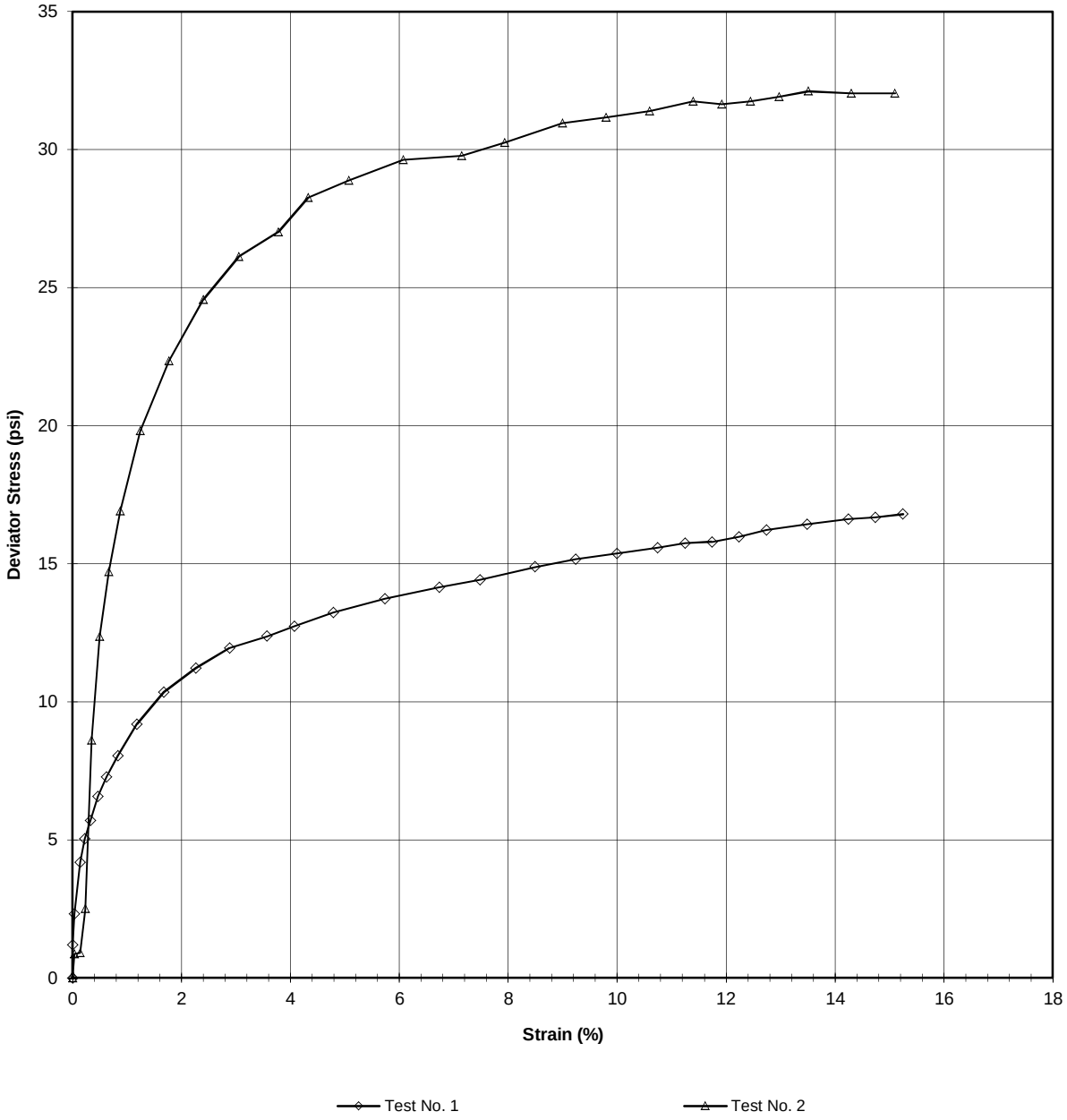
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-406D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	2.7-3.7
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-01		
Visual Description:	GRAY-BROWN SANDY ELASTIC SILT		



Tested By: SFS Date: 4/30/15 Approved By: MPS Date: 6/4/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler		
Client Reference:	Dan River Steam Station Ash Removal		
Project No.:	2015-616-02		
Lab ID:	2015-616-02-01	Specific Gravity (Measured)	2.69

Visual Description: GRAY-BROWN SANDY ELASTIC SILT (UNDISTURBED)

SAMPLE CONDITION SUMMARY

Boring No.:	OW-406D	OW-406D
Depth (ft):	3.2-3.7	2.7-3.2
Sample No.:	UD	UD
Test No.	T1	T2
Deformation Rate (in/min)	0.001	0.001
Back Pressure (psi)	50.0	50.0
Consolidation Time (days)	1	1
Moisture Content (%) (INITIAL)	31.3	29.5
Total Unit Weight (pcf)	117.9	120.9
Dry Unit Weight (pcf)	89.8	93.4
Moisture Content (%) (FINAL)	33.0	27.8
Initial State Void Ratio,e	0.870	0.798
Void Ratio at Shear, e	0.830	0.713

Tested By: SFS Date: 4/30/15 Input Checked By: GEM Date: 6/4/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS

ASTM D4767-11

MOISTURE CONTENT

	T1	T2
Tare Number	814	828
Weight of Tare & Wet Sample (g)	298.13	253
Weight of Tare & Dry Sample (g)	253.25	226.6
Weight of Tare (g)	109.77	137.07
Moisture Content (%) (INITIAL)	31.28	29.49
Tare Number	814	805
Weight of Tare & Wet Sample (g)	598.93	724.94
Weight of Tare & Dry Sample (g)	477.44	589.72
Weight of Tare (g)	109.78	102.78
Moisture Content (%) (FINAL)	33.04	27.77

UNIT WEIGHT

Weight of Tube & Wet Sample (g)		1208.68	1181.6
Weight of Tube (g)		0	0
Weight of Wet Sample (g)		1208.68	1181.6
Length 1 (in)		6.14	5.838
Length 2 (in)		6.164	5.852
Length 3 (in)		6.122	5.843
Top Diameter (in)		2.848	2.849
Middle Diameter (in)		2.849	2.843
Bottom Diameter (in)		2.839	2.852
Average Length (in)		6.142	5.844333
Average Area (in)		6.359	6.370
Sample Volume (cm^3)		639.98	610.11
Unit Wet Weight (g/cm^3)		1.89	1.94
Unit Wet Weight (pcf)		117.91	120.91
Unit Dry Weight (pcf)		89.81	93.37
Unit Dry Weight (g/cm^3)		1.44	1.50
Initial Burette Reading		**24**	**24**
Final Burette Reading		**17.4**	**8**
Initial Dial Reading		**58**	**70**
Dial Reading After Saturation		**81**	**112**
Dial Reading After Consolidation		**103**	**164**
Volume Change during Consolidation		6.6	16
Volume Change during Saturation		7.19	13.15
Volume at Shear (cm^3)	*These	626.19	580.95
Volume of Solids (cm^3)	measurements	342.26	339.23
Volume of Voids (cm^3)	are all	283.93	241.73
Volume of Water (cm^3)	at	304.23	253.40
Void Ratio, e	shear	0.830	0.713

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

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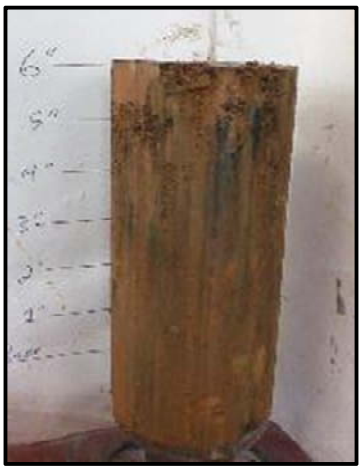
Client:	Amec Foster Wheeler	Boring No.:	OW-406D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	2.7-3.7
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-01		

TEST 1 INITIAL



TEST 1 FINAL

TEST 2 INITIAL

TEST 2 FINAL

Tested By	*SFS*	*Date*	*4/30/15*	*Approved By*	MPS	*Date*	6/4/15

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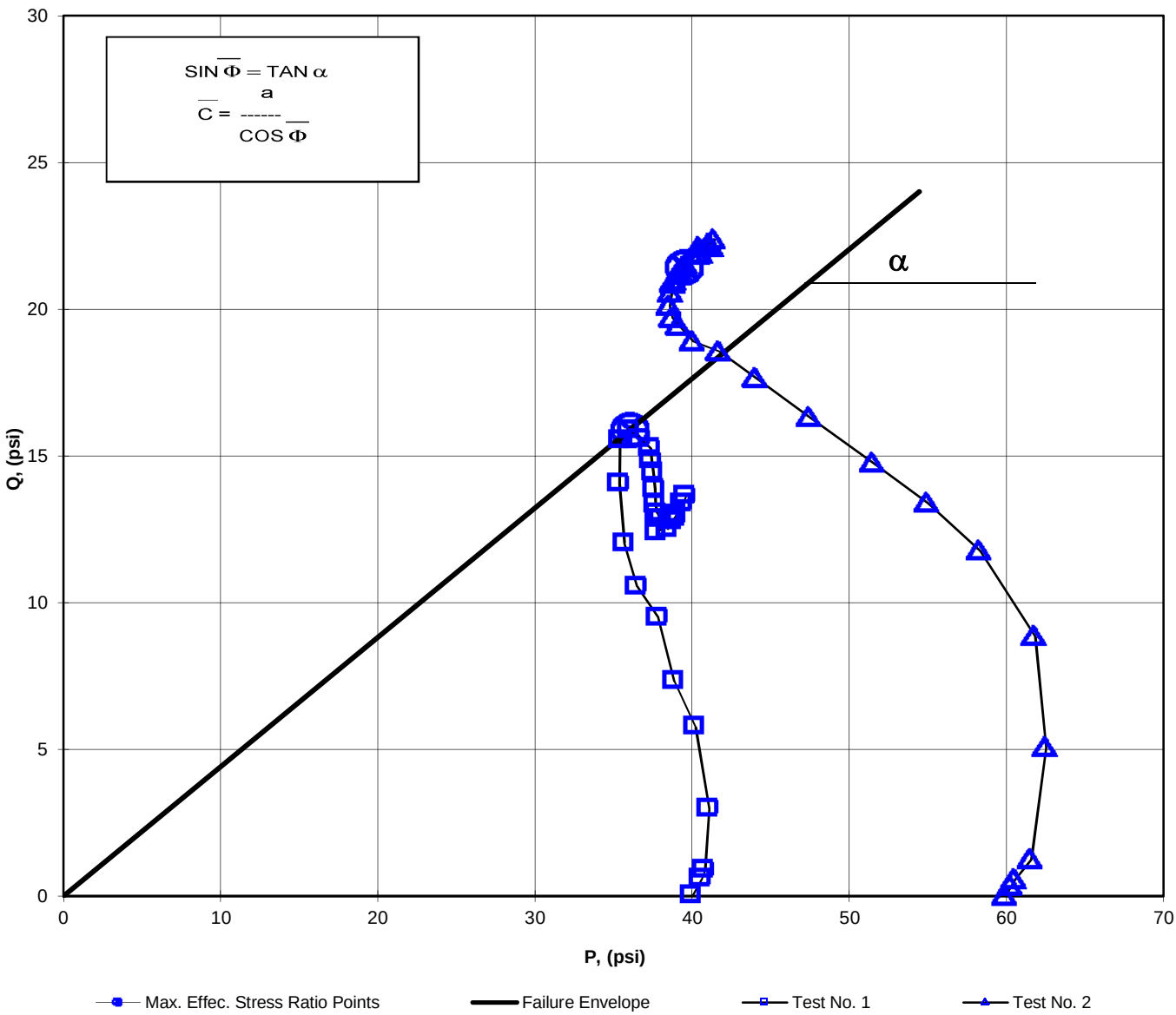
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-407D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	44.3-45.3
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-02		

Consolidated Undrained Triaxial Test with Pore Pressure



a	=	**0.00**	$\overline{\mathbf{C}}$	=	**0.00**
α	=	**23.8**	$\overline{\Phi}$	=	**26.15**

Tested By: SFS Date: 4/30/15 Approved By: MPS Date: 6/4/15

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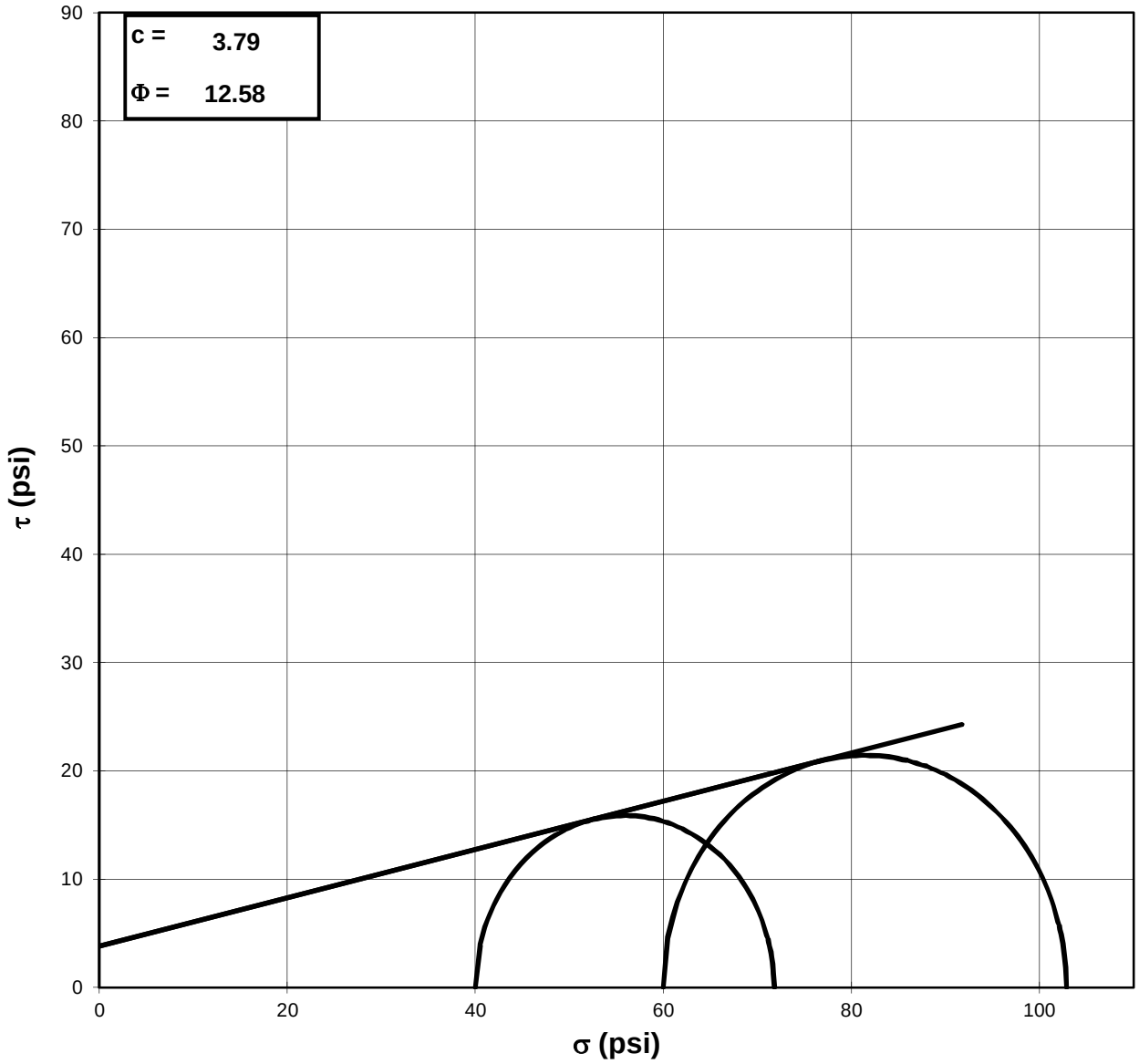
MOHR TOTAL STRENGTH ENVELOPE

ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-407D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	44.3-45.3
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-02		
Visual Description:	YELLOW BROWN & GRAY SANDY LEAN CLAY (UNDISTURBED)		



Failure Based on Maximum Effective Principal Stress Ratio

NOTE: GRAPH NOT TO SCALE

Tested By: SFS *Date:* 4/30/15 *Approved By:* MPS *Date:* 6/4/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

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Client:	Amec Foster Wheeler	Boring No.:	OW-407D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	44.8-45.3
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-02		

Visual Description: YELLOW BROWN & GRAY SANDY LEAN CLAY (UNDISTURBED)

Stage No.	1
Test No.	1

PRESSURES (psi)

Cell Pressure (psi)	90.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	40.0
Pore Pressure Response (%)	100

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	36.02
Q	=	15.88

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	6.250	Diameter 1:	2.847
Length 2:	6.244	Diameter 2:	2.850
Length 3:	6.189	Diameter 3:	2.849
Avg. Length:	6.228	*Avg. Diam.:*	2.849

VOLUME CHANGE

Initial Burette Reading (ml)	48.0
Final Burette Reading (ml)	23.5
Final Change (ml)	24.5

Initial Dial Reading (mil)	30
Dial Reading After Saturation (mil)	33
Dial Reading After Consolidation (mil)	161

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
15.5	0.000	50.0
22.5	0.002	49.9
26.3	0.003	50.0
52.7	0.009	51.9
87.6	0.015	55.5
107.3	0.021	58.4
134.8	0.030	61.6
148.4	0.039	64.0
167.2	0.051	66.3
193.3	0.072	68.7
213.1	0.102	70.1
218.7	0.138	69.8
216.2	0.174	68.8
213.5	0.216	67.9
208.9	0.246	67.4
204.9	0.288	66.8
199.5	0.345	66.2
194.0	0.405	65.6
191.8	0.450	65.2
191.0	0.510	64.9
192.1	0.555	64.7
187.3	0.600	64.6
194.1	0.645	64.1
195.5	0.675	64.1
192.5	0.705	64.0
197.0	0.735	64.0
201.3	0.765	64.0
201.6	0.810	63.9
209.9	0.855	63.9
214.9	0.885	64.0
213.2	0.915	64.0

Tested By: SFS Date: 4/30/15 Input Checked By: GEM Date: 6/4/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-407D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	44.8-45.3
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-02		

Visual Description: YELLOW BROWN & GRAY SANDY LEAN CLAY (UNDISTURBED)

Effective Confining Pressure (psi)	40.0	*Stage No.*	1
		Test No	1

INITIAL DIMENSIONS

Initial Sample Length (in)	6.23
Initial Sample Diameter (in)	2.85
Initial Sample Area (in^2)	6.37
Initial Sample Volume (in^3)	39.69

VOLUME CHANGE

Volume After Consolidation (in^3)	38.14
Length After Consolidation (in)	6.10
Area After Consolidation (in^2)	6.256

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	1.13	-0.04	41.18	40.1	1.028	-0.03	40.62	0.56
0.05	1.73	0.05	41.70	40.0	1.043	0.03	40.83	0.87
0.15	5.94	1.88	44.07	38.1	1.156	0.32	41.10	2.97
0.25	11.50	5.52	45.99	34.5	1.333	0.48	40.24	5.75
0.34	14.62	8.44	46.20	31.6	1.463	0.58	38.89	7.31
0.49	18.98	11.65	47.35	28.4	1.669	0.61	37.86	9.49
0.64	21.11	14.04	47.09	26.0	1.813	0.66	36.53	10.56
0.84	24.05	16.32	47.74	23.7	2.015	0.68	35.72	12.02
1.18	28.10	18.68	49.43	21.3	2.317	0.66	35.39	14.05
1.67	31.07	20.12	50.96	19.9	2.562	0.65	35.43	15.54
2.26	31.75	19.87	51.90	20.1	2.576	0.63	36.02	15.88
2.85	31.17	18.87	52.31	21.1	2.474	0.61	36.73	15.58
3.54	30.54	17.92	52.63	22.1	2.382	0.59	37.37	15.27
4.03	29.68	17.40	52.29	22.6	2.312	0.59	37.45	14.84
4.72	28.85	16.87	51.98	23.1	2.247	0.58	37.56	14.42
5.66	27.76	16.25	51.52	23.8	2.168	0.59	37.64	13.88
6.64	26.64	15.65	51.01	24.4	2.093	0.59	37.69	13.32
7.38	26.11	15.26	50.86	24.8	2.055	0.58	37.81	13.05
8.37	25.72	14.95	50.78	25.1	2.026	0.58	37.92	12.86
9.10	25.67	14.76	50.92	25.2	2.017	0.58	38.09	12.84
9.84	24.77	14.64	50.14	25.4	1.976	0.59	37.76	12.39
10.58	25.54	14.14	51.41	25.9	1.987	0.55	38.64	12.77
11.07	25.59	14.10	51.50	25.9	1.988	0.55	38.71	12.79
11.56	25.03	14.05	50.99	26.0	1.964	0.56	38.48	12.51
12.06	25.52	14.03	51.51	26.0	1.982	0.55	38.75	12.76
12.55	25.98	13.98	52.01	26.0	1.998	0.54	39.02	12.99
13.29	25.80	13.96	51.86	26.1	1.990	0.54	38.96	12.90
14.02	26.73	13.96	52.78	26.1	2.026	0.52	39.42	13.36
14.52	27.26	14.01	53.26	26.0	2.048	0.51	39.63	13.63
15.01	26.86	14.07	52.80	25.9	2.036	0.52	39.37	13.43

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-407D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	44.3-44.8
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-02		

Visual Description: YELLOW BROWN & GRAY SANDY LEAN CLAY (UNDISTURBED)

Stage No.	1
Test No.	2

PRESSURES (psi)

Cell Pressure (psi)	110.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	60.0
Pore Pressure Response (%)	99

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	39.48
Q	=	21.44

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.776	Diameter 1:	2.813
Length 2:	5.774	Diameter 2:	2.805
Length 3:	5.808	Diameter 3:	2.813
Avg. Length:	5.786	*Avg. Diam.:*	2.810

VOLUME CHANGE

Initial Burette Reading (ml)	96.0
Final Burette Reading (ml)	34.6
Final Change (ml)	61.4

Initial Dial Reading (mil)	160
Dial Reading After Saturation (mil)	191
Dial Reading After Consolidation (mil)	443

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
13.5	0.000	50.0
17.4	0.000	50.0
20.1	0.002	50.0
27.9	0.012	49.7
71.8	0.016	52.5
115.3	0.020	57.0
149.0	0.026	63.4
167.9	0.033	68.4
184.1	0.042	73.2
202.6	0.057	78.8
219.0	0.079	83.6
230.5	0.105	86.8
235.6	0.131	88.8
243.3	0.163	90.2
247.3	0.184	90.9
253.5	0.215	91.5
260.2	0.247	91.8
265.5	0.276	92.0
267.3	0.299	92.1
269.6	0.328	92.1
272.7	0.350	92.0
275.5	0.371	92.0
278.4	0.393	92.0
282.0	0.447	91.8
292.6	0.506	91.6
292.5	0.557	91.4
296.1	0.617	91.3
303.6	0.669	91.1
309.3	0.728	90.9
308.7	0.779	90.8
306.6	0.830	90.6

Tested By: SFS Date: 4/30/15 Input Checked By: GEM Date: 6/4/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-407D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	44.3-44.8
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-02		

Visual Description: YELLOW BROWN & GRAY SANDY LEAN CLAY (UNDISTURBED)

Effective Confining Pressure (psi)	60.0	*Stage No.*	1
		Test No	2

INITIAL DIMENSIONS

Initial Sample Length (in)	5.79
Initial Sample Diameter (in)	2.81
Initial Sample Area (in^2)	6.20
Initial Sample Volume (in^3)	35.89

VOLUME CHANGE

Volume After Consolidation (in^3)	31.57
Length After Consolidation (in)	5.50
Area After Consolidation (in^2)	5.736

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.00	0.67	-0.01	60.67	60.0	1.011	-0.02	60.33	0.34
0.03	1.15	-0.01	61.15	60.0	1.019	-0.01	60.58	0.58
0.22	2.50	-0.35	62.84	60.3	1.041	-0.14	61.59	1.25
0.29	10.13	2.50	67.61	57.5	1.176	0.25	62.55	5.06
0.37	17.68	6.98	70.68	53.0	1.333	0.40	61.84	8.84
0.48	23.50	13.41	70.08	46.6	1.505	0.58	58.33	11.75
0.60	26.76	18.35	68.40	41.6	1.643	0.69	55.02	13.38
0.76	29.52	23.20	66.30	36.8	1.802	0.79	51.54	14.76
1.04	32.62	28.76	63.84	31.2	2.045	0.89	47.53	16.31
1.43	35.31	33.56	61.74	26.4	2.336	0.96	44.08	17.65
1.91	37.11	36.80	60.29	23.2	2.601	1.00	41.74	18.56
2.39	37.80	38.79	58.99	21.2	2.784	1.04	40.09	18.90
2.95	38.87	40.21	58.64	19.8	2.965	1.04	39.21	19.43
3.34	39.40	40.90	58.48	19.1	3.065	1.05	38.78	19.70
3.92	40.20	41.49	58.70	18.5	3.173	1.04	38.60	20.10
4.48	41.07	41.82	59.23	18.2	3.262	1.03	38.70	20.54
5.02	41.72	41.98	59.72	18.0	3.318	1.02	38.86	20.86
5.43	41.84	42.04	59.78	17.9	3.331	1.02	38.86	20.92
5.97	41.98	42.04	59.92	17.9	3.339	1.01	38.93	20.99
6.36	42.30	42.01	60.27	18.0	3.354	1.00	39.12	21.15
6.75	42.59	41.99	60.58	18.0	3.366	1.00	39.29	21.29
7.13	42.88	41.95	60.92	18.0	3.377	0.99	39.48	21.44
8.12	43.00	41.81	61.18	18.2	3.366	0.98	39.68	21.50
9.20	44.18	41.59	62.58	18.4	3.401	0.95	40.49	22.09
10.13	43.70	41.42	62.27	18.6	3.354	0.96	40.42	21.85
11.21	43.74	41.24	62.49	18.7	3.334	0.95	40.61	21.87
12.15	44.43	41.07	63.35	18.9	3.349	0.93	41.14	22.22
13.22	44.74	40.90	63.82	19.1	3.345	0.92	41.45	22.37
14.16	44.17	40.76	63.40	19.2	3.297	0.93	41.32	22.09
15.08	43.38	40.59	62.77	19.4	3.237	0.95	41.08	21.69

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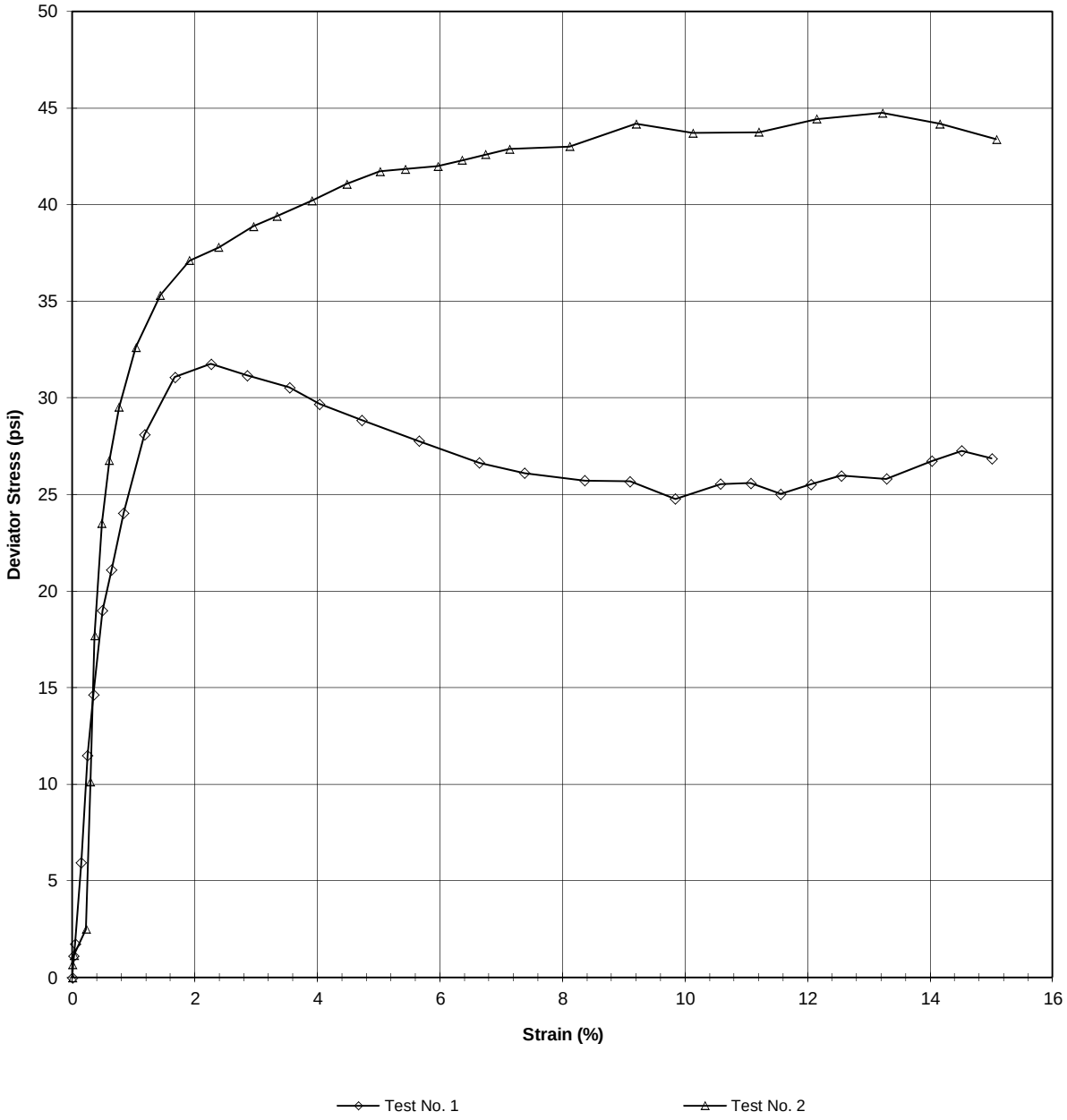
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-407D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	44.3-45.3
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-02		
Visual Description:	YELLOW BROWN & GRAY SANDY LEAN CLAY		



Tested By: SFS Date: 4/30/15 Approved By: MPS Date: 6/4/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler		
Client Reference:	Dan River Steam Station Ash Removal		
Project No.:	2015-616-02		
Lab ID:	2015-616-02-02	Specific Gravity (Measured)	2.65

Visual Description: YELLOW BROWN & GRAY SANDY LEAN CLAY (UNDISTURBED)

SAMPLE CONDITION SUMMARY

Boring No.:	OW-407D	OW-407D
Depth (ft):	44.8-45.3	44.3-44.8
Sample No.:	UD	UD
Test No.	T1	T2
Deformation Rate (in/min)	0.0003	0.0003
Back Pressure (psi)	50.0	50.0
Consolidation Time (days)	1	1
Moisture Content (%) (INITIAL)	24.9	24.9
Total Unit Weight (pcf)	120.8	123.6
Dry Unit Weight (pcf)	96.7	99.0
Moisture Content (%) (FINAL)	26.2	22.9
Initial State Void Ratio,e	0.710	0.671
Void Ratio at Shear, e	0.643	0.470

Tested By: SFS Date: 4/30/15 Input Checked By: GEM Date: 6/4/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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WITH PORE PRESSURE READINGS

ASTM D4767-11

MOISTURE CONTENT

	T1	T2
Tare Number	812	812
Weight of Tare & Wet Sample (g)	335.16	335.16
Weight of Tare & Dry Sample (g)	289.5	289.5
Weight of Tare (g)	106	106
Moisture Content (%) (INITIAL)	24.88	24.88
Tare Number	811	813
Weight of Tare & Wet Sample (g)	788.51	682.75
Weight of Tare & Dry Sample (g)	645.77	575.93
Weight of Tare (g)	101.14	109.46
Moisture Content (%) (FINAL)	26.21	22.90

UNIT WEIGHT

Weight of Tube & Wet Sample (g)		1258.68	1164.86
Weight of Tube (g)		0	0
Weight of Wet Sample (g)		1258.68	1164.86
Length 1 (in)		6.25	5.776
Length 2 (in)		6.244	5.774
Length 3 (in)		6.189	5.808
Top Diameter (in)		2.847	2.813
Middle Diameter (in)		2.85	2.805
Bottom Diameter (in)		2.849	2.813
Average Length (in)		6.227667	5.786
Average Area (in)		6.373	6.203
Sample Volume (cm^3)		650.43	588.15
Unit Wet Weight (g/cm^3)		1.94	1.98
Unit Wet Weight (pcf)		120.81	123.65
Unit Dry Weight (pcf)		96.74	99.01
Unit Dry Weight (g/cm^3)		1.55	1.59
Initial Burette Reading		**48**	**96**
Final Burette Reading		**23.5**	**34.6**
Initial Dial Reading		**30**	**160**
Dial Reading After Saturation		**33**	**191**
Dial Reading After Consolidation		**161**	**443**
Volume Change during Consolidation		24.5	61.4
Volume Change during Saturation		0.94	9.45
Volume at Shear (cm^3)	*These	624.99	517.29
Volume of Solids (cm^3)	measurements	380.34	351.99
Volume of Voids (cm^3)	are all	244.65	165.31
Volume of Water (cm^3)	at	264.15	213.60
Void Ratio, e	shear	0.643	0.470

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ASTM D4767-11

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Client:	Amec Foster Wheeler	Boring No.:	OW-407D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	44.3-45.3
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-02		

TEST 1 INITIAL

TEST 1 FINAL

TEST 2 INITIAL

TEST 2 FINAL

Tested By	*SFS*	*Date*	*4/30/15*	*Approved By*	MPS	*Date*	6/4/15

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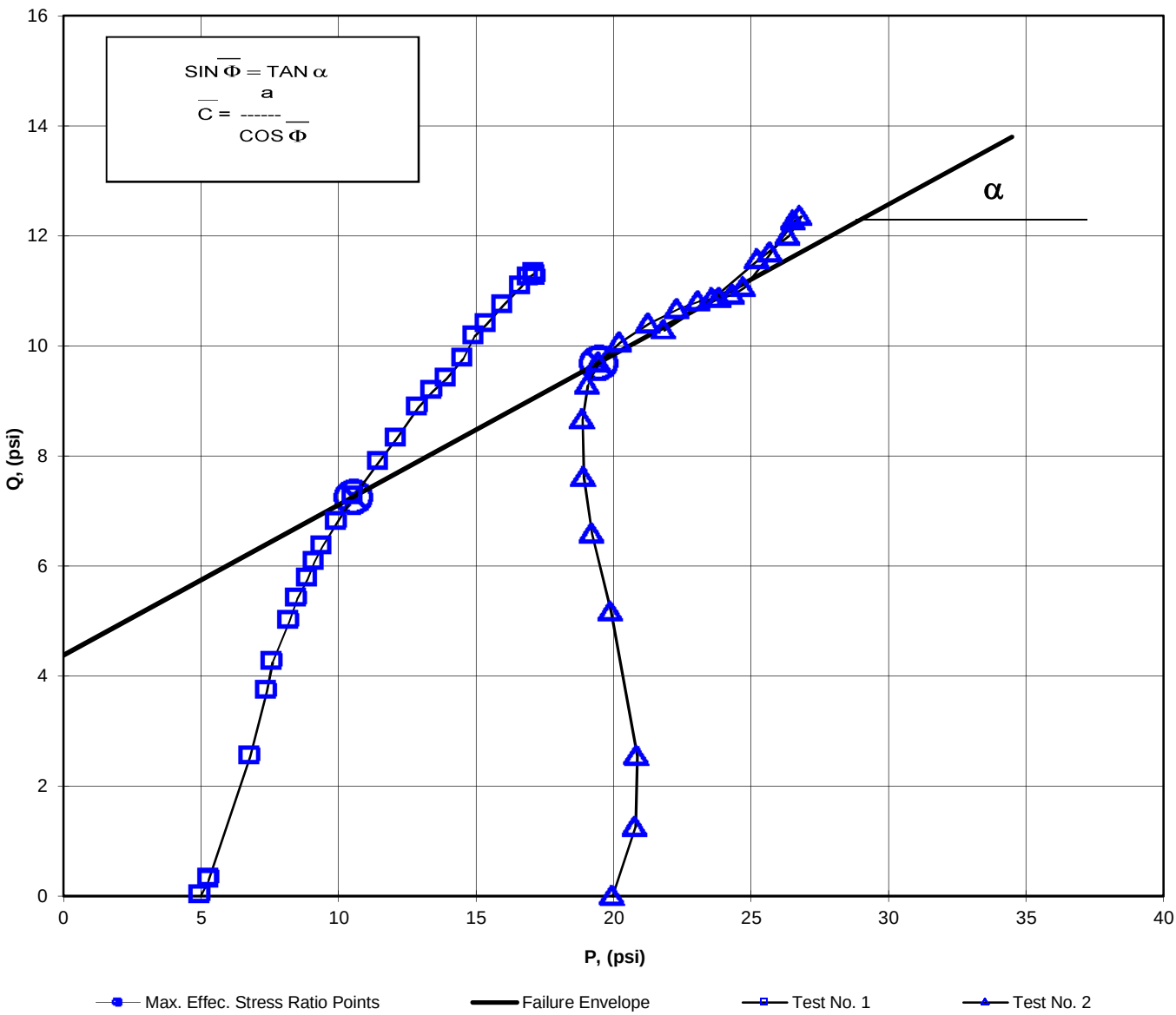
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-417D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	2.8-3.8
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-03		

Consolidated Undrained Triaxial Test with Pore Pressure



a	=	**4.38**	$\overline{C}$	=	**4.55**
α	=	**15.3**	$\overline{\Phi}$	=	**15.85**

Tested By: SFS Date: 5/7/15 Approved By: MPS Date: 5/18/15

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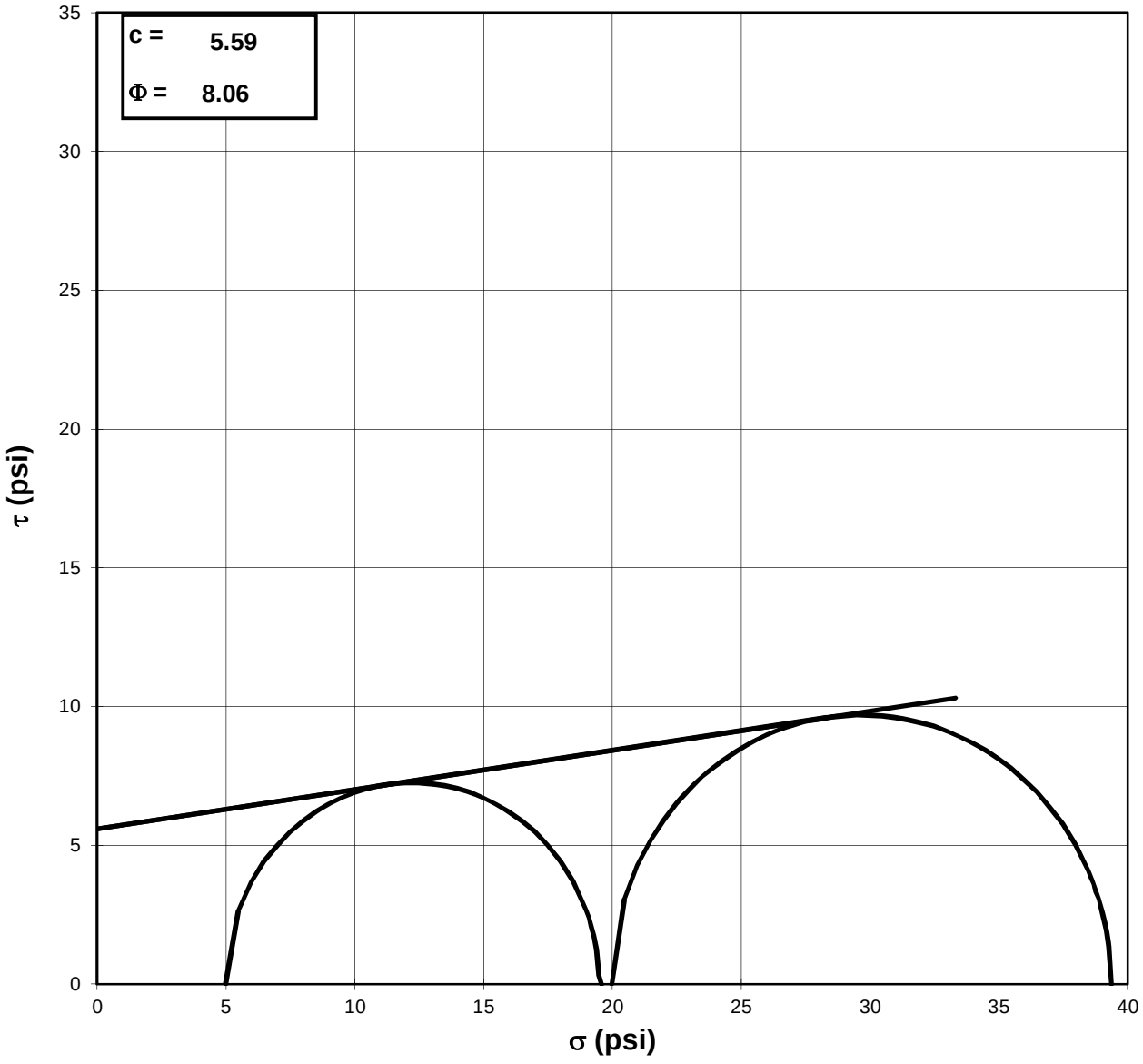
MOHR TOTAL STRENGTH ENVELOPE

ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-417D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	2.8-3.8
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-03		
Visual Description:	ORANGE ELASTIC SILT WITH SAND (UNDISTURBED)		



Failure Based on Maximum Effective Principal Stress Ratio

NOTE: GRAPH NOT TO SCALE

Tested By: SFS *Date:* 5/7/15 *Approved By:* MPS *Date:* 5/18/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

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Client:	Amec Foster Wheeler	Boring No.:	OW-417D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	2.8-3.3
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-03		

Visual Description: ORANGE ELASTIC SILT WITH SAND (UNDISTURBED)

Stage No.	1
Test No.	1

PRESSURES (psi)

Cell Pressure (psi)	55.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	5.0
Pore Pressure Response (%)	99

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	10.53
Q	=	7.25

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.825	Diameter 1:	2.861
Length 2:	5.776	Diameter 2:	2.834
Length 3:	5.824	Diameter 3:	2.842
Avg. Length:	5.808	*Avg. Diam.:*	2.846

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	18.8
Final Change (ml)	5.2

Initial Dial Reading (mil)	33
Dial Reading After Saturation (mil)	41
Dial Reading After Consolidation (mil)	51

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
11.9	0.000	50.0
15.5	0.002	50.0
15.8	0.003	50.0
43.9	0.009	50.7
58.9	0.015	51.3
65.7	0.021	51.6
75.1	0.030	51.8
80.3	0.039	51.9
85.0	0.051	51.9
89.3	0.072	51.9
93.2	0.102	51.9
99.5	0.138	51.8
106.1	0.174	51.7
115.1	0.216	51.4
121.2	0.246	51.2
129.5	0.288	51.0
134.7	0.345	50.7
139.2	0.405	50.5
145.2	0.450	50.2
152.3	0.510	50.2
156.6	0.555	50.0
162.7	0.600	49.7
168.8	0.645	49.4
172.1	0.675	49.3
174.2	0.705	49.2
174.0	0.735	49.1

Tested By: SFS Date: 5/7/15 Input Checked By: GEM Date: 5/18/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-417D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	2.8-3.3
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-03		

Visual Description: ORANGE ELASTIC SILT WITH SAND (UNDISTURBED)

Effective Confining Pressure (psi)	5.0	*Stage No.*	1
		Test No	1

INITIAL DIMENSIONS

Initial Sample Length (in)	5.81
Initial Sample Diameter (in)	2.85
Initial Sample Area (in^2)	6.36
Initial Sample Volume (in^3)	36.94

VOLUME CHANGE

Volume After Consolidation (in^3)	36.47
Length After Consolidation (in)	5.79
Area After Consolidation (in^2)	6.299

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.03	0.57	-0.01	5.57	5.0	1.115	-0.02	5.29	0.29
0.05	0.62	-0.01	5.62	5.0	1.125	-0.02	5.31	0.31
0.16	5.08	0.73	9.33	4.3	2.194	0.15	6.79	2.54
0.26	7.44	1.31	11.12	3.7	3.022	0.18	7.40	3.72
0.36	8.51	1.63	11.87	3.4	3.538	0.19	7.61	4.26
0.52	9.98	1.76	13.21	3.2	4.091	0.18	8.22	4.99
0.67	10.79	1.88	13.89	3.1	4.473	0.18	8.50	5.39
0.88	11.50	1.86	14.63	3.1	4.678	0.16	8.88	5.75
1.24	12.14	1.94	15.20	3.1	4.977	0.16	9.12	6.07
1.76	12.69	1.93	15.74	3.1	5.149	0.15	9.40	6.34
2.38	13.57	1.83	16.73	3.2	5.298	0.14	9.95	6.79
3.01	14.51	1.71	17.79	3.3	5.425	0.12	10.53	7.25
3.73	15.78	1.41	19.36	3.6	5.404	0.09	11.47	7.89
4.25	16.62	1.18	20.42	3.8	5.365	0.07	12.12	8.31
4.97	17.74	0.96	21.78	4.0	5.402	0.05	12.90	8.87
5.96	18.33	0.72	22.60	4.3	5.298	0.04	13.43	9.17
6.99	18.80	0.45	23.34	4.5	5.143	0.02	13.94	9.40
7.77	19.53	0.22	24.30	4.8	5.096	0.01	14.53	9.76
8.81	20.34	0.20	25.12	4.8	5.249	0.01	14.96	10.17
9.58	20.78	-0.02	25.79	5.0	5.148	0.00	15.40	10.39
10.36	21.47	-0.27	26.72	5.3	5.084	-0.01	15.99	10.73
11.14	22.14	-0.59	27.71	5.6	4.970	-0.03	16.65	11.07
11.66	22.47	-0.70	28.16	5.7	4.952	-0.03	16.92	11.24
12.18	22.64	-0.84	28.47	5.8	4.882	-0.04	17.15	11.32
12.69	22.48	-0.96	28.43	5.9	4.779	-0.04	17.19	11.24

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-417D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	3.3-3.8
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-03		

Visual Description: ORANGE ELASTIC SILT WITH SAND (UNDISTURBED)

Stage No.	1
Test No.	2

PRESSURES (psi)

Cell Pressure (psi)	70.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	20.0
Pore Pressure Response (%)	100

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	19.48
Q	=	9.70

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	6.114	Diameter 1:	2.863
Length 2:	6.112	Diameter 2:	2.870
Length 3:	6.136	Diameter 3:	2.865
Avg. Length:	6.121	*Avg. Diam.:*	2.866

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	14.4
Final Change (ml)	9.6

Initial Dial Reading (mil)	102
Dial Reading After Saturation (mil)	108
Dial Reading After Consolidation (mil)	155

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
6.7	0.000	50.0
22.6	0.000	50.4
39.2	0.002	51.7
72.7	0.008	55.2
91.1	0.013	57.3
104.2	0.019	58.7
117.8	0.028	59.7
126.1	0.037	60.2
131.6	0.049	60.2
136.8	0.071	59.8
141.9	0.102	59.1
146.2	0.138	58.3
148.9	0.175	57.7
150.7	0.218	57.0
152.3	0.248	56.5
155.2	0.291	56.3
165.3	0.349	55.9
174.9	0.411	55.7
177.4	0.456	55.5
174.3	0.517	55.6
169.6	0.563	56.3
160.9	0.610	57.2
154.0	0.655	58.4

Tested By: SFS Date: 5/7/15 Input Checked By: GEM Date: 5/18/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-417D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	3.3-3.8
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-03		

Visual Description: ORANGE ELASTIC SILT WITH SAND (UNDISTURBED)

Effective Confining Pressure (psi)	20.0	*Stage No.*	1
		Test No	2

INITIAL DIMENSIONS

Initial Sample Length (in)	6.12
Initial Sample Diameter (in)	2.87
Initial Sample Area (in^2)	6.45
Initial Sample Volume (in^3)	39.49

VOLUME CHANGE

Volume After Consolidation (in^3)	38.78
Length After Consolidation (in)	6.07
Area After Consolidation (in^2)	6.392

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.01	2.50	0.41	22.06	19.6	1.128	0.17	20.81	1.25
0.03	5.09	1.66	23.40	18.3	1.278	0.33	20.86	2.54
0.13	10.31	5.22	25.07	14.8	1.699	0.51	19.91	5.16
0.22	13.17	7.34	25.82	12.6	2.042	0.56	19.23	6.59
0.32	15.22	8.66	26.53	11.3	2.345	0.57	18.92	7.61
0.46	17.30	9.75	27.53	10.2	2.691	0.56	18.88	8.65
0.60	18.57	10.18	28.36	9.8	2.896	0.55	19.08	9.28
0.81	19.40	10.20	29.18	9.8	2.983	0.53	19.48	9.70
1.17	20.12	9.80	30.30	10.2	2.976	0.49	20.24	10.06
1.67	20.80	9.09	31.69	10.9	2.909	0.44	21.29	10.40
2.28	21.34	8.30	33.02	11.7	2.827	0.39	22.35	10.67
2.88	21.61	7.67	33.93	12.3	2.756	0.35	23.12	10.81
3.59	21.73	6.96	34.75	13.0	2.669	0.32	23.89	10.87
4.09	21.86	6.55	35.29	13.4	2.627	0.30	24.36	10.93
4.80	22.12	6.26	35.83	13.7	2.613	0.28	24.77	11.06
5.76	23.39	5.94	37.43	14.0	2.667	0.25	25.73	11.70
6.77	24.53	5.65	38.86	14.3	2.712	0.23	26.59	12.27
7.52	24.70	5.49	39.18	14.5	2.705	0.22	26.83	12.35
8.52	24.00	5.59	38.39	14.4	2.668	0.23	26.39	12.00
9.28	23.12	6.26	36.84	13.7	2.684	0.27	25.28	11.56
10.05	21.71	7.22	34.47	12.8	2.701	0.33	23.62	10.85
10.80	20.56	8.40	32.14	11.6	2.776	0.41	21.86	10.28

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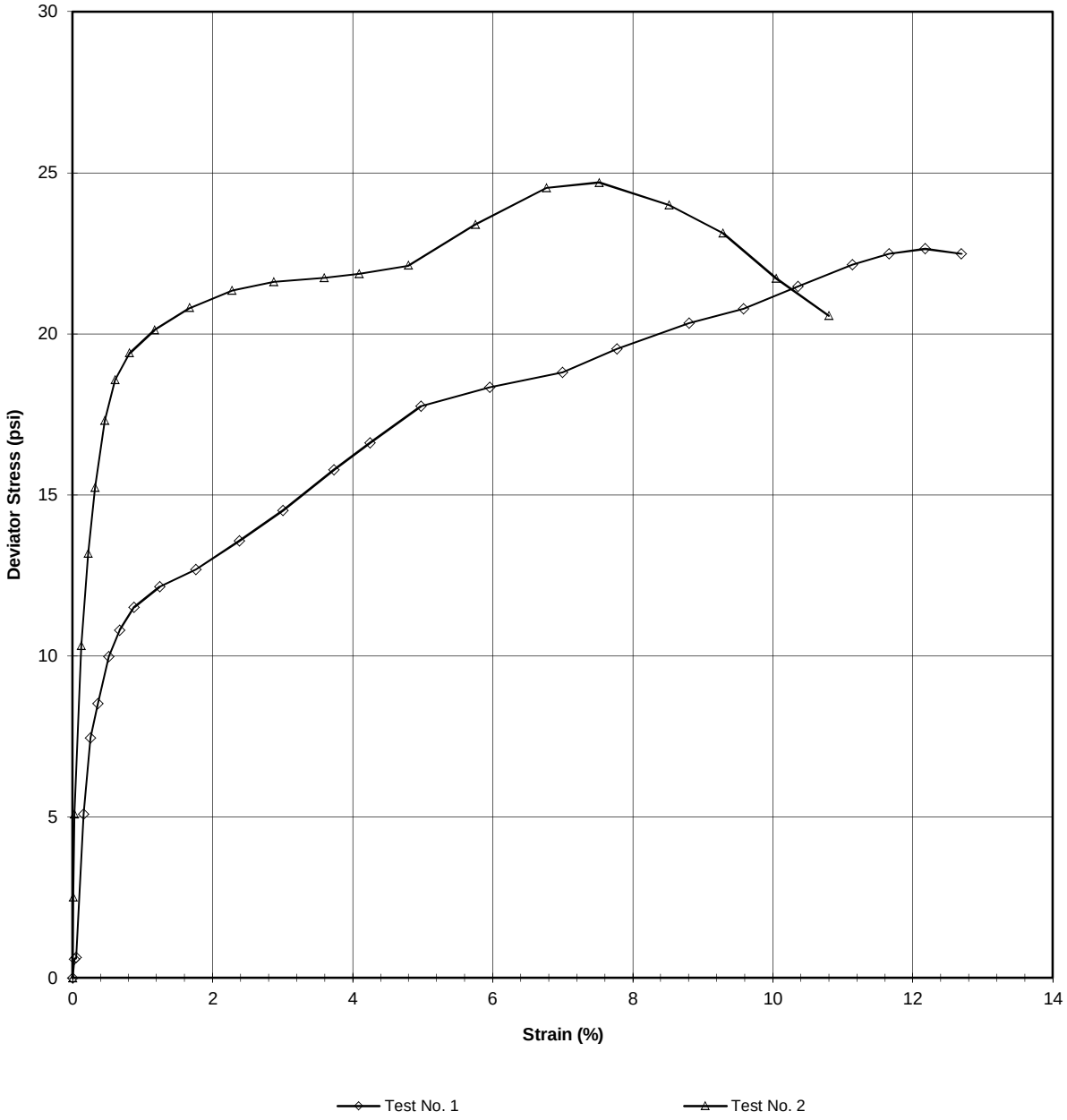
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-417D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	2.8-3.8
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-03		
Visual Description:	ORANGE ELASTIC SILT WITH SAND (UNDISTURBED)		



Tested By: SFS Date: 5/7/15 Approved By: MPS Date: 5/18/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler		
Client Reference:	Dan River Steam Station Ash Removal		
Project No.:	2015-616-02		
Lab ID:	2015-616-02-03	Specific Gravity (Measured)	2.88

Visual Description: ORANGE ELASTIC SILT WITH SAND (UNDISTURBED)

SAMPLE CONDITION SUMMARY

Boring No.:	OW-417D	OW-417D
Depth (ft):	2.8-3.3	3.3-3.8
Sample No.:	UD	UD
Test No.	T1	T2
Deformation Rate (in/min)	0.0003	0.0003
Back Pressure (psi)	50.0	50.0
Consolidation Time (days)	1	1
Moisture Content (%) (INITIAL)	32.8	26.5
Total Unit Weight (pcf)	122.2	129.5
Dry Unit Weight (pcf)	92.1	102.4
Moisture Content (%) (FINAL)	22.9	21.8
Initial State Void Ratio,e	0.952	0.755
Void Ratio at Shear, e	0.928	0.724

Tested By: SFS Date: 5/7/15 Input Checked By: GEM Date: 5/18/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS

ASTM D4767-11

MOISTURE CONTENT

	T1	T2
Tare Number	803	810
Weight of Tare & Wet Sample (g)	248.17	374.94
Weight of Tare & Dry Sample (g)	212.19	320.11
Weight of Tare (g)	102.35	112.89
Moisture Content (%) (INITIAL)	32.76	26.46
Tare Number	806	813
Weight of Tare & Wet Sample (g)	535.17	461.92
Weight of Tare & Dry Sample (g)	454.09	398.78
Weight of Tare (g)	100.62	109.41
Moisture Content (%) (FINAL)	22.94	21.82

UNIT WEIGHT

Weight of Tube & Wet Sample (g)		1185.32	1342.37
Weight of Tube (g)		0	0
Weight of Wet Sample (g)		1185.32	1342.37
Length 1 (in)		5.825	6.114
Length 2 (in)		5.776	6.112
Length 3 (in)		5.824	6.136
Top Diameter (in)		2.861	2.863
Middle Diameter (in)		2.834	2.87
Bottom Diameter (in)		2.842	2.865
Average Length (in)		5.808333	6.120667
Average Area (in)		6.360	6.451
Sample Volume (cm^3)		605.36	647.06
Unit Wet Weight (g/cm^3)		1.96	2.07
Unit Wet Weight (pcf)		122.24	129.52
Unit Dry Weight (pcf)		92.08	102.42
Unit Dry Weight (g/cm^3)		1.48	1.64
Initial Burette Reading		**24**	**24**
Final Burette Reading		**18.8**	**14.4**
Initial Dial Reading		**33**	**102**
Dial Reading After Saturation		**41**	**108**
Dial Reading After Consolidation		**51**	**155**
Volume Change during Consolidation		5.2	9.6
Volume Change during Saturation		2.50	1.90
Volume at Shear (cm^3)	*These	597.65	635.55
Volume of Solids (cm^3)	measurements	310.02	368.58
Volume of Voids (cm^3)	are all	287.64	266.98
Volume of Water (cm^3)	at	204.80	231.62
Void Ratio, e	shear	0.928	0.724

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

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Client:	Amec Foster Wheeler	Boring No.:	OW-417D
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	2.8-3.8
Project No.:	2015-616-02	Sample No.:	UD
Lab ID:	2015-616-02-03		

TEST 1 INITIAL

TEST 1 FINAL

TEST 2 INITIAL

TEST 2 FINAL

Tested By SFS *Date* 5/7/15 *Approved By* MPS *Date* 5/18/15

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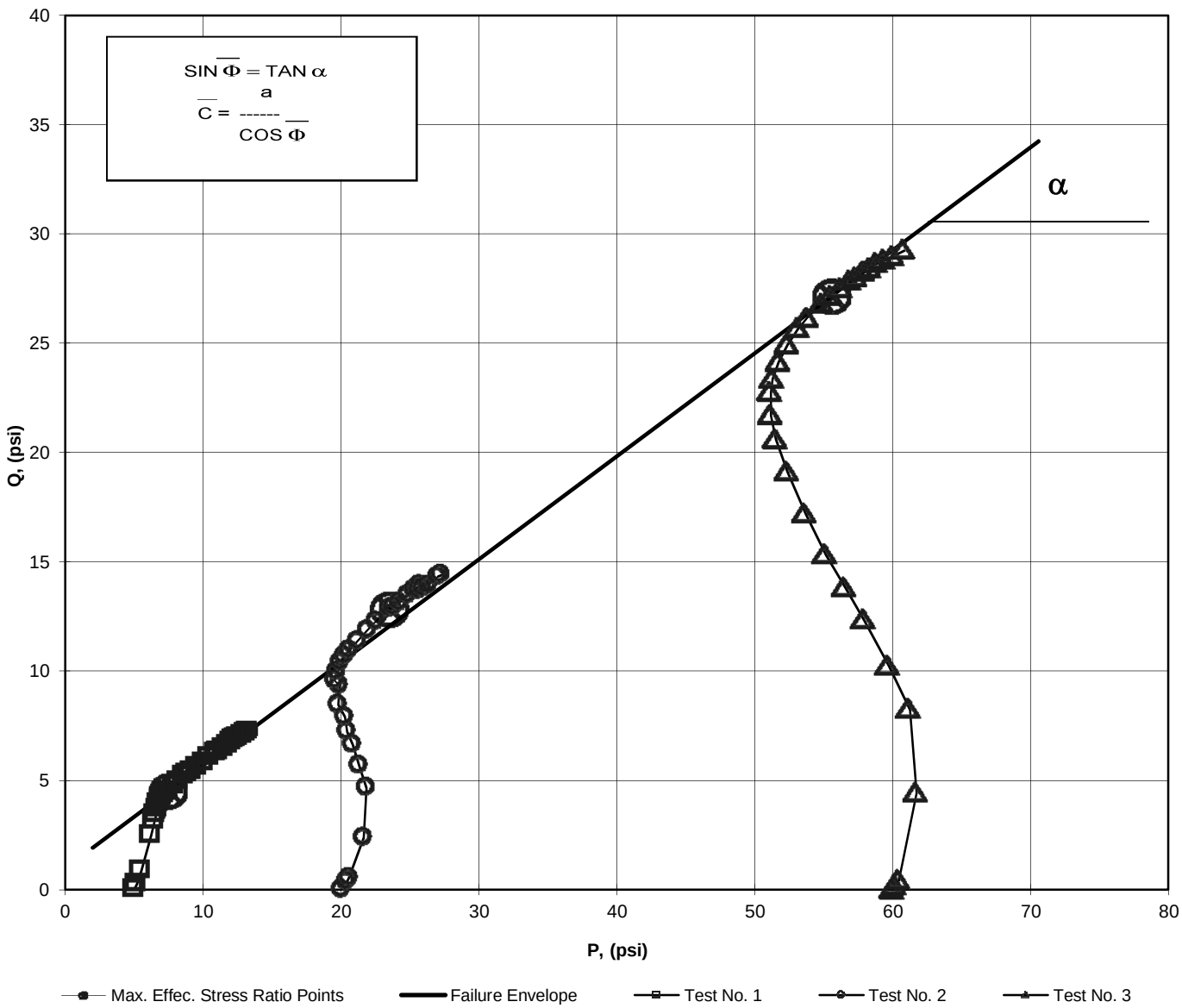
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	B-453
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	0.0-10.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-04		

Consolidated Undrained Triaxial Test with Pore Pressure



a	=	**0.00**	$\overline{C}$	=	**0.00**
α	=	**25.2**	$\overline{\Phi}$	=	**28.10**

Tested By: SFS Date: 5/20/15 Approved By: MPS Date: 6/4/15

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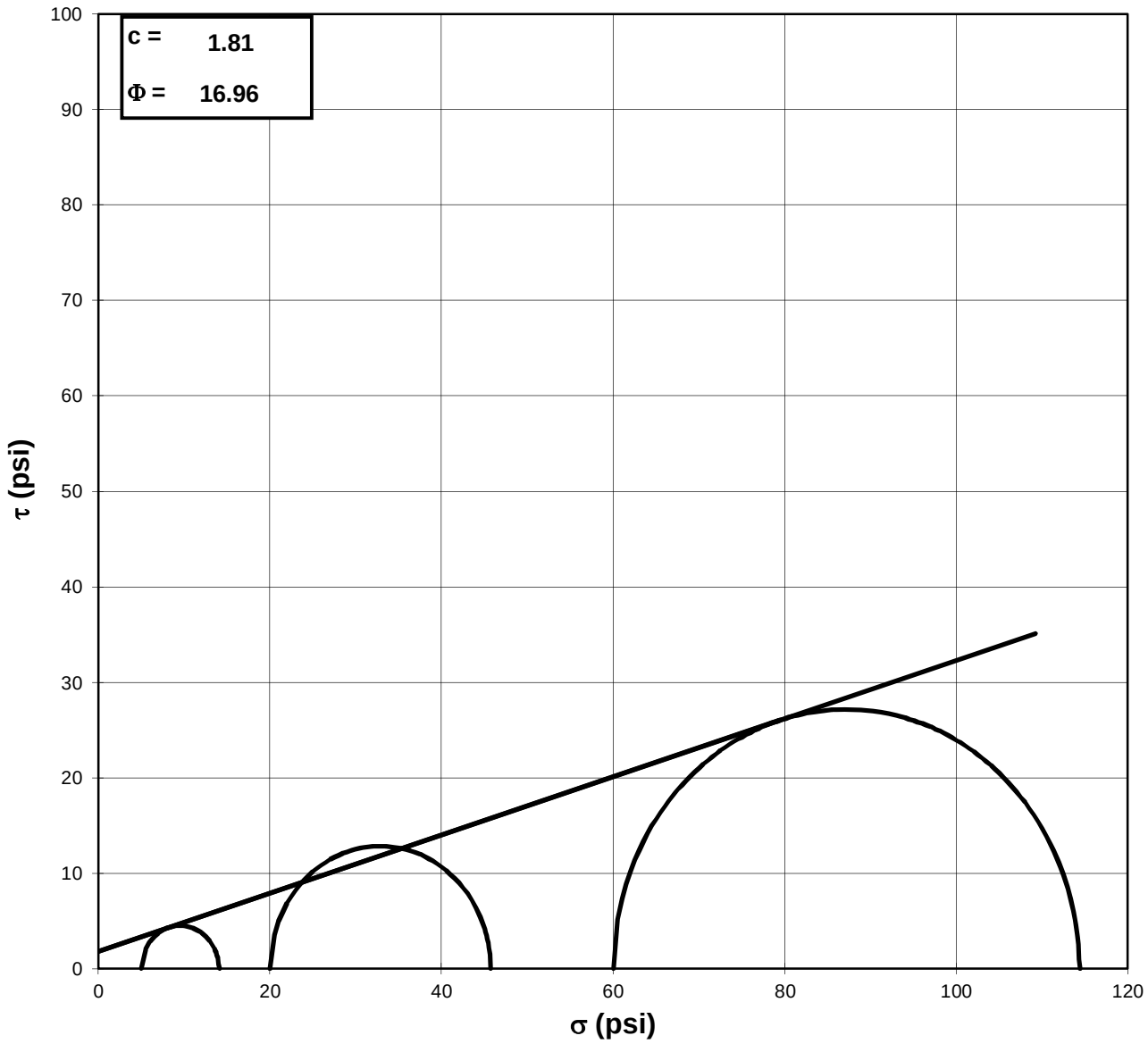
MOHR TOTAL STRENGTH ENVELOPE

ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	B-453
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	0.0-10.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-04		
Visual Description:	YELLOW- BROWN FAT CLAY WITH SAND (REMOLDED)		



Failure Based on Maximum Effective Principal Stress Ratio

NOTE: GRAPH NOT TO SCALE

Tested By: SFS *Date:* 5/20/15 *Approved By:* MPS *Date:* 6/4/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	B-453
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	0.0-10.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-04		

Visual Description: YELLOW- BROWN FAT CLAY WITH SAND (REMOLDED)

Stage No.	1
Test No.	1

PRESSURES (psi)

Cell Pressure (psi)	55.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	5.0
Pore Pressure Response (%)	97

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	7.50
Q	=	4.51

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length:	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	19.7
Final Change (ml)	4.3

Initial Dial Reading (mil)	27
Dial Reading After Saturation (mil)	27
Dial Reading After Consolidation (mil)	27

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
8.2	0.000	50.0
11.6	0.001	50.1
19.4	0.003	50.3
40.2	0.007	51.2
48.4	0.013	51.6
52.5	0.019	51.8
55.9	0.028	52.0
58.8	0.037	52.1
61.5	0.049	52.1
64.4	0.070	52.1
67.0	0.100	52.0
70.5	0.136	51.9
73.1	0.171	51.7
76.9	0.214	51.5
79.1	0.244	51.4
81.0	0.285	51.2
84.4	0.343	51.0
88.1	0.402	50.8
92.2	0.448	50.6
96.0	0.508	50.3
97.5	0.553	50.2
100.3	0.598	50.0
103.0	0.643	49.8
105.5	0.674	49.7
107.7	0.704	49.6
108.8	0.734	49.5
110.2	0.764	49.3
112.6	0.809	49.2
115.6	0.854	49.0
116.9	0.884	48.9
121.7	0.914	48.8

Tested By: SFS Date: 5/20/15 Input Checked By: GEM Date: 6/4/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	B-453
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	0.0-10.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-04		

Visual Description: YELLOW- BROWN FAT CLAY WITH SAND (REMOLDED)

Effective Confining Pressure (psi)	5.0	*Stage No.*	1
		Test No	1

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	38.36
Length After Consolidation (in)	6.00
Area After Consolidation (in^2)	6.398

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	0.53	0.10	5.47	4.9	1.107	0.19	5.20	0.26
0.05	1.74	0.37	6.40	4.7	1.373	0.22	5.53	0.87
0.11	4.99	1.28	8.74	3.8	2.331	0.26	6.25	2.50
0.22	6.27	1.68	9.62	3.4	2.872	0.28	6.49	3.14
0.31	6.89	1.86	10.06	3.2	3.176	0.28	6.62	3.45
0.46	7.42	2.03	10.42	3.0	3.471	0.28	6.71	3.71
0.61	7.86	2.11	10.78	2.9	3.686	0.28	6.86	3.93
0.81	8.26	2.15	11.15	2.9	3.863	0.27	7.02	4.13
1.17	8.67	2.15	11.56	2.9	4.004	0.26	7.23	4.34
1.66	9.03	2.05	12.01	3.0	4.027	0.23	7.50	4.51
2.27	9.51	1.89	12.66	3.1	4.026	0.20	7.90	4.76
2.86	9.85	1.71	13.18	3.3	3.962	0.18	8.25	4.93
3.56	10.35	1.53	13.85	3.5	3.959	0.15	8.68	5.18
4.06	10.63	1.42	14.25	3.6	3.940	0.14	8.93	5.32
4.76	10.83	1.25	14.61	3.8	3.862	0.12	9.20	5.41
5.72	11.22	1.03	15.22	4.0	3.802	0.09	9.61	5.61
6.71	11.64	0.79	15.88	4.2	3.747	0.07	10.06	5.82
7.47	12.15	0.61	16.57	4.4	3.746	0.05	10.50	6.07
8.47	12.55	0.36	17.23	4.7	3.687	0.03	10.95	6.28
9.23	12.67	0.19	17.51	4.8	3.618	0.02	11.17	6.33
9.98	12.96	0.01	17.98	5.0	3.579	0.00	11.50	6.48
10.73	13.23	-0.18	18.44	5.2	3.539	-0.01	11.82	6.61
11.24	13.49	-0.28	18.80	5.3	3.537	-0.02	12.06	6.74
11.74	13.72	-0.40	19.15	5.4	3.526	-0.03	12.29	6.86
12.24	13.79	-0.51	19.34	5.5	3.488	-0.04	12.44	6.90
12.74	13.90	-0.62	19.55	5.6	3.461	-0.05	12.60	6.95
13.49	14.11	-0.77	19.92	5.8	3.431	-0.06	12.86	7.06
14.24	14.39	-0.94	20.36	6.0	3.408	-0.07	13.17	7.19
14.75	14.48	-1.03	20.55	6.1	3.386	-0.07	13.31	7.24
15.25	15.02	-1.13	21.19	6.2	3.436	-0.08	13.68	7.51

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CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	B-453
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	0.0-10.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-04		

Visual Description: YELLOW- BROWN FAT CLAY WITH SAND (REMOLDED)

Stage No.	1
Test No.	2

PRESSURES (psi)

Cell Pressure (psi)	70.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	20.0
Pore Pressure Response (%)	97

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	23.50
Q	=	12.85

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	48.0
Final Burette Reading (ml)	19.9
Final Change (ml)	28.1

Initial Dial Reading (mil)	114
Dial Reading After Saturation (mil)	114
Dial Reading After Consolidation (mil)	147

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
10.6	0.000	50.0
14.8	0.001	50.0
17.1	0.003	50.0
39.9	0.007	50.8
68.3	0.013	52.8
80.9	0.019	54.4
93.2	0.028	55.8
100.7	0.037	56.8
109.1	0.049	57.7
116.5	0.070	58.7
128.2	0.100	59.5
131.9	0.136	60.1
137.6	0.171	60.3
143.9	0.214	60.5
148.2	0.244	60.5
152.9	0.285	60.4
159.7	0.343	60.2
168.0	0.402	60.0
174.8	0.448	59.8
184.5	0.508	59.4
186.9	0.553	59.2
191.3	0.598	58.9
197.5	0.643	58.6
201.7	0.674	58.4
206.1	0.704	58.2
203.6	0.734	58.1
206.2	0.764	57.9
209.8	0.809	57.6
217.3	0.854	57.3
219.9	0.884	57.1
221.9	0.914	57.0

Tested By: SFS Date: 5/20/15 Input Checked By: GEM Date: 6/4/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	B-453
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	0.0-10.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-04		

Visual Description: YELLOW- BROWN FAT CLAY WITH SAND (REMOLDED)

Effective Confining Pressure (psi)	20.0	*Stage No.*	1
		Test No	2

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	36.91
Length After Consolidation (in)	5.96
Area After Consolidation (in^2)	6.190

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	0.67	-0.03	20.74	20.1	1.034	-0.04	20.40	0.34
0.05	1.05	-0.03	21.12	20.1	1.052	-0.03	20.59	0.52
0.11	4.73	0.75	24.02	19.3	1.245	0.16	21.66	2.36
0.22	9.29	2.84	26.49	17.2	1.540	0.31	21.85	4.65
0.32	11.32	4.36	27.00	15.7	1.722	0.40	21.34	5.66
0.47	13.27	5.83	27.48	14.2	1.934	0.45	20.84	6.64
0.62	14.45	6.82	27.67	13.2	2.094	0.49	20.44	7.23
0.82	15.78	7.65	28.17	12.4	2.274	0.50	20.28	7.89
1.17	16.90	8.67	28.26	11.4	2.487	0.53	19.81	8.45
1.67	18.68	9.49	29.23	10.5	2.771	0.52	19.89	9.34
2.28	19.14	10.05	29.12	10.0	2.916	0.54	19.56	9.57
2.87	19.92	10.31	29.65	9.7	3.047	0.53	19.69	9.96
3.58	20.76	10.45	30.34	9.6	3.166	0.52	19.96	10.38
4.08	21.32	10.46	30.89	9.6	3.227	0.51	20.23	10.66
4.79	21.88	10.37	31.54	9.7	3.264	0.49	20.60	10.94
5.75	22.70	10.20	32.53	9.8	3.307	0.46	21.19	11.35
6.75	23.71	9.97	33.78	10.1	3.356	0.43	21.92	11.86
7.51	24.53	9.75	34.82	10.3	3.384	0.41	22.55	12.27
8.52	25.69	9.38	36.35	10.7	3.411	0.38	23.50	12.85
9.28	25.83	9.16	36.72	10.9	3.374	0.37	23.80	12.92
10.03	26.25	8.94	37.35	11.1	3.365	0.35	24.23	13.13
10.79	26.93	8.64	38.33	11.4	3.362	0.33	24.86	13.46
11.30	27.37	8.42	38.99	11.6	3.356	0.32	25.30	13.69
11.81	27.85	8.24	39.65	11.8	3.361	0.30	25.72	13.93
12.30	27.34	8.08	39.29	12.0	3.286	0.30	25.63	13.67
12.81	27.54	7.86	39.72	12.2	3.262	0.29	25.95	13.77
13.56	27.81	7.59	40.26	12.4	3.235	0.28	26.35	13.91
14.32	28.61	7.31	41.34	12.7	3.249	0.26	27.03	14.31
14.83	28.79	7.14	41.69	12.9	3.231	0.26	27.29	14.39
15.34	28.89	6.97	41.96	13.1	3.210	0.25	27.52	14.45

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	B-453
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	0.0-10.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-04		

Visual Description: YELLOW- BROWN FAT CLAY WITH SAND (REMOLDED)

Stage No.	1
Test No.	3

PRESSURES (psi)

Cell Pressure (psi)	110.1
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	60.0
Pore Pressure Response (%)	96

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	55.58
Q	=	27.16

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length:	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	72.0
Final Burette Reading (ml)	21.7
Final Change (ml)	50.3

Initial Dial Reading (mil)	102
Dial Reading After Saturation (mil)	102
Dial Reading After Consolidation (mil)	206

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
14.8	0.000	50.0
16.7	0.000	50.0
19.9	0.002	50.0
68.2	0.007	52.7
114.4	0.012	57.0
138.6	0.017	60.5
164.3	0.025	64.4
182.3	0.033	67.3
201.0	0.044	70.2
224.5	0.063	73.5
249.0	0.091	76.8
268.8	0.125	79.1
284.0	0.159	80.6
299.1	0.199	81.6
307.9	0.228	82.1
320.0	0.267	82.4
333.0	0.320	82.6
345.8	0.379	82.6
354.9	0.422	82.4
366.9	0.478	81.9
374.5	0.521	81.6
381.8	0.565	81.3
389.3	0.607	80.9
393.4	0.636	80.7
399.2	0.664	80.4
403.5	0.693	80.1
408.8	0.721	79.9
414.2	0.765	79.4
420.2	0.808	79.0
428.6	0.864	78.5
434.9	0.907	78.0

Tested By: SFS Date: 5/20/15 Input Checked By: GEM Date: 6/4/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	B-453
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	0.0-10.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-04		

Visual Description: YELLOW- BROWN FAT CLAY WITH SAND (REMOLDED)

Effective Confining Pressure (psi)	60.0	*Stage No.*	1
		Test No	3

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	35.55
Length After Consolidation (in)	5.89
Area After Consolidation (in^2)	6.035

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.00	0.31	0.00	60.34	60.0	1.005	-0.01	60.19	0.15
0.03	0.84	-0.01	60.89	60.0	1.014	-0.02	60.47	0.42
0.11	8.83	2.69	66.18	57.3	1.154	0.32	61.76	4.42
0.20	16.47	7.01	69.49	53.0	1.311	0.44	61.25	8.24
0.28	20.45	10.53	69.95	49.5	1.413	0.54	59.73	10.22
0.42	24.66	14.42	70.28	45.6	1.541	0.61	57.94	12.33
0.56	27.60	17.27	70.37	42.8	1.645	0.65	56.57	13.80
0.74	30.62	20.17	70.48	39.9	1.768	0.69	55.17	15.31
1.07	34.37	23.53	70.87	36.5	1.942	0.71	53.69	17.18
1.54	38.20	26.75	71.49	33.3	2.148	0.73	52.39	19.10
2.11	41.20	29.08	72.15	31.0	2.331	0.74	51.55	20.60
2.70	43.40	30.55	72.88	29.5	2.472	0.73	51.18	21.70
3.38	45.51	31.62	73.93	28.4	2.602	0.72	51.17	22.76
3.87	46.69	32.06	74.66	28.0	2.669	0.72	51.32	23.34
4.54	48.27	32.42	75.89	27.6	2.748	0.70	51.75	24.14
5.44	49.86	32.57	77.32	27.5	2.815	0.68	52.39	24.93
6.44	51.31	32.53	78.81	27.5	2.866	0.66	53.16	25.65
7.16	52.30	32.34	79.99	27.7	2.889	0.64	53.84	26.15
8.12	53.60	31.93	81.70	28.1	2.907	0.62	54.90	26.80
8.85	54.32	31.61	82.74	28.4	2.911	0.61	55.58	27.16
9.58	54.98	31.26	83.75	28.8	2.911	0.59	56.26	27.49
10.30	55.65	30.92	84.76	29.1	2.912	0.58	56.94	27.83
10.79	55.96	30.65	85.34	29.4	2.905	0.57	57.36	27.98
11.27	56.51	30.37	86.18	29.7	2.905	0.56	57.92	28.26
11.76	56.83	30.09	86.77	29.9	2.898	0.55	58.36	28.42
12.24	57.28	29.84	87.47	30.2	2.897	0.54	58.83	28.64
12.98	57.58	29.40	88.21	30.6	2.880	0.53	59.42	28.79
13.71	57.96	28.97	89.02	31.1	2.866	0.52	60.05	28.98
14.67	58.49	28.43	90.09	31.6	2.851	0.51	60.85	29.25
15.39	58.89	28.00	90.93	32.0	2.838	0.50	61.48	29.44

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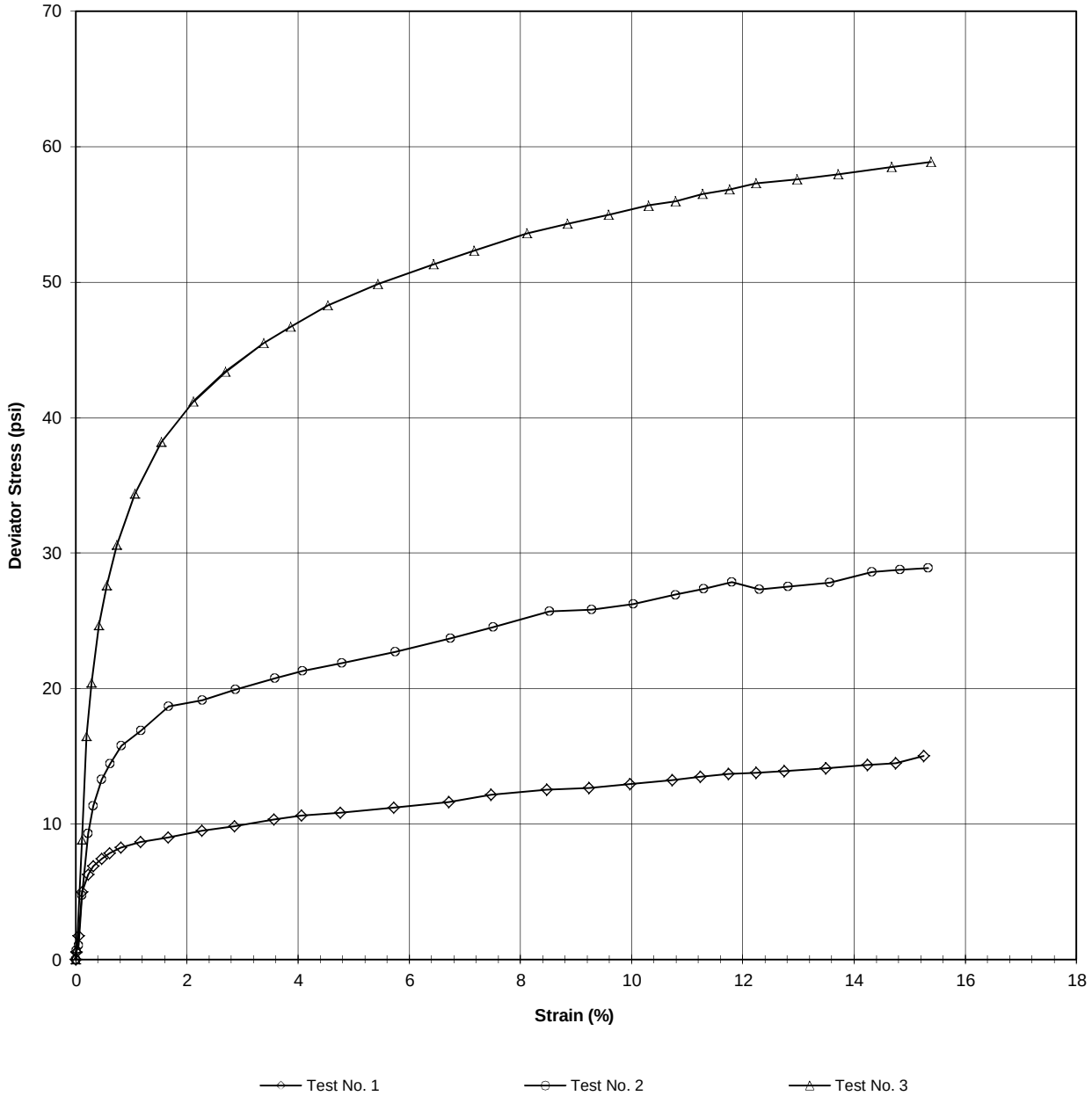
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	B-453
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	0.0-10.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-04		
Visual Description:	YELLOW- BROWN FAT CLAY WITH SAND (REMOLDED)		



Tested By: SFS Date: 5/20/15 Approved By: MPS Date: 6/4/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler		
Client Reference:	Dan River Steam Station Ash Removal		
Project No.:	2015-616-02		
Lab ID:	2015-616-02-04	Specific Gravity (assumed)	2.7

Visual Description: YELLOW- BROWN FAT CLAY WITH SAND (REMOLDED)

SAMPLE CONDITION SUMMARY

Boring No.:	B-453	B-453	B-453
Depth (ft):	0.0-10.0	0.0-10.0	0.0-10.0
Sample No.:	BULK	BULK	BULK
Test No.	T1	T2	T3
Deformation Rate (in/min)	0.0009	0.0009	0.0009
Back Pressure (psi)	50.0	50.0	50.0
Consolidation Time (days)	1	1	1
Moisture Content (%) (INITIAL)	25.5	25.4	25.6
Total Unit Weight (pcf)	117.2	117.4	118.7
Dry Unit Weight (pcf)	93.4	93.6	94.5
Moisture Content (%) (FINAL)	26.4	26.2	26.0
Initial State Void Ratio,e	0.804	0.800	0.783
Void Ratio at Shear, e	0.792	0.721	0.641

Tested By: SFS Date: 5/20/15 Input Checked By: GEM Date: 6/4/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS

ASTM D4767-11

MOISTURE CONTENT

	T1	T2	T3
Tare Number	805	803	807
Weight of Tare & Wet Sample (g)	373.33	363.88	382.78
Weight of Tare & Dry Sample (g)	318.40	310.90	325.89
Weight of Tare (g)	102.83	102.22	103.44
Moisture Content (%) (INITIAL)	25.48	25.39	25.57
Tare Number	805	802	812
Weight of Tare & Wet Sample (g)	564.62	628.27	513.9
Weight of Tare & Dry Sample (g)	468.01	519.34	429.68
Weight of Tare (g)	102.73	103.32	105.99
Moisture Content (%) (FINAL)	26.45	26.18	26.02

UNIT WEIGHT

Weight of Tube & Wet Sample (g)	2742.01	2743.59	2757.15
Weight of Tube (g)	1553.64	1553.64	1553.64
Weight of Wet Sample (g)	1188.37	1189.95	1203.51
Length 1 (in)	5.995	5.995	5.995
Length 2 (in)	5.995	5.995	5.995
Length 3 (in)	5.995	5.995	5.995
Top Diameter (in)	2.864	2.864	2.864
Middle Diameter (in)	2.864	2.864	2.864
Bottom Diameter (in)	2.864	2.864	2.864
Average Length (in)	5.995	5.995	5.995
Average Area (in)	6.442	6.442	6.442
Sample Volume (cm^3)	632.89	632.89	632.89
Unit Wet Weight (g/cm^3)	1.88	1.88	1.90
Unit Wet Weight (pcf)	117.22	117.38	118.72
Unit Dry Weight (pcf)	93.42	93.61	94.54
Unit Dry Weight (g/cm^3)	1.50	1.50	1.51
Initial Burette Reading	**24**	**48**	**72**
Final Burette Reading	**19.7**	**19.9**	**21.7**
Initial Dial Reading	**27**	**114**	**102**
Dial Reading After Saturation	**27**	**114**	**102**
Dial Reading After Consolidation	**27**	**147**	**206**
Volume Change during Consolidation	4.3	28.1	50.3
Volume Change during Saturation	0.00	0.00	0.00
Volume at Shear (cm^3) *These	628.59	604.79	582.59
Volume of Solids (cm^3) measurements	350.75	351.49	354.96
Volume of Voids (cm^3) are all	277.84	253.30	227.62
Volume of Water (cm^3) at	250.47	248.49	249.36
Void Ratio, e shear	0.792	0.721	0.641

CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

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Client:	Amec Foster Wheeler	Boring No.:	B-453
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	0.0-10.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-04		

TEST 1 INITIAL

N/A

TEST 1 FINAL

TEST 2 INITIAL

N/A

TEST 2 FINAL

TEST 3 INITIAL

N/A

TEST 3 FINAL

Tested By *SFS* *Date* *5/20/15* *Approved By* MPS *Date* 6/4/15

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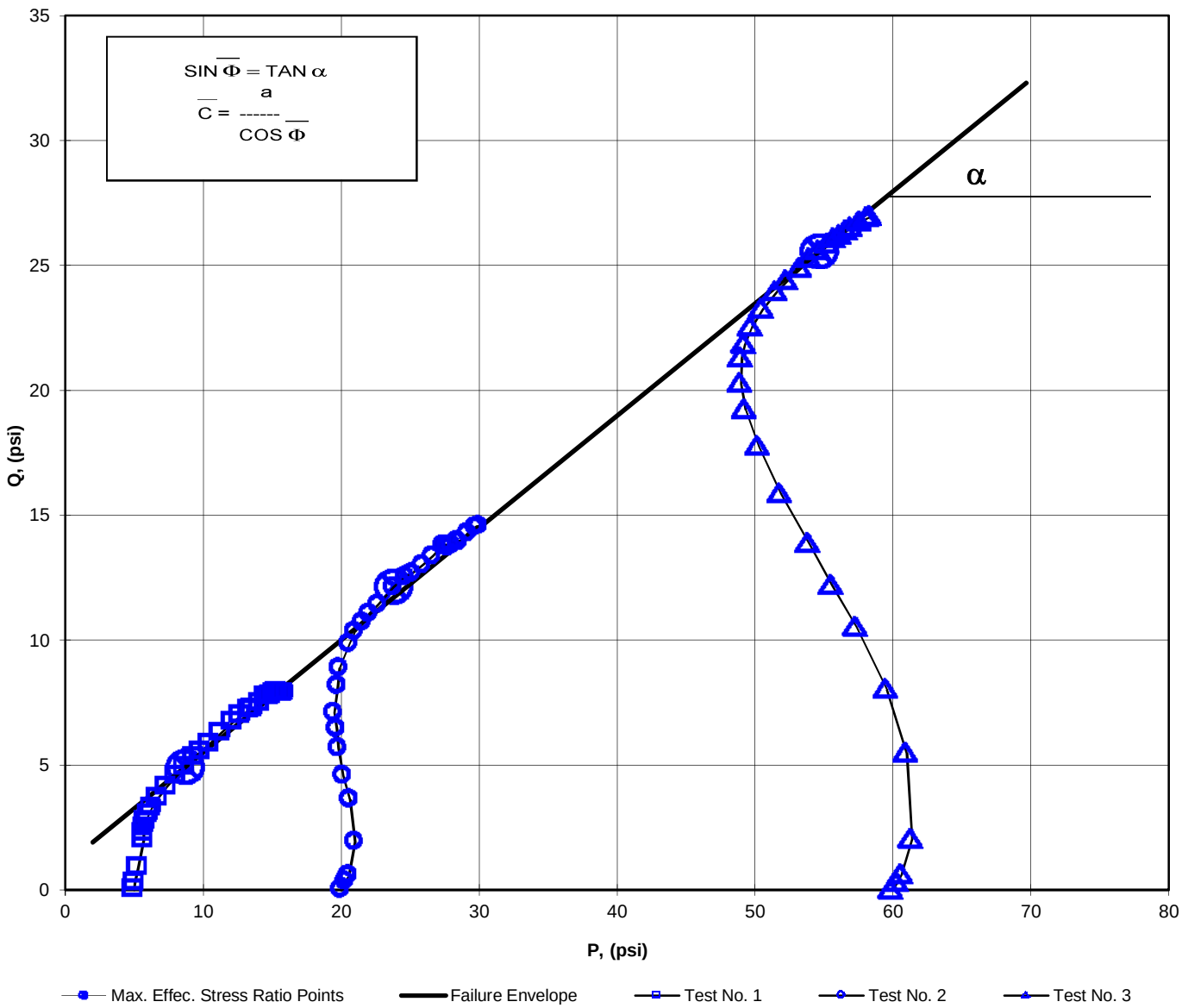
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-412S
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10.0-20.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-06		

Consolidated Undrained Triaxial Test with Pore Pressure



a	=	**0.00**	$\overline{\mathbf{C}}$	=	**0.00**
α	=	**24.2**	$\overline{\mathbf{\Phi}}$	=	**26.68**

page 2 of 12 DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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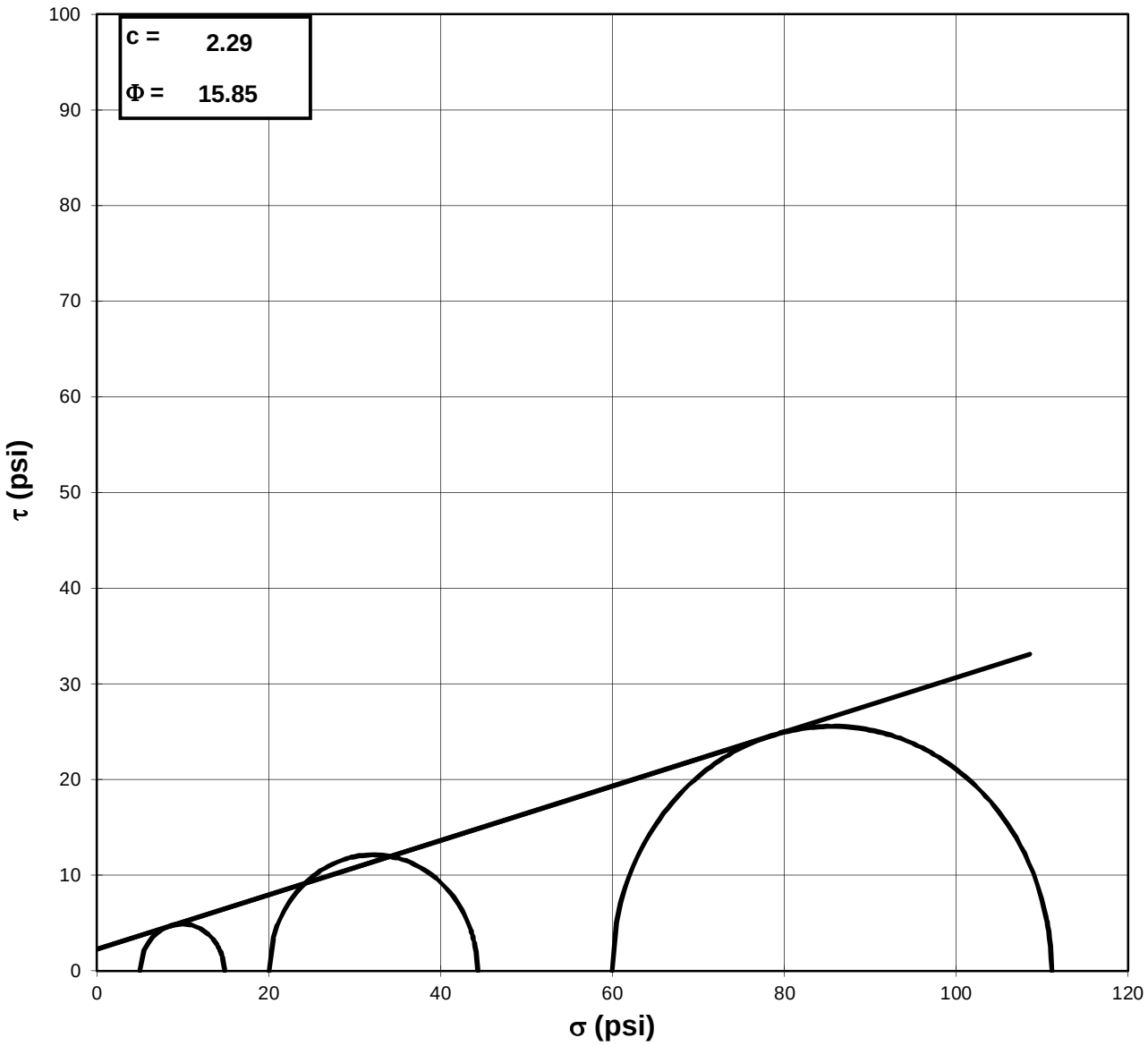
MOHR TOTAL STRENGTH ENVELOPE

ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-412S
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10.0-20.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-06		
Visual Description:	YELLOW & YELLOW BROWN CLAY (REMOLDED)		



Failure Based on Maximum Effective Principal Stress Ratio

NOTE: GRAPH NOT TO SCALE

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CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-412S
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10.0-20.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-06		

Visual Description: YELLOW & YELLOW BROWN CLAY (REMOLDED)

Stage No.	1
Test No.	1

PRESSURES (psi)

Cell Pressure (psi)	55.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	5.0
Pore Pressure Response (%)	97

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	8.68
Q	=	4.91

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length:	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	12.9
Final Change (ml)	11.1

Initial Dial Reading (mil)	130
Dial Reading After Saturation (mil)	130
Dial Reading After Consolidation (mil)	152

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
7.6	0.000	50.0
11.1	0.001	50.2
18.9	0.002	50.6
32.8	0.007	51.3
36.5	0.014	51.6
39.3	0.020	51.7
42.9	0.029	51.9
46.0	0.037	51.9
49.6	0.050	52.0
54.7	0.070	51.9
61.0	0.100	51.7
66.8	0.136	51.5
71.8	0.172	51.2
77.3	0.215	50.9
81.0	0.245	50.7
85.7	0.287	50.4
92.4	0.344	49.9
99.0	0.404	49.5
103.4	0.449	49.2
107.5	0.508	48.8
108.9	0.555	48.6
113.3	0.598	48.3
117.6	0.644	48.1
118.5	0.674	47.9
119.8	0.704	47.8
121.8	0.735	47.6
122.9	0.765	47.5
123.5	0.809	47.3
124.4	0.855	47.1
125.1	0.885	47.0
126.7	0.915	46.8

Tested By: SFS Date: 5/12/15 Input Checked By: GEM Date: 6/415

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

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Client:	Amec Foster Wheeler	Boring No.:	OW-412S
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10.0-20.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-06		

Visual Description: YELLOW & YELLOW BROWN CLAY (REMOLDED)

Effective Confining Pressure (psi)	5.0	*Stage No.*	1
		Test No	1

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	37.94
Length After Consolidation (in)	5.97
Area After Consolidation (in^2)	6.353

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	0.56	0.21	5.34	4.8	1.116	0.40	5.06	0.28
0.03	1.79	0.60	6.18	4.4	1.406	0.34	5.29	0.89
0.12	3.97	1.30	7.67	3.7	2.075	0.34	5.68	1.99
0.23	4.54	1.58	7.95	3.4	2.328	0.36	5.68	2.27
0.33	4.98	1.75	8.22	3.2	2.533	0.36	5.73	2.49
0.49	5.53	1.89	8.64	3.1	2.779	0.35	5.87	2.77
0.62	6.01	1.95	9.06	3.0	2.973	0.33	6.05	3.01
0.83	6.57	1.96	9.60	3.0	3.166	0.31	6.31	3.28
1.17	7.33	1.91	10.41	3.1	3.379	0.27	6.75	3.66
1.68	8.27	1.75	11.51	3.2	3.546	0.22	7.38	4.13
2.28	9.11	1.49	12.62	3.5	3.600	0.17	8.06	4.56
2.89	9.82	1.22	13.59	3.8	3.603	0.13	8.68	4.91
3.60	10.59	0.91	14.68	4.1	3.591	0.09	9.38	5.29
4.10	11.08	0.68	15.40	4.3	3.570	0.06	9.86	5.54
4.80	11.71	0.36	16.34	4.6	3.527	0.03	10.48	5.85
5.76	12.58	-0.07	17.64	5.1	3.485	-0.01	11.35	6.29
6.76	13.42	-0.49	18.90	5.5	3.448	-0.04	12.19	6.71
7.51	13.96	-0.79	19.74	5.8	3.412	-0.06	12.77	6.98
8.51	14.39	-1.18	20.56	6.2	3.332	-0.08	13.37	7.19
9.29	14.47	-1.44	20.90	6.4	3.251	-0.10	13.67	7.24
10.02	14.97	-1.68	21.65	6.7	3.244	-0.12	14.16	7.49
10.78	15.46	-1.91	22.37	6.9	3.238	-0.13	14.64	7.73
11.28	15.49	-2.06	22.55	7.1	3.194	-0.14	14.80	7.74
11.79	15.58	-2.20	22.78	7.2	3.164	-0.15	14.99	7.79
12.30	15.77	-2.35	23.11	7.3	3.147	-0.15	15.23	7.88
12.80	15.83	-2.49	23.32	7.5	3.114	-0.16	15.41	7.92
13.55	15.78	-2.70	23.47	7.7	3.050	-0.18	15.58	7.89
14.32	15.76	-2.91	23.67	7.9	2.994	-0.19	15.79	7.88
14.81	15.76	-3.03	23.78	8.0	2.964	-0.20	15.90	7.88
15.32	15.88	-3.15	24.03	8.1	2.949	-0.20	16.09	7.94

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CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-412S
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10.0-20.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-06		

Visual Description: YELLOW & YELLOW BROWN CLAY (REMOLDED)

Stage No.	1
Test No.	2

PRESSURES (psi)

Cell Pressure (psi)	70.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	20.0
Pore Pressure Response (%)	98

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	23.83
Q	=	12.13

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	6.7
Final Change (ml)	17.3
Initial Dial Reading (mil)	120
Dial Reading After Saturation (mil)	120
Dial Reading After Consolidation (mil)	193

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
8.5	0.000	50.0
12.8	0.008	50.0
15.9	0.005	50.0
32.9	0.001	50.9
54.7	0.012	53.0
66.8	0.017	54.4
80.9	0.028	55.9
90.9	0.032	56.8
99.2	0.044	57.6
113.4	0.070	58.4
123.3	0.099	59.0
136.6	0.143	59.3
143.5	0.169	59.3
149.6	0.212	59.2
155.2	0.251	59.0
161.0	0.292	58.8
172.1	0.348	58.3
179.2	0.399	57.9
182.7	0.450	57.5
190.0	0.532	57.1
195.8	0.560	56.7
203.0	0.588	56.4
204.8	0.636	56.1
204.3	0.659	55.9
206.8	0.689	55.8
210.5	0.720	55.6
211.1	0.749	55.4
217.6	0.788	55.1
223.2	0.834	54.8
225.4	0.872	54.6
224.2	0.901	54.4

Tested By: SFS Date: 5/12/15 Input Checked By: GEM Date: 6/4/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-412S
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10.0-20.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-06		

Visual Description: YELLOW & YELLOW BROWN CLAY (REMOLDED)

Effective Confining Pressure (psi)	20.0	*Stage No.*	1
		Test No	2

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	37.57
Length After Consolidation (in)	5.92
Area After Consolidation (in^2)	6.343

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.13	0.67	0.02	20.68	20.0	1.033	0.03	20.35	0.33
0.08	1.16	0.04	21.16	20.0	1.058	0.03	20.58	0.58
0.02	3.84	0.95	22.92	19.1	1.201	0.25	21.01	1.92
0.21	7.26	3.00	24.29	17.0	1.426	0.42	20.66	3.63
0.29	9.16	4.45	24.75	15.6	1.588	0.50	20.16	4.58
0.47	11.35	5.88	25.51	14.2	1.802	0.53	19.83	5.68
0.55	12.91	6.78	26.17	13.3	1.974	0.54	19.71	6.46
0.74	14.18	7.61	26.61	12.4	2.141	0.55	19.52	7.09
1.18	16.33	8.44	27.93	11.6	2.408	0.53	19.77	8.17
1.67	17.78	9.01	28.81	11.0	2.613	0.52	19.92	8.89
2.41	19.70	9.27	30.47	10.8	2.831	0.48	20.61	9.85
2.86	20.67	9.34	31.36	10.7	2.932	0.46	21.03	10.33
3.57	21.45	9.19	32.29	10.8	2.978	0.44	21.57	10.72
4.24	22.15	9.03	33.15	11.0	3.013	0.42	22.07	11.07
4.94	22.85	8.77	34.11	11.3	3.029	0.39	22.69	11.42
5.87	24.27	8.34	35.97	11.7	3.074	0.35	23.83	12.13
6.73	25.10	7.90	37.23	12.1	3.068	0.32	24.68	12.55
7.59	25.37	7.54	37.87	12.5	3.030	0.30	25.18	12.69
8.99	26.03	7.12	38.95	12.9	3.015	0.28	25.94	13.02
9.45	26.73	6.75	40.02	13.3	3.012	0.26	26.65	13.37
9.93	27.61	6.41	41.24	13.6	3.026	0.24	27.43	13.80
10.75	27.61	6.10	41.55	13.9	2.982	0.23	27.74	13.81
11.12	27.42	5.95	41.51	14.1	2.947	0.22	27.80	13.71
11.64	27.61	5.77	41.87	14.3	2.936	0.21	28.07	13.81
12.15	27.97	5.56	42.45	14.5	2.932	0.20	28.47	13.99
12.65	27.89	5.39	42.54	14.6	2.904	0.20	28.59	13.95
13.31	28.57	5.10	43.50	14.9	2.913	0.18	29.22	14.28
14.08	29.07	4.79	44.32	15.2	2.907	0.17	29.78	14.54
14.72	29.16	4.59	44.61	15.5	2.887	0.16	30.03	14.58
15.22	28.82	4.42	44.43	15.6	2.846	0.16	30.02	14.41

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-412S
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10.0-20.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-06		

Visual Description: YELLOW & YELLOW BROWN CLAY (REMOLDED)

Stage No.	1
Test No.	3

PRESSURES (psi)

Cell Pressure (psi)	110.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	60.0
Pore Pressure Response (%)	97

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	54.69
Q	=	25.57

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length:	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	48.0
Final Burette Reading (ml)	0.7
Final Change (ml)	47.3

Initial Dial Reading (mil)	98
Dial Reading After Saturation (mil)	98
Dial Reading After Consolidation (mil)	227

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
14.2	0.000	50.0
17.7	0.000	49.9
21.9	0.001	49.9
39.0	0.007	50.6
81.2	0.013	54.5
112.2	0.019	58.4
142.9	0.027	63.1
163.3	0.036	66.5
184.3	0.048	69.9
209.5	0.069	73.9
234.1	0.099	77.4
253.9	0.135	79.9
268.3	0.170	81.2
282.9	0.211	82.2
291.6	0.241	82.5
302.3	0.283	82.7
314.7	0.340	82.6
327.1	0.400	82.3
335.4	0.444	82.0
345.7	0.506	81.5
353.6	0.551	81.2
360.9	0.595	80.9
367.4	0.638	80.5
372.3	0.670	80.2
376.4	0.701	80.0
381.3	0.731	79.7
384.8	0.760	79.4
391.6	0.803	79.1
397.0	0.849	78.7
400.2	0.879	78.5
403.7	0.909	78.3

Tested By: SFS Date: 5/12/15 Input Checked By: GEM Date: 6/4/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-412S
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10.0-20.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-06		

Visual Description: YELLOW & YELLOW BROWN CLAY (REMOLDED)

Effective Confining Pressure (psi)	60.0	*Stage No.*	1
		Test No	3

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	35.73
Length After Consolidation (in)	5.87
Area After Consolidation (in^2)	6.092

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.00	0.57	-0.08	60.61	60.0	1.010	-0.14	60.32	0.29
0.03	1.26	-0.08	61.30	60.0	1.021	-0.07	60.67	0.63
0.12	4.06	0.60	63.42	59.4	1.068	0.15	61.39	2.03
0.22	10.97	4.43	66.50	55.5	1.198	0.42	61.01	5.48
0.32	16.03	8.39	67.60	51.6	1.311	0.54	59.59	8.02
0.46	21.03	13.09	67.91	46.9	1.449	0.64	57.39	10.52
0.61	24.33	16.51	67.78	43.4	1.560	0.70	55.61	12.17
0.81	27.69	19.88	67.77	40.1	1.691	0.74	53.92	13.85
1.18	31.67	23.89	67.74	36.1	1.878	0.78	51.91	15.84
1.69	35.49	27.41	68.04	32.6	2.090	0.80	50.30	17.74
2.30	38.44	29.83	68.57	30.1	2.276	0.80	49.35	19.22
2.89	40.50	31.20	69.26	28.8	2.408	0.79	49.01	20.25
3.59	42.53	32.16	70.33	27.8	2.530	0.78	49.07	21.26
4.10	43.67	32.50	71.14	27.5	2.590	0.77	49.30	21.84
4.82	45.02	32.69	72.28	27.3	2.651	0.75	49.78	22.51
5.79	46.47	32.61	73.82	27.4	2.699	0.72	50.59	23.24
6.82	47.86	32.32	75.50	27.6	2.732	0.70	51.57	23.93
7.57	48.74	31.97	76.73	28.0	2.741	0.68	52.36	24.37
8.62	49.73	31.47	78.21	28.5	2.746	0.65	53.35	24.86
9.39	50.48	31.18	79.27	28.8	2.754	0.64	54.02	25.24
10.14	51.13	30.84	80.25	29.1	2.756	0.62	54.69	25.57
10.88	51.66	30.45	81.18	29.5	2.750	0.61	55.35	25.83
11.42	52.07	30.20	81.83	29.8	2.750	0.60	55.80	26.04
11.95	52.35	29.93	82.38	30.0	2.744	0.59	56.20	26.18
12.46	52.75	29.66	83.05	30.3	2.741	0.58	56.68	26.37
12.95	52.96	29.40	83.52	30.6	2.733	0.57	57.04	26.48
13.70	53.47	29.05	84.38	30.9	2.730	0.56	57.64	26.73
14.47	53.75	28.67	85.04	31.3	2.718	0.55	58.16	26.87
14.99	53.86	28.46	85.36	31.5	2.710	0.54	58.43	26.93
15.50	54.02	28.26	85.72	31.7	2.704	0.54	58.71	27.01

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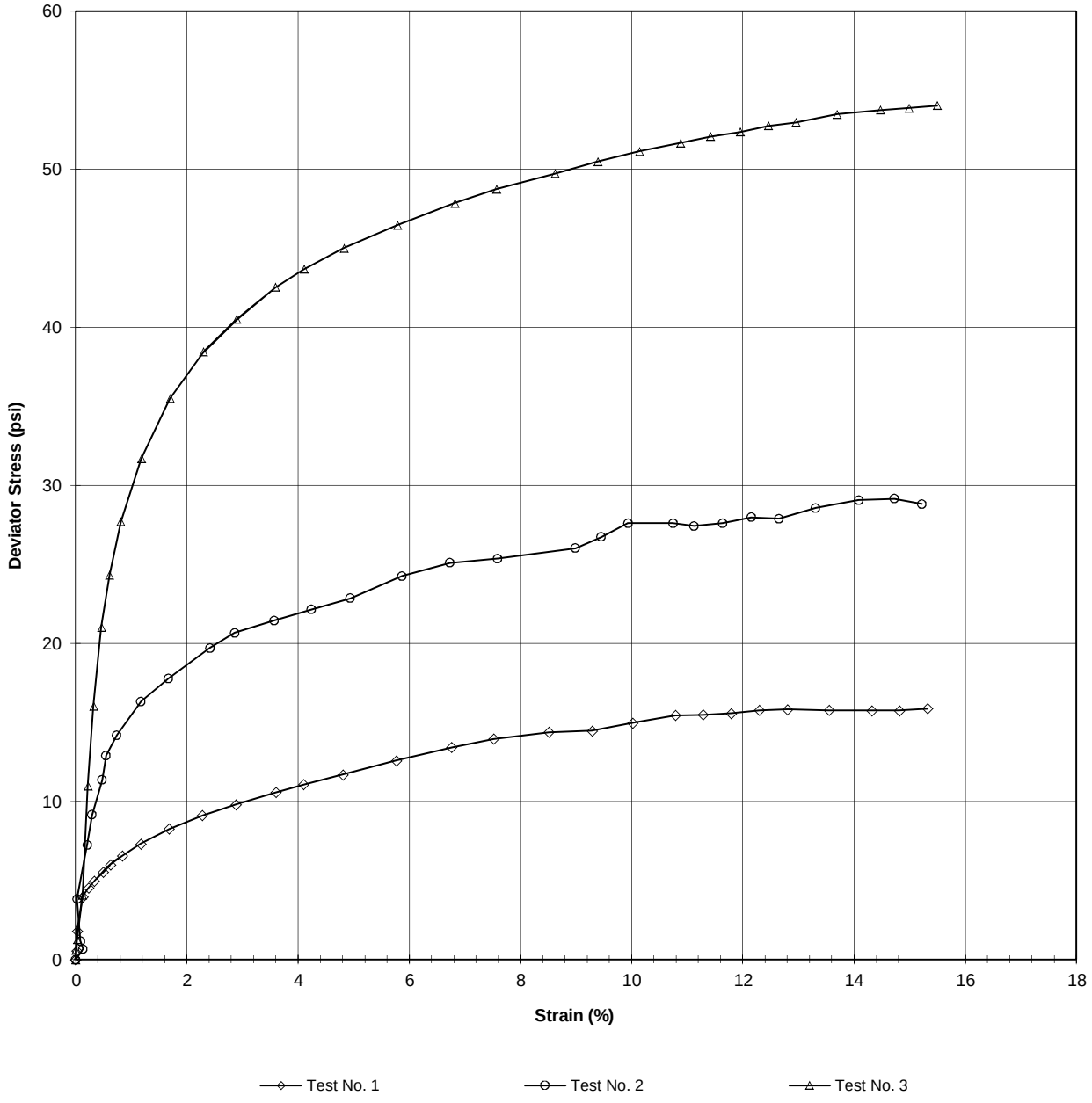
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-412S
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10.0-20.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-06		
Visual Description:	YELLOW & YELLOW BROWN CLAY		



Tested By: SFS Date: 5/12/15 Approved By: MPS Date: 6/4/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler		
Client Reference:	Dan River Steam Station Ash Removal		
Project No.:	2015-616-02		
Lab ID:	2015-616-02-06	Specific Gravity (assumed)	2.7

Visual Description: YELLOW & YELLOW BROWN CLAY (REMOLDED)

SAMPLE CONDITION SUMMARY

Boring No.:	OW-412S	OW-412S	OW-412S
Depth (ft):	10.0-20.0	10.0-20.0	10.0-20.0
Sample No.:	BULK	BULK	BULK
Test No.	T1	T2	T3
Deformation Rate (in/min)	0.0005	0.0005	0.0005
Back Pressure (psi)	50.0	50.0	50.0
Consolidation Time (days)	1	1	1
Moisture Content (%) (INITIAL)	18.6	18.7	18.8
Total Unit Weight (pcf)	126.9	127.1	127.9
Dry Unit Weight (pcf)	107.0	107.0	107.7
Moisture Content (%) (FINAL)	21.1	19.7	17.8
Initial State Void Ratio,e	0.575	0.575	0.565
Void Ratio at Shear, e	0.548	0.532	0.448

Tested By: SFS Date: 5/12/15 Input Checked By: GEM Date: 6/4/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS

ASTM D4767-11

MOISTURE CONTENT

	T1	T2	T3
Tare Number	805	810	814
Weight of Tare & Wet Sample (g)	358.8	380.49	402.17
Weight of Tare & Dry Sample (g)	318.57	337.27	355.96
Weight of Tare (g)	102.76	106.26	109.75
Moisture Content (%) (INITIAL)	18.64	18.71	18.77
Tare Number	810	809	805
Weight of Tare & Wet Sample (g)	867.9	781.68	792.78
Weight of Tare & Dry Sample (g)	736.38	671.09	688.66
Weight of Tare (g)	112.76	108.79	102.77
Moisture Content (%) (FINAL)	21.09	19.67	17.77

UNIT WEIGHT

Weight of Tube & Wet Sample (g)	2840.52	2841.69	2850.19
Weight of Tube (g)	1553.64	1553.64	1553.64
Weight of Wet Sample (g)	1286.88	1288.05	1296.55
Length 1 (in)	5.995	5.995	5.995
Length 2 (in)	5.995	5.995	5.995
Length 3 (in)	5.995	5.995	5.995
Top Diameter (in)	2.864	2.864	2.864
Middle Diameter (in)	2.864	2.864	2.864
Bottom Diameter (in)	2.864	2.864	2.864
Average Length (in)	5.995	5.995	5.995
Average Area (in)	6.442	6.442	6.442
Sample Volume (cm^3)	632.89	632.89	632.89
Unit Wet Weight (g/cm^3)	2.03	2.04	2.05
Unit Wet Weight (pcf)	126.94	127.06	127.90
Unit Dry Weight (pcf)	107.00	107.03	107.68
Unit Dry Weight (g/cm^3)	1.71	1.71	1.73
Initial Burette Reading	**24**	**24**	**48**
Final Burette Reading	**12.9**	**6.7**	**0.7**
Initial Dial Reading	**130**	**120**	**98**
Dial Reading After Saturation	**130**	**120**	**98**
Dial Reading After Consolidation	**152**	**193**	**227**
Volume Change during Consolidation	11.1	17.3	47.3
Volume Change during Saturation	0.00	0.00	0.00
Volume at Shear (cm^3) *These	621.79	615.59	585.59
Volume of Solids (cm^3) measurements	401.73	401.87	404.32
Volume of Voids (cm^3) are all	220.05	213.72	181.27
Volume of Water (cm^3) at	228.76	213.40	194.00
Void Ratio, e shear	0.548	0.532	0.448

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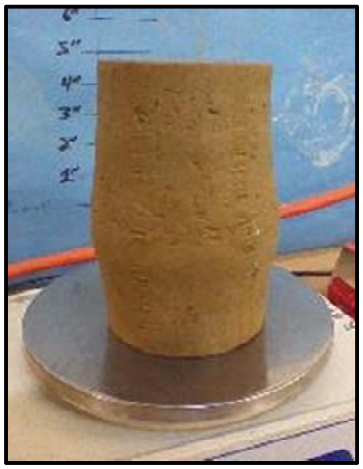
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	Amec Foster Wheeler	Boring No.:	OW-412S
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10.0-20.0
Project No.:	2015-616-02	Sample No.:	BULK
Lab ID:	2015-616-02-06		

TEST 1 INITIAL

N/A

TEST 1 FINAL



TEST 2 INITIAL

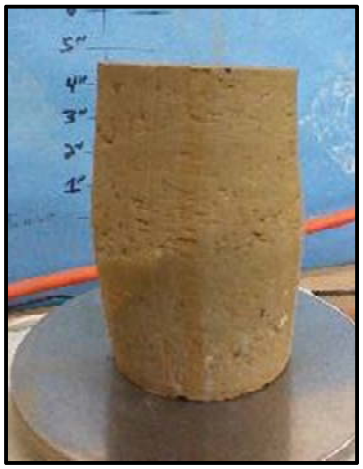
N/A

TEST 2 FINAL

TEST 3 INITIAL

N/A

TEST 3 FINAL



Tested By *SFS* *Date* *5/12/15* *Approved By* MPS *Date* 6/4/15

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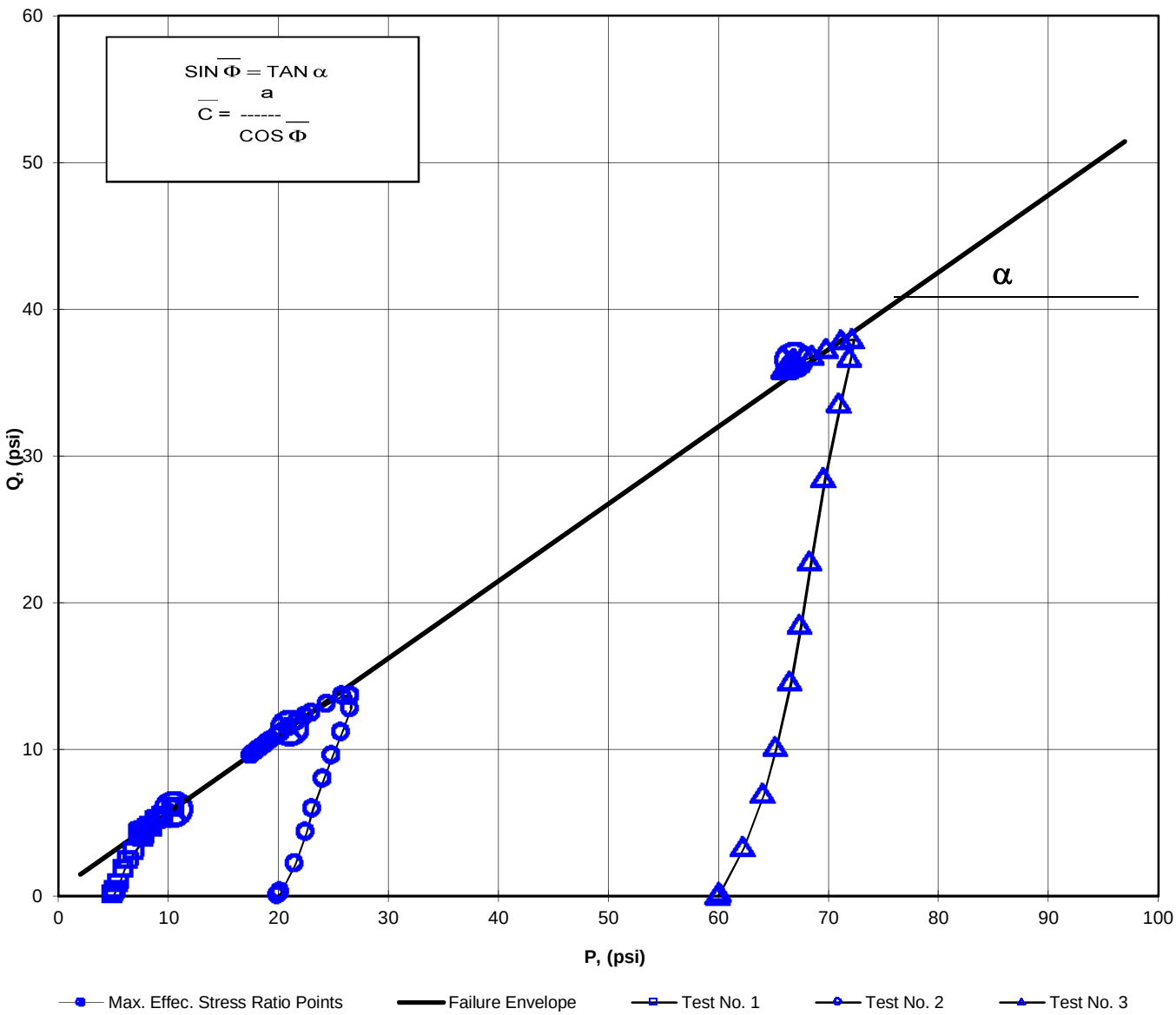
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B319
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10-20
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-01		

Consolidated Undrained Triaxial Test with Pore Pressure



a	=	**0.00**	**C̄**	=	**0.00**
α	=	**27.7**	**Φ̄**	=	**31.73**

Tested By: SFS Date: 12/16/14 Approved By: MPS Date: 6/3/15

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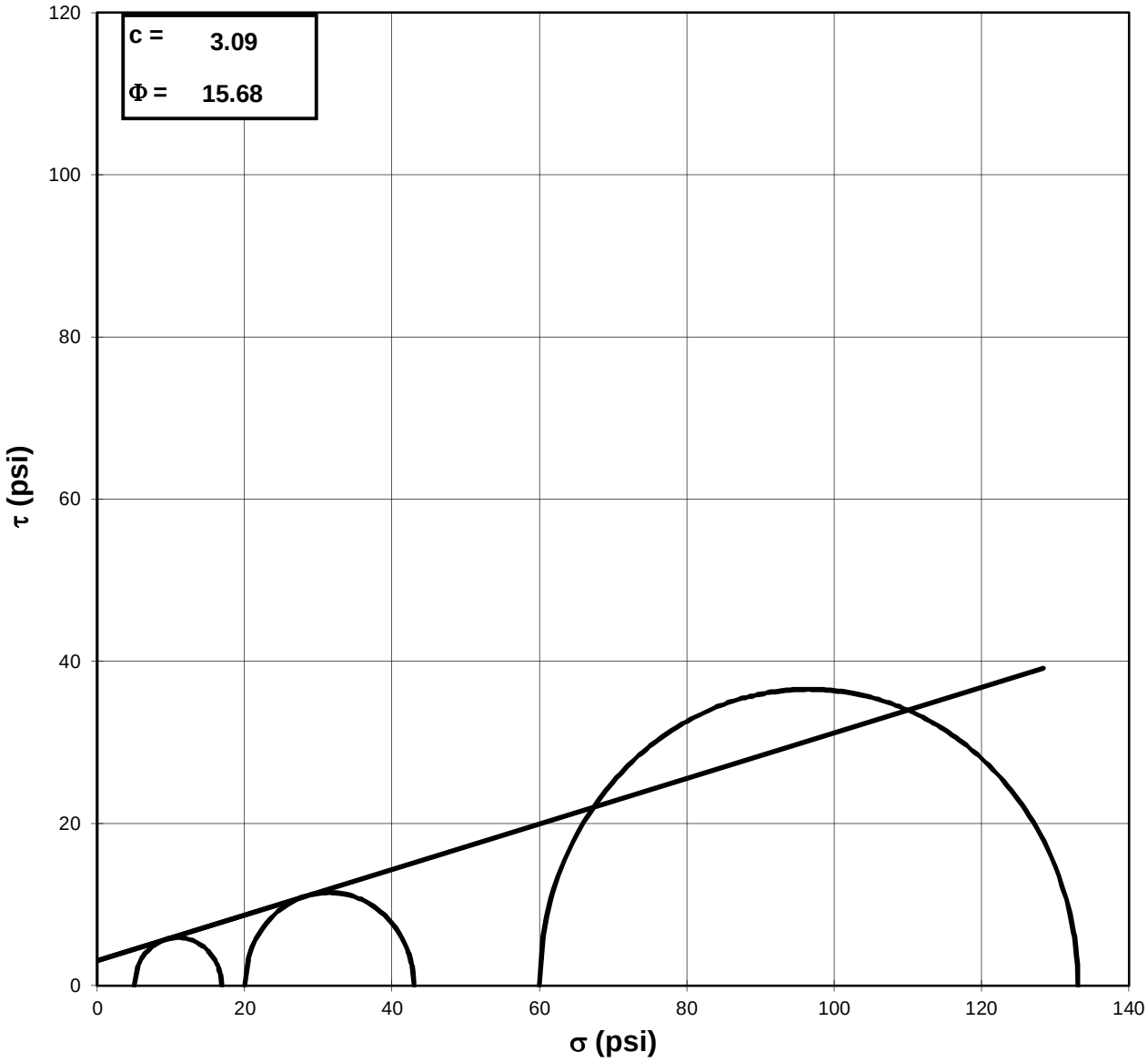
MOHR TOTAL STRENGTH ENVELOPE

ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B319
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10-20
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-01		
Visual Description:	DARK GRAY SILT (REMOLDED)		



Failure Based on Maximum Effective Principal Stress Ratio

NOTE: GRAPH NOT TO SCALE

Tested By: SFS *Date:* 12/16/14 *Approved By:* MPS *Date:* 6/3/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

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Client:	AMEC FOSTER WHEELER	Boring No.:	B319
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10-20
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-01		

Visual Description: DARK GRAY SILT (REMOLDED)

Stage No.	1
Test No.	1

PRESSURES (psi)

Cell Pressure (psi)	55.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	5.0
Pore Pressure Response (%)	95

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	10.46
Q	=	5.93

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length:	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	2.6
Final Change (ml)	21.4

Initial Dial Reading (mil)	80
Dial Reading After Saturation (mil)	85
Dial Reading After Consolidation (mil)	90

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
9.7	0.000	50.0
14.1	0.012	50.1
19.9	0.023	50.3
31.8	0.040	50.8
39.9	0.065	51.0
47.6	0.089	51.1
59.5	0.127	51.0
68.2	0.156	51.0
76.6	0.216	50.8
86.5	0.236	50.5
87.5	0.268	50.3
79.9	0.282	50.8
76.8	0.286	51.0
76.5	0.314	51.2
71.6	0.336	51.3
70.6	0.369	51.4
68.8	0.424	51.5
68.6	0.475	51.6
67.4	0.520	51.6
68.4	0.575	51.6
68.8	0.619	51.7
68.6	0.673	51.7
70.9	0.713	51.7
68.0	0.739	51.7
69.9	0.763	51.7
70.3	0.797	51.7
70.1	0.824	51.7
71.6	0.874	51.7
71.7	0.924	51.7
71.4	0.939	51.7
72.4	0.971	51.7

Tested By: SFS Date: 12/16/14 Input Checked By: MPS Date: 6/3/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

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Client:	AMEC FOSTER WHEELER	Boring No.:	B319
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10-20
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-01		

Visual Description: DARK GRAY SILT (REMOLDED)

Effective Confining Pressure (psi)	5.0	*Stage No.*	1
		Test No	1

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	37.22
Length After Consolidation (in)	5.99
Area After Consolidation (in^2)	6.219

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.20	0.70	0.11	5.60	4.9	1.143	0.17	5.25	0.35
0.38	1.63	0.31	6.34	4.7	1.346	0.20	5.52	0.81
0.66	3.52	0.79	7.75	4.2	1.835	0.24	5.98	1.76
1.08	4.81	0.99	8.84	4.0	2.193	0.22	6.43	2.40
1.48	6.01	1.06	9.96	4.0	2.519	0.19	6.96	3.00
2.12	7.84	1.05	11.80	4.0	2.976	0.14	7.89	3.92
2.61	9.15	0.97	13.20	4.0	3.263	0.11	8.62	4.58
3.61	10.36	0.78	14.60	4.2	3.446	0.08	9.42	5.18
3.94	11.87	0.48	16.40	4.5	3.618	0.04	10.46	5.93
4.48	11.95	0.35	16.62	4.7	3.559	0.03	10.64	5.97
4.72	10.75	0.79	14.98	4.2	3.544	0.08	9.60	5.38
4.78	10.27	1.01	14.28	4.0	3.563	0.10	9.14	5.14
5.25	10.17	1.17	14.01	3.8	3.646	0.12	8.93	5.08
5.62	9.39	1.28	13.13	3.7	3.515	0.14	8.43	4.70
6.17	9.19	1.40	12.81	3.6	3.537	0.16	8.21	4.59
7.08	8.82	1.50	12.34	3.5	3.508	0.18	7.93	4.41
7.93	8.72	1.58	12.16	3.4	3.536	0.19	7.80	4.36
8.68	8.47	1.63	11.86	3.4	3.499	0.20	7.62	4.24
9.61	8.53	1.65	11.90	3.4	3.531	0.20	7.63	4.26
10.35	8.51	1.71	11.82	3.3	3.575	0.21	7.56	4.26
11.25	8.40	1.74	11.67	3.3	3.562	0.22	7.48	4.20
11.91	8.67	1.71	11.97	3.3	3.622	0.21	7.64	4.33
12.34	8.22	1.73	11.50	3.3	3.504	0.22	7.39	4.11
12.75	8.44	1.72	11.73	3.3	3.564	0.21	7.51	4.22
13.32	8.45	1.74	11.73	3.3	3.574	0.22	7.50	4.22
13.77	8.37	1.71	11.67	3.3	3.532	0.22	7.49	4.18
14.60	8.50	1.70	11.82	3.3	3.561	0.21	7.57	4.25
15.44	8.43	1.70	11.75	3.3	3.539	0.21	7.54	4.22
15.69	8.37	1.70	11.68	3.3	3.522	0.21	7.50	4.18
16.23	8.44	1.69	11.77	3.3	3.540	0.21	7.54	4.22

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CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B319
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10-20
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-01		

Visual Description: DARK GRAY SILT (REMOLDED)

Stage No.	1
Test No.	2

PRESSURES (psi)

Cell Pressure (psi)	70.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	20.0
Pore Pressure Response (%)	95

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	21.02
Q	=	11.49

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	16.0
Final Change (ml)	8.0

Initial Dial Reading (mil)	85
Dial Reading After Saturation (mil)	88
Dial Reading After Consolidation (mil)	105

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
11.6	0.000	50.0
13.7	0.001	50.0
14.6	0.003	50.0
39.3	0.008	50.6
66.8	0.013	51.7
86.9	0.018	52.7
113.3	0.026	53.8
133.8	0.035	54.6
154.5	0.046	55.3
176.3	0.067	56.2
188.1	0.097	57.0
189.3	0.132	57.8
182.9	0.167	58.6
176.2	0.207	59.3
173.7	0.238	59.7
170.3	0.280	60.1
166.6	0.335	60.5
163.0	0.393	60.7
161.0	0.439	60.9
159.0	0.498	61.2
158.0	0.543	61.3
156.0	0.586	61.4
155.7	0.630	61.5
155.3	0.660	61.6
155.0	0.691	61.7
154.8	0.721	61.8
154.7	0.751	61.8
153.6	0.793	61.9
153.8	0.839	61.9
153.8	0.869	62.0
154.0	0.899	62.0

Tested By: SFS Date: 12/16/14 Input Checked By: MPS Date: 6/3/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B319
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10-20
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-01		

Visual Description: DARK GRAY SILT (REMOLDED)

Effective Confining Pressure (psi)	20.0	*Stage No.*	1
		Test No	2

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	38.07
Length After Consolidation (in)	5.98
Area After Consolidation (in^2)	6.372

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	0.34	0.00	20.34	20.0	1.017	0.00	20.18	0.17
0.04	0.48	-0.01	20.50	20.0	1.024	-0.02	20.26	0.24
0.13	4.34	0.60	23.75	19.4	1.224	0.15	21.58	2.17
0.21	8.64	1.73	26.91	18.3	1.473	0.21	22.59	4.32
0.30	11.79	2.71	29.08	17.3	1.681	0.24	23.19	5.89
0.44	15.90	3.80	32.11	16.2	1.981	0.25	24.16	7.95
0.58	19.07	4.59	34.49	15.4	2.237	0.25	24.95	9.54
0.78	22.25	5.32	36.94	14.7	2.515	0.25	25.82	11.13
1.12	25.55	6.17	39.40	13.8	2.846	0.25	26.62	12.78
1.62	27.26	7.00	40.27	13.0	3.095	0.27	26.64	13.63
2.22	27.28	7.76	39.52	12.2	3.227	0.30	25.89	13.64
2.80	26.14	8.61	37.54	11.4	3.293	0.35	24.47	13.07
3.47	24.94	9.36	35.59	10.7	3.342	0.39	23.12	12.47
3.98	24.43	9.71	34.73	10.3	3.374	0.42	22.51	12.22
4.69	23.74	10.10	33.65	9.9	3.396	0.45	21.78	11.87
5.60	22.97	10.47	32.51	9.5	3.409	0.48	21.02	11.49
6.59	22.20	10.75	31.46	9.3	3.397	0.51	20.36	11.10
7.34	21.73	10.96	30.78	9.1	3.401	0.53	19.92	10.87
8.34	21.21	11.18	30.04	8.8	3.403	0.55	19.43	10.61
9.09	20.88	11.32	29.57	8.7	3.403	0.57	19.13	10.44
9.81	20.45	11.44	29.01	8.6	3.387	0.59	18.79	10.22
10.55	20.23	11.55	28.68	8.5	3.393	0.60	18.56	10.11
11.05	20.06	11.63	28.43	8.4	3.394	0.61	18.41	10.03
11.57	19.91	11.69	28.22	8.3	3.394	0.62	18.27	9.95
12.07	19.76	11.76	28.01	8.2	3.397	0.63	18.13	9.88
12.56	19.64	11.81	27.83	8.2	3.397	0.63	18.01	9.82
13.27	19.33	11.89	27.45	8.1	3.381	0.65	17.78	9.66
14.04	19.19	11.95	27.25	8.1	3.383	0.66	17.65	9.60
14.55	19.08	12.00	27.09	8.0	3.382	0.66	17.55	9.54
15.04	18.98	12.04	26.95	8.0	3.383	0.67	17.46	9.49

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B319
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10-20
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-01		

Visual Description: DARK GRAY SILT (REMOLDED)

Stage No.	1
Test No.	3

PRESSURES (psi)

Cell Pressure (psi)	110.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	60.0
Pore Pressure Response (%)	95

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	66.94
Q	=	36.55

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length:	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	9.1
Final Change (ml)	14.9

Initial Dial Reading (mil)	120
Dial Reading After Saturation (mil)	124
Dial Reading After Consolidation (mil)	167

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
20.3	0.000	50.0
21.3	0.001	50.0
22.7	0.003	50.0
61.9	0.008	51.0
108.2	0.014	52.8
148.5	0.020	54.8
205.7	0.028	58.0
255.1	0.037	60.9
310.6	0.049	64.3
384.4	0.070	68.7
452.0	0.100	72.4
494.9	0.135	74.5
514.4	0.171	75.6
516.6	0.213	76.5
511.8	0.243	77.3
509.6	0.285	78.2
507.8	0.342	79.0
509.1	0.402	79.5
511.3	0.446	79.6
515.7	0.507	79.8
520.8	0.551	79.8
526.0	0.597	79.8
531.0	0.642	79.8
534.6	0.671	79.8
538.4	0.702	79.7
543.0	0.732	79.7
548.6	0.762	79.7
555.3	0.807	79.6
560.9	0.852	79.6
563.3	0.882	79.5
564.6	0.912	79.5

Tested By: SFS Date: 12/16/14 Input Checked By: MPS Date: 6/3/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B319
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10-20
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-01		

Visual Description: DARK GRAY SILT (REMOLDED)

Effective Confining Pressure (psi)	60.0	*Stage No.*	1
		Test No	3

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	37.63
Length After Consolidation (in)	5.95
Area After Consolidation (in^2)	6.327

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	0.16	0.01	60.15	60.0	1.003	0.06	60.07	0.08
0.05	0.38	0.01	60.37	60.0	1.006	0.02	60.18	0.19
0.13	6.57	0.96	65.61	59.0	1.111	0.15	62.32	3.28
0.24	13.87	2.79	71.07	57.2	1.242	0.21	64.14	6.93
0.33	20.20	4.79	75.41	55.2	1.366	0.25	65.31	10.10
0.48	29.16	7.95	81.21	52.0	1.560	0.29	66.63	14.58
0.63	36.87	10.90	85.96	49.1	1.751	0.31	67.53	18.44
0.82	45.50	14.27	91.22	45.7	1.995	0.33	68.47	22.75
1.17	56.87	18.69	98.17	41.3	2.377	0.35	69.74	28.43
1.67	67.09	22.42	104.67	37.6	2.785	0.35	71.12	33.54
2.27	73.30	24.53	108.77	35.5	3.067	0.35	72.12	36.65
2.87	75.85	25.57	110.27	34.4	3.203	0.35	72.35	37.92
3.58	75.63	26.50	109.13	33.5	3.258	0.37	71.32	37.82
4.08	74.51	27.30	107.21	32.7	3.279	0.39	69.95	37.26
4.80	73.62	28.17	105.45	31.8	3.313	0.40	68.64	36.81
5.74	72.62	28.97	103.65	31.0	3.341	0.42	67.34	36.31
6.76	72.03	29.45	102.58	30.5	3.358	0.43	66.56	36.02
7.50	71.78	29.61	102.17	30.4	3.362	0.43	66.28	35.89
8.52	71.63	29.75	101.87	30.2	3.368	0.44	66.06	35.81
9.27	71.77	29.80	101.96	30.2	3.377	0.44	66.08	35.88
10.04	71.91	29.80	102.11	30.2	3.381	0.44	66.15	35.95
10.79	72.01	29.78	102.24	30.2	3.383	0.44	66.23	36.01
11.29	72.11	29.75	102.36	30.3	3.384	0.43	66.31	36.06
11.80	72.23	29.73	102.49	30.3	3.386	0.43	66.38	36.11
12.31	72.45	29.69	102.75	30.3	3.391	0.43	66.53	36.22
12.81	72.80	29.67	103.13	30.3	3.401	0.43	66.73	36.40
13.57	73.09	29.60	103.49	30.4	3.405	0.43	66.94	36.55
14.33	73.19	29.55	103.64	30.4	3.404	0.43	67.04	36.60
14.83	73.09	29.52	103.56	30.5	3.398	0.43	67.02	36.54
15.33	72.83	29.44	103.39	30.6	3.384	0.43	66.97	36.42

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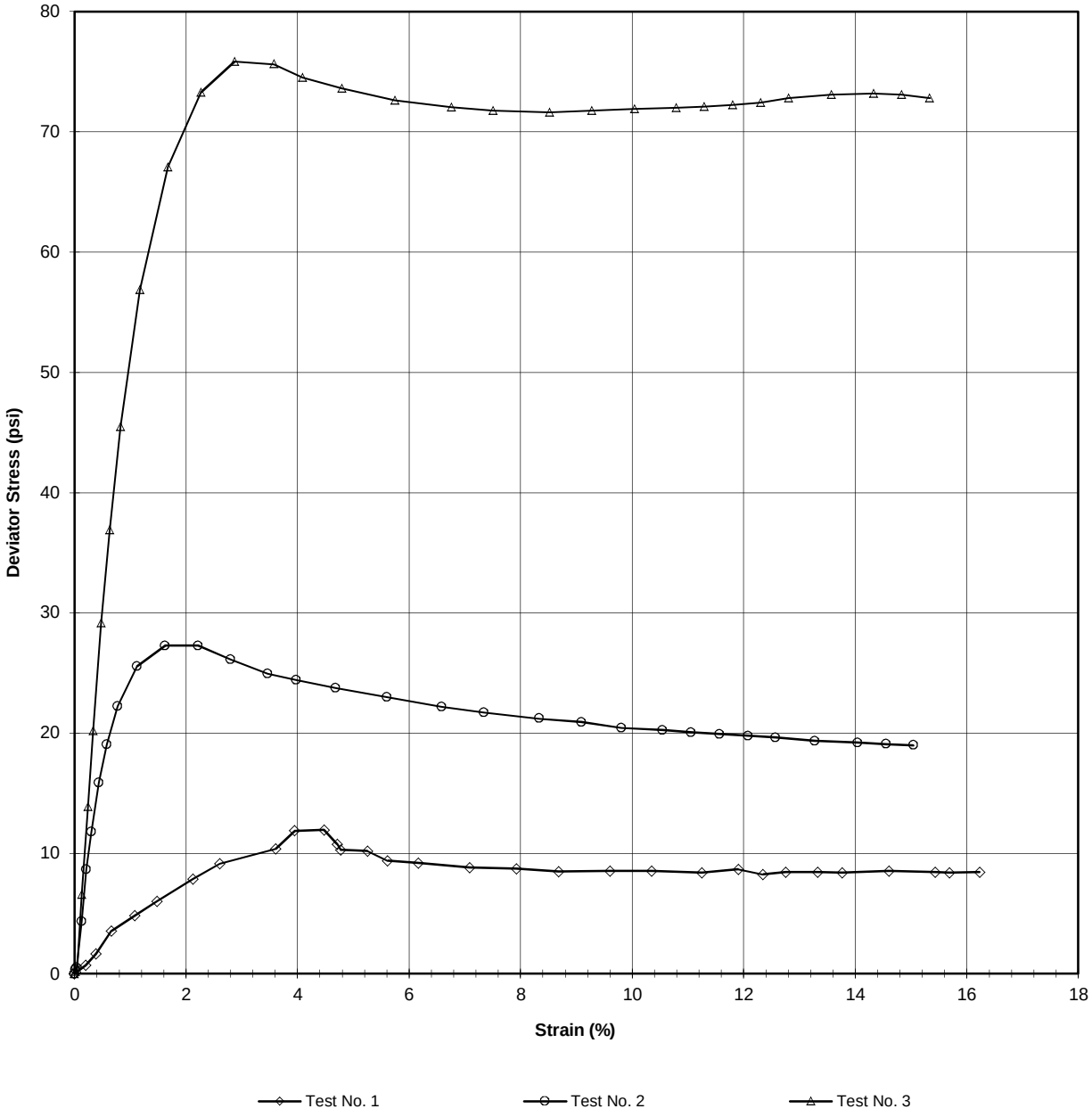
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B319
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10-20
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-01		
Visual Description:	DARKGRAY (REMOLDED)		



Tested By: SFS Date: 12/16/14 Approved By: MPS Date: 6/3/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER		
Client Reference:	Dan River Steam Station Ash Removal		
Project No.:	2014-813-01		
Lab ID:	2014-813-01-01	Specific Gravity (Measured)	2.26

Visual Description: DARK GRAY SILT (REMOLDED)

SAMPLE CONDITION SUMMARY

Boring No.:	B319	B319	B319
Depth (ft):	10-20	10-20	10-20
Sample No.:	BULK	BULK	BULK
Test No.	T1	T2	T3
Deformation Rate (in/min)	0.002	0.002	0.002
Back Pressure (psi)	50.0	50.0	50.0
Consolidation Time (days)	1	1	1
Moisture Content (%) (INITIAL)	31.7	31.7	31.7
Total Unit Weight (pcf)	93.4	93.6	94.4
Dry Unit Weight (pcf)	71.0	71.1	71.7
Moisture Content (%) (FINAL)	41.8	41.4	40.3
Initial State Void Ratio,e	0.988	0.985	0.968
Void Ratio at Shear, e	0.916	0.957	0.918

Tested By: SFS Date: 12/16/14 Input Checked By: MPS Date: 6/3/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS

ASTM D4767-11

MOISTURE CONTENT

	T1	T2	T3
Tare Number	813	813	813
Weight of Tare & Wet Sample (g)	452.3	452.3	452.3
Weight of Tare & Dry Sample (g)	369.99	369.99	369.99
Weight of Tare (g)	109.97	109.97	109.97
Moisture Content (%) (INITIAL)	31.66	31.66	31.66
Tare Number	809	808	813
Weight of Tare & Wet Sample (g)	596.03	611.35	653.92
Weight of Tare & Dry Sample (g)	452.27	462.64	497.59
Weight of Tare (g)	108.72	103.63	109.97
Moisture Content (%) (FINAL)	41.85	41.42	40.33

UNIT WEIGHT

Weight of Tube & Wet Sample (g)	2501.34	2502.54	2510.96
Weight of Tube (g)	1554.07	1554.07	1554.07
Weight of Wet Sample (g)	947.27	948.47	956.89
Length 1 (in)	5.995	5.995	5.995
Length 2 (in)	5.995	5.995	5.995
Length 3 (in)	5.995	5.995	5.995
Top Diameter (in)	2.864	2.864	2.864
Middle Diameter (in)	2.864	2.864	2.864
Bottom Diameter (in)	2.864	2.864	2.864
Average Length (in)	5.995	5.995	5.995
Average Area (in)	6.442	6.442	6.442
Sample Volume (cm^3)	632.89	632.89	632.89
Unit Wet Weight (g/cm^3)	1.50	1.50	1.51
Unit Wet Weight (pcf)	93.44	93.56	94.39
Unit Dry Weight (pcf)	70.97	71.06	71.70
Unit Dry Weight (g/cm^3)	1.14	1.14	1.15
Initial Burette Reading	**24**	**24**	**24**
Final Burette Reading	**2.6**	**16**	**9.1**
Initial Dial Reading	**80**	**85**	**120**
Dial Reading After Saturation	**85**	**88**	**124**
Dial Reading After Consolidation	**90**	**105**	**167**
Volume Change during Consolidation	21.4	8	14.9
Volume Change during Saturation	1.58	0.95	1.27
Volume at Shear (cm^3) *These	609.90	623.94	616.72
Volume of Solids (cm^3) measurements	318.37	318.77	321.60
Volume of Voids (cm^3) are all	291.54	305.17	295.12
Volume of Water (cm^3) at	301.08	298.41	293.13
Void Ratio, e shear	0.916	0.957	0.918

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

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Client:	AMEC FOSTER WHEELER	Boring No.:	B319
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	10-20
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-01		

TEST 1 INITIAL

N/A

TEST 1 FINAL

TEST 2 INITIAL

N/A

TEST 2 FINAL

TEST 3 INITIAL

N/A

TEST 3 FINAL

Tested By *SFS* *Date* *12/16/14* *Approved By* MPS *Date* 6/3/15

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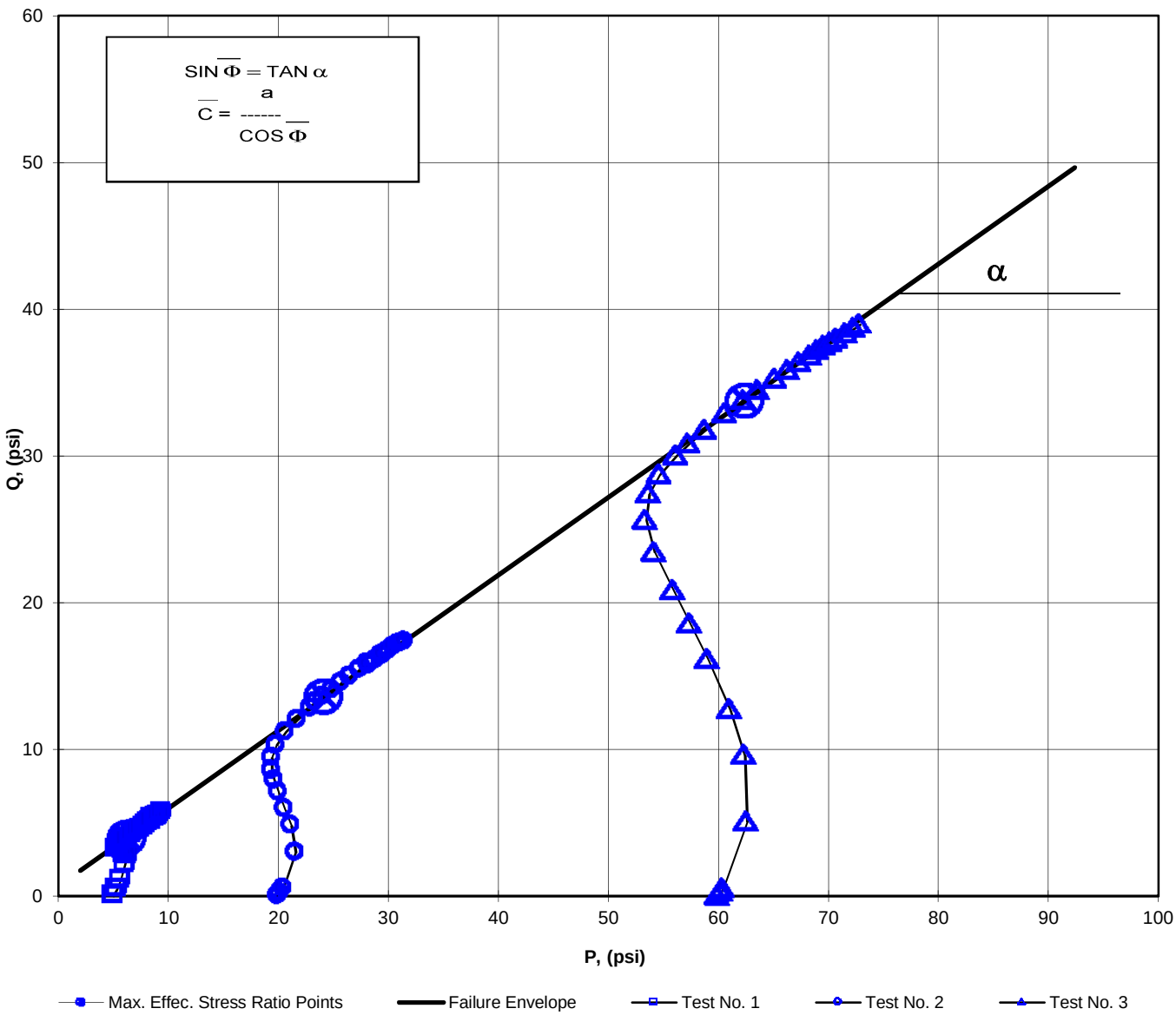
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B322
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	48.6-58.5
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-02		

Consolidated Undrained Triaxial Test with Pore Pressure



a	=	**0.00**	$\overline{\mathbf{C}}$	=	**0.00**
α	=	**27.9**	$\overline{\Phi}$	=	**32.01**

Tested By: SFS Date: 12/16/14 Approved By: MPS Date: 6/3/15

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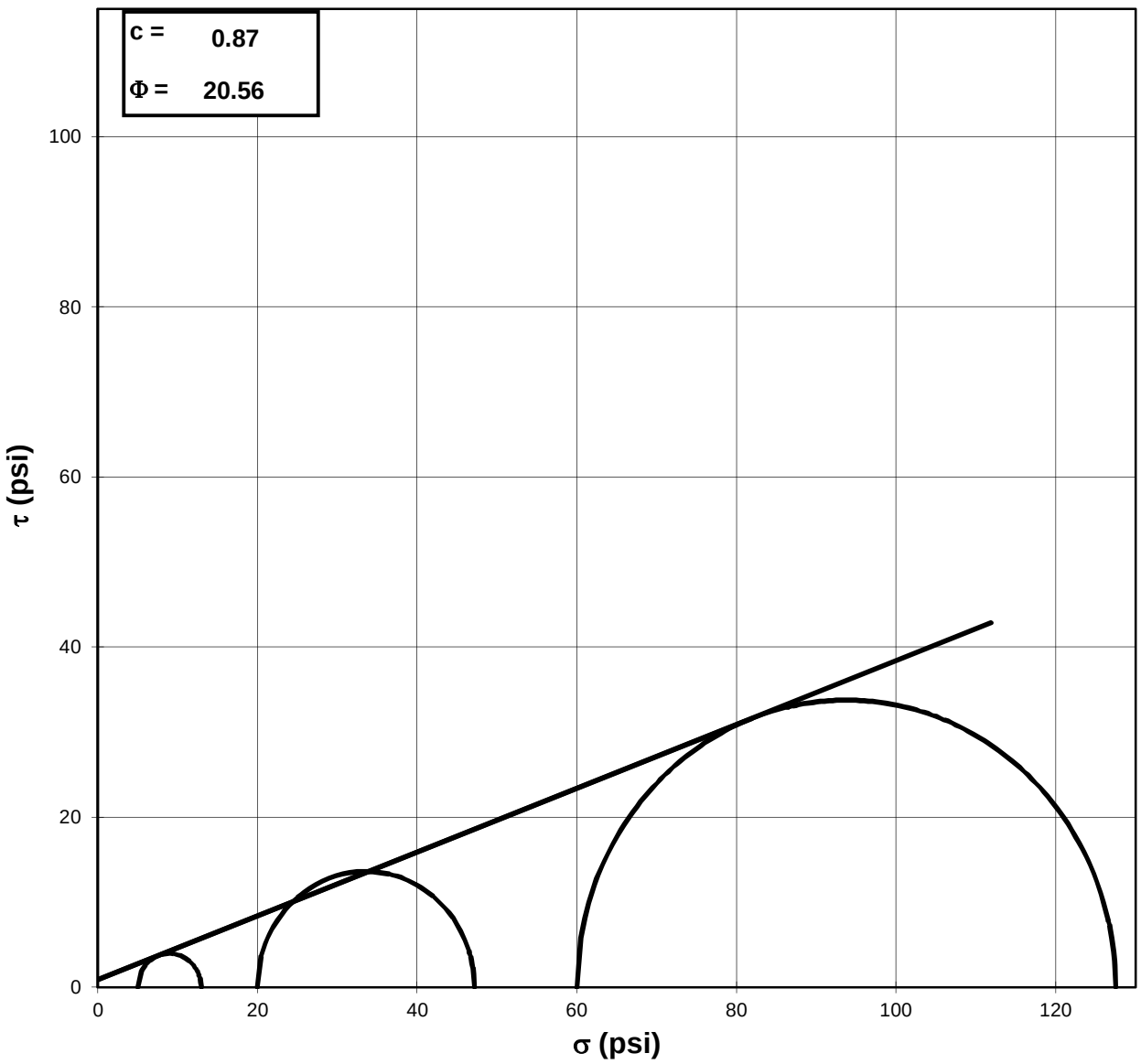
MOHR TOTAL STRENGTH ENVELOPE

ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B322
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	48.6-58.5
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-02		
Visual Description:	DARK GRAY SILT WITH SAND (REMOLDED)		



Failure Based on Maximum Effective Principal Stress Ratio

NOTE: GRAPH NOT TO SCALE

Tested By: SFS *Date:* 12/16/14 *Approved By:* MPS *Date:* 6/3/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

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Client:	AMEC FOSTER WHEELER	Boring No.:	B322
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	48.6-58.5
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-02		

Visual Description: DARK GRAY SILT WITH SAND (REMOLDED)

Stage No.	1
Test No.	1

PRESSURES (psi)

Cell Pressure (psi)	55.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	5.0
Pore Pressure Response (%)	96

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	6.21
Q	=	3.97

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length:	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	20.1
Final Change (ml)	3.9

Initial Dial Reading (mil)	87
Dial Reading After Saturation (mil)	88
Dial Reading After Consolidation (mil)	98

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
7.6	0.000	50.0
13.9	0.001	50.1
21.9	0.002	50.4
34.7	0.003	51.0
42.5	0.005	51.4
43.9	0.014	51.8
47.6	0.018	52.2
48.9	0.029	52.4
49.2	0.040	52.6
48.8	0.061	52.8
53.0	0.087	52.9
55.3	0.129	52.9
59.9	0.163	52.8
58.1	0.196	52.7
59.7	0.233	52.6
58.8	0.264	52.6
64.0	0.320	52.4
68.3	0.369	52.3
69.1	0.421	52.2
71.3	0.478	52.1
74.3	0.525	51.9
76.7	0.571	51.9
79.4	0.613	51.8
84.0	0.643	51.7
80.9	0.668	51.6
82.0	0.705	51.6
85.9	0.736	51.6
87.5	0.777	51.4
89.0	0.823	51.4
93.0	0.848	51.3
94.2	0.881	51.2

Tested By: SFS Date: 12/16/14 Input Checked By: MPS Date: 6/3/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

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Client:	AMEC FOSTER WHEELER	Boring No.:	B322
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	48.6-58.5
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-02		

Visual Description: DARK GRAY SILT WITH SAND (REMOLDED)

Effective Confining Pressure (psi)	5.0	*Stage No.*	1
		Test No	1

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	38.36
Length After Consolidation (in)	5.98
Area After Consolidation (in^2)	6.411

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	0.98	0.12	5.86	4.9	1.200	0.13	5.37	0.49
0.03	2.22	0.42	6.81	4.6	1.484	0.20	5.70	1.11
0.04	4.21	1.04	8.18	4.0	2.062	0.26	6.07	2.11
0.09	5.43	1.44	9.00	3.6	2.520	0.28	6.28	2.71
0.24	5.64	1.79	8.86	3.2	2.750	0.33	6.04	2.82
0.31	6.22	2.17	9.05	2.8	3.191	0.36	5.94	3.11
0.49	6.40	2.37	9.04	2.6	3.422	0.39	5.84	3.20
0.67	6.44	2.63	8.82	2.4	3.704	0.43	5.60	3.22
1.02	6.35	2.82	8.53	2.2	3.901	0.46	5.36	3.17
1.46	6.97	2.92	9.06	2.1	4.342	0.44	5.57	3.48
2.15	7.27	2.86	9.42	2.2	4.376	0.41	5.79	3.63
2.72	7.94	2.77	10.18	2.2	4.537	0.36	6.21	3.97
3.27	7.62	2.75	9.88	2.3	4.370	0.38	6.07	3.81
3.89	7.80	2.63	10.18	2.4	4.284	0.35	6.28	3.90
4.42	7.62	2.58	10.05	2.4	4.138	0.35	6.24	3.81
5.35	8.31	2.45	10.87	2.6	4.251	0.31	6.71	4.16
6.17	8.88	2.31	11.58	2.7	4.293	0.27	7.14	4.44
7.04	8.91	2.18	11.74	2.8	4.152	0.26	7.28	4.45
7.99	9.14	2.09	12.06	2.9	4.128	0.24	7.49	4.57
8.77	9.48	1.93	12.56	3.1	4.081	0.21	7.82	4.74
9.55	9.74	1.87	12.88	3.1	4.107	0.20	8.01	4.87
10.24	10.05	1.80	13.25	3.2	4.134	0.19	8.23	5.02
10.74	10.63	1.75	13.89	3.3	4.257	0.17	8.58	5.31
11.17	10.16	1.64	13.52	3.4	4.015	0.17	8.45	5.08
11.79	10.22	1.64	13.60	3.4	4.030	0.17	8.49	5.11
12.31	10.71	1.56	14.16	3.4	4.106	0.15	8.80	5.36
12.99	10.83	1.45	14.39	3.6	4.046	0.14	8.97	5.42
13.76	10.94	1.36	14.59	3.6	4.000	0.13	9.12	5.47
14.17	11.42	1.28	15.15	3.7	4.066	0.12	9.44	5.71
14.73	11.51	1.23	15.29	3.8	4.047	0.11	9.53	5.75

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CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B322
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	48.6-58.5
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-02		

Visual Description: DARK GRAY SILT WITH SAND (REMOLDED)

Stage No.	1
Test No.	2

PRESSURES (psi)

Cell Pressure (psi)	70.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	20.0
Pore Pressure Response (%)	98

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	24.08
Q	=	13.60

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	13.6
Final Change (ml)	10.4

Initial Dial Reading (mil)	35
Dial Reading After Saturation (mil)	37
Dial Reading After Consolidation (mil)	69

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
10.0	0.000	50.0
12.5	0.001	50.0
16.1	0.003	50.0
47.5	0.006	51.4
71.2	0.011	53.6
85.8	0.017	55.3
100.4	0.026	57.1
110.7	0.035	58.2
120.0	0.046	59.1
131.3	0.067	60.0
143.1	0.097	60.4
155.3	0.131	60.4
167.1	0.167	60.2
179.0	0.208	59.9
185.4	0.238	59.8
191.6	0.278	59.5
199.7	0.333	59.2
208.5	0.393	58.7
215.6	0.437	58.4
224.7	0.495	58.0
232.3	0.539	57.7
232.2	0.584	57.4
238.6	0.628	57.2
245.0	0.657	57.0
246.6	0.687	56.8
252.4	0.716	56.6
257.6	0.745	56.5
262.6	0.790	56.2
265.5	0.835	55.9
268.3	0.865	55.8
275.0	0.893	55.6

Tested By: SFS Date: 12/16/14 Input Checked By: MPS Date: 6/3/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B322
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	48.6-58.5
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-02		

Visual Description: DARK GRAY SILT WITH SAND (REMOLDED)

Effective Confining Pressure (psi)	20.0	*Stage No.*	1
		Test No	2

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	37.95
Length After Consolidation (in)	5.96
Area After Consolidation (in^2)	6.366

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma_1}$	$\overline{\sigma_3}$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	0.38	0.01	20.37	20.0	1.019	0.02	20.18	0.19
0.05	0.96	0.00	20.96	20.0	1.048	0.00	20.48	0.48
0.10	5.89	1.35	24.53	18.6	1.316	0.23	21.59	2.94
0.19	9.60	3.59	26.00	16.4	1.585	0.38	21.20	4.80
0.29	11.86	5.31	26.55	14.7	1.808	0.46	20.62	5.93
0.44	14.13	7.04	27.09	13.0	2.091	0.51	20.02	7.07
0.58	15.72	8.17	27.55	11.8	2.330	0.53	19.69	7.86
0.78	17.14	9.12	28.02	10.9	2.576	0.54	19.45	8.57
1.12	18.85	9.98	28.86	10.0	2.882	0.54	19.44	9.42
1.62	20.56	10.42	30.13	9.6	3.147	0.52	19.85	10.28
2.20	22.32	10.43	31.88	9.6	3.333	0.48	20.72	11.16
2.80	23.98	10.21	33.77	9.8	3.450	0.43	21.78	11.99
3.49	25.62	9.84	35.77	10.2	3.523	0.39	22.96	12.81
3.98	26.45	9.78	36.66	10.2	3.590	0.38	23.44	13.23
4.67	27.19	9.51	37.67	10.5	3.594	0.36	24.08	13.60
5.58	28.13	9.14	38.99	10.9	3.592	0.33	24.92	14.07
6.59	29.12	8.73	40.39	11.3	3.584	0.31	25.83	14.56
7.33	29.93	8.41	41.51	11.6	3.584	0.29	26.55	14.96
8.30	30.93	8.00	42.92	12.0	3.579	0.26	27.46	15.46
9.05	31.77	7.71	44.05	12.3	3.586	0.25	28.17	15.88
9.80	31.48	7.42	44.05	12.6	3.504	0.24	28.31	15.74
10.53	32.12	7.15	44.97	12.8	3.500	0.23	28.91	16.06
11.02	32.84	6.97	45.87	13.0	3.522	0.22	29.45	16.42
11.53	32.88	6.79	46.08	13.2	3.490	0.21	29.64	16.44
12.01	33.50	6.62	46.88	13.4	3.505	0.20	30.13	16.75
12.50	34.03	6.44	47.58	13.6	3.511	0.19	30.57	17.01
13.25	34.42	6.19	48.23	13.8	3.493	0.18	31.02	17.21
14.01	34.51	5.94	48.58	14.1	3.455	0.18	31.32	17.26
14.50	34.69	5.76	48.93	14.2	3.436	0.17	31.58	17.34
14.98	35.39	5.59	49.80	14.4	3.456	0.16	32.10	17.69

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WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B322
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	48.6-58.5
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-02		

Visual Description: DARK GRAY SILT WITH SAND (REMOLDED)

Stage No.	1
Test No.	3

PRESSURES (psi)

Cell Pressure (psi)	110.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	60.0
Pore Pressure Response (%)	98

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	62.40
Q	=	33.75

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length:	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	3.2
Final Change (ml)	20.8

Initial Dial Reading (mil)	122
Dial Reading After Saturation (mil)	123
Dial Reading After Consolidation (mil)	181

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
20.8	0.000	50.0
24.8	0.001	50.0
27.0	0.002	50.0
84.1	0.007	52.4
141.6	0.013	57.2
180.8	0.019	61.6
224.3	0.028	67.0
255.3	0.036	71.0
284.7	0.048	74.9
318.7	0.070	79.1
348.4	0.099	82.2
373.2	0.135	83.6
392.6	0.172	84.0
412.3	0.213	83.8
424.7	0.243	83.5
440.1	0.285	82.9
458.8	0.342	82.1
476.1	0.402	81.4
489.2	0.447	80.8
505.0	0.507	80.0
516.8	0.551	79.4
528.5	0.596	78.9
539.8	0.642	78.4
547.6	0.672	78.1
554.9	0.702	77.8
561.6	0.732	77.4
568.2	0.761	77.2
578.6	0.807	76.7
588.8	0.852	76.3
595.8	0.881	76.0
602.5	0.912	75.8

Tested By: SFS Date: 12/16/14 Input Checked By: MPS Date: 6/3/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B322
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	48.6-58.5
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-02		

Visual Description: DARK GRAY SILT WITH SAND (REMOLDED)

Effective Confining Pressure (psi)	60.0	*Stage No.*	1
		Test No	3

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	37.33
Length After Consolidation (in)	5.94
Area After Consolidation (in^2)	6.289

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	0.64	0.03	60.64	60.0	1.011	0.04	60.32	0.32
0.04	0.99	0.03	60.99	60.0	1.016	0.03	60.49	0.49
0.12	10.05	2.41	67.66	57.6	1.174	0.24	62.64	5.02
0.22	19.16	7.19	72.00	52.8	1.363	0.38	62.42	9.58
0.32	25.36	11.58	73.81	48.4	1.524	0.47	61.12	12.68
0.47	32.20	17.02	75.21	43.0	1.749	0.54	59.11	16.10
0.61	37.05	21.04	76.03	39.0	1.951	0.58	57.51	18.53
0.82	41.61	24.88	76.76	35.1	2.184	0.61	55.95	20.81
1.17	46.82	29.16	77.68	30.9	2.517	0.64	54.27	23.41
1.67	51.21	32.17	79.06	27.9	2.839	0.64	53.46	25.61
2.28	54.75	33.66	81.12	26.4	3.076	0.63	53.74	27.37
2.89	57.40	34.01	83.41	26.0	3.207	0.60	54.71	28.70
3.60	60.00	33.81	86.21	26.2	3.289	0.58	56.21	30.00
4.09	61.59	33.48	88.13	26.5	3.321	0.55	57.34	30.80
4.80	63.47	32.93	90.57	27.1	3.343	0.53	58.83	31.74
5.76	65.63	32.16	93.49	27.9	3.356	0.50	60.68	32.82
6.77	67.50	31.38	96.15	28.6	3.356	0.47	62.40	33.75
7.53	68.86	30.79	98.10	29.2	3.355	0.46	63.67	34.43
8.53	70.42	30.00	100.44	30.0	3.345	0.43	65.23	35.21
9.29	71.54	29.43	102.13	30.6	3.339	0.42	66.36	35.77
10.05	72.62	28.91	103.74	31.1	3.334	0.41	67.43	36.31
10.81	73.60	28.41	105.21	31.6	3.328	0.39	68.41	36.80
11.32	74.28	28.08	106.22	31.9	3.326	0.39	69.08	37.14
11.82	74.88	27.78	107.12	32.2	3.323	0.38	69.68	37.44
12.33	75.39	27.46	107.95	32.6	3.315	0.37	70.26	37.70
12.83	75.88	27.18	108.72	32.8	3.310	0.37	70.78	37.94
13.59	76.64	26.73	109.94	33.3	3.302	0.36	71.62	38.32
14.35	77.35	26.32	111.06	33.7	3.295	0.35	72.38	38.68
14.85	77.85	26.05	111.82	34.0	3.291	0.34	72.90	38.92
15.36	78.28	25.80	112.51	34.2	3.287	0.34	73.37	39.14

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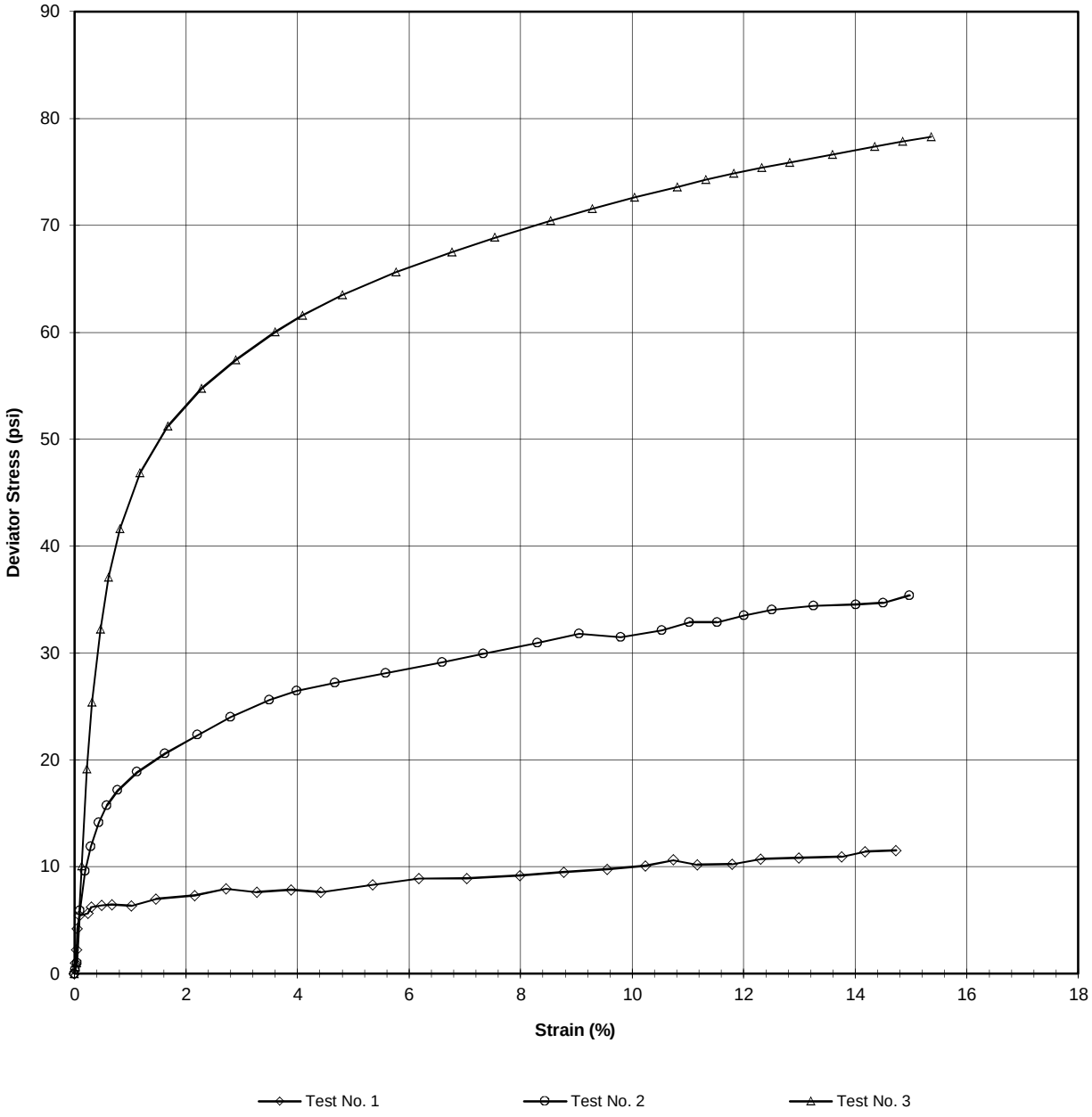
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B322
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	48.6-58.5
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-02		
Visual Description:	DARK GRAY SILT WITH SAND		



Tested By: SFS Date: 12/16/14 Approved By: MPS Date: 6/3/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER		
Client Reference:	Dan River Steam Station Ash Removal		
Project No.:	2014-813-01		
Lab ID:	2014-813-01-02	Specific Gravity (Measured)	2.29

Visual Description: DARK GRAY SILT WITH SAND (REMOLDED)

SAMPLE CONDITION SUMMARY

Boring No.:	B322	B322	B322
Depth (ft):	48.6-58.5	48.6-58.5	48.6-58.5
Sample No.:	BULK	BULK	BULK
Test No.	T1	T2	T3
Deformation Rate (in/min)	0.002	0.002	0.002
Back Pressure (psi)	50.0	50.0	50.0
Consolidation Time (days)	1	1	1
Moisture Content (%) (INITIAL)	25.2	25.2	25.2
Total Unit Weight (pcf)	105.2	106.5	106.8
Dry Unit Weight (pcf)	84.0	85.1	85.3
Moisture Content (%) (FINAL)	31.2	29.7	28.6
Initial State Void Ratio,e	0.701	0.681	0.676
Void Ratio at Shear, e	0.690	0.652	0.620

Tested By: SFS Date: 12/16/14 Input Checked By: MPS Date: 6/3/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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WITH PORE PRESSURE READINGS

ASTM D4767-11

MOISTURE CONTENT

	T1	T2	T3
Tare Number	803	803	803
Weight of Tare & Wet Sample (g)	430.2	430.2	430.2
Weight of Tare & Dry Sample (g)	364.2	364.2	364.2
Weight of Tare (g)	102.78	102.78	102.78
Moisture Content (%) (INITIAL)	25.25	25.25	25.25
Tare Number	800	803	812
Weight of Tare & Wet Sample (g)	719.75	643.33	633.97
Weight of Tare & Dry Sample (g)	573.26	519.44	516.6
Weight of Tare (g)	103.96	102.89	106.5
Moisture Content (%) (FINAL)	31.21	29.74	28.62

UNIT WEIGHT

Weight of Tube & Wet Sample (g)	2620.8	2634.03	2637.04
Weight of Tube (g)	1554.07	1554.07	1554.07
Weight of Wet Sample (g)	1066.73	1079.96	1082.97
Length 1 (in)	5.995	5.995	5.995
Length 2 (in)	5.995	5.995	5.995
Length 3 (in)	5.995	5.995	5.995
Top Diameter (in)	2.864	2.864	2.864
Middle Diameter (in)	2.864	2.864	2.864
Bottom Diameter (in)	2.864	2.864	2.864
Average Length (in)	5.995	5.995	5.995
Average Area (in)	6.442	6.442	6.442
Sample Volume (cm^3)	632.89	632.89	632.89
Unit Wet Weight (g/cm^3)	1.69	1.71	1.71
Unit Wet Weight (pcf)	105.23	106.53	106.83
Unit Dry Weight (pcf)	84.01	85.06	85.29
Unit Dry Weight (g/cm^3)	1.35	1.36	1.37
Initial Burette Reading	**24**	**24**	**24**
Final Burette Reading	**20.1**	**13.6**	**3.2**
Initial Dial Reading	**87**	**35**	**122**
Dial Reading After Saturation	**88**	**37**	**123**
Dial Reading After Consolidation	**98**	**69**	**181**
Volume Change during Consolidation	3.9	10.4	20.8
Volume Change during Saturation	0.32	0.63	0.32
Volume at Shear (cm^3) *These	628.67	621.85	611.77
Volume of Solids (cm^3) measurements	371.92	376.54	377.58
Volume of Voids (cm^3) are all	256.75	245.32	234.19
Volume of Water (cm^3) at	265.86	256.45	247.47
Void Ratio, e shear	0.690	0.652	0.620

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

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Client:	AMEC FOSTER WHEELER	Boring No.:	B322
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	48.6-58.5
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-02		

TEST 1 INITIAL

N/A

TEST 1 FINAL

TEST 2 INITIAL

N/A

TEST 2 FINAL

TEST 3 INITIAL

N/A

TEST 3 FINAL

Tested By *SFS* *Date* *12/16/14* *Approved By* MPS *Date* 6/3/15

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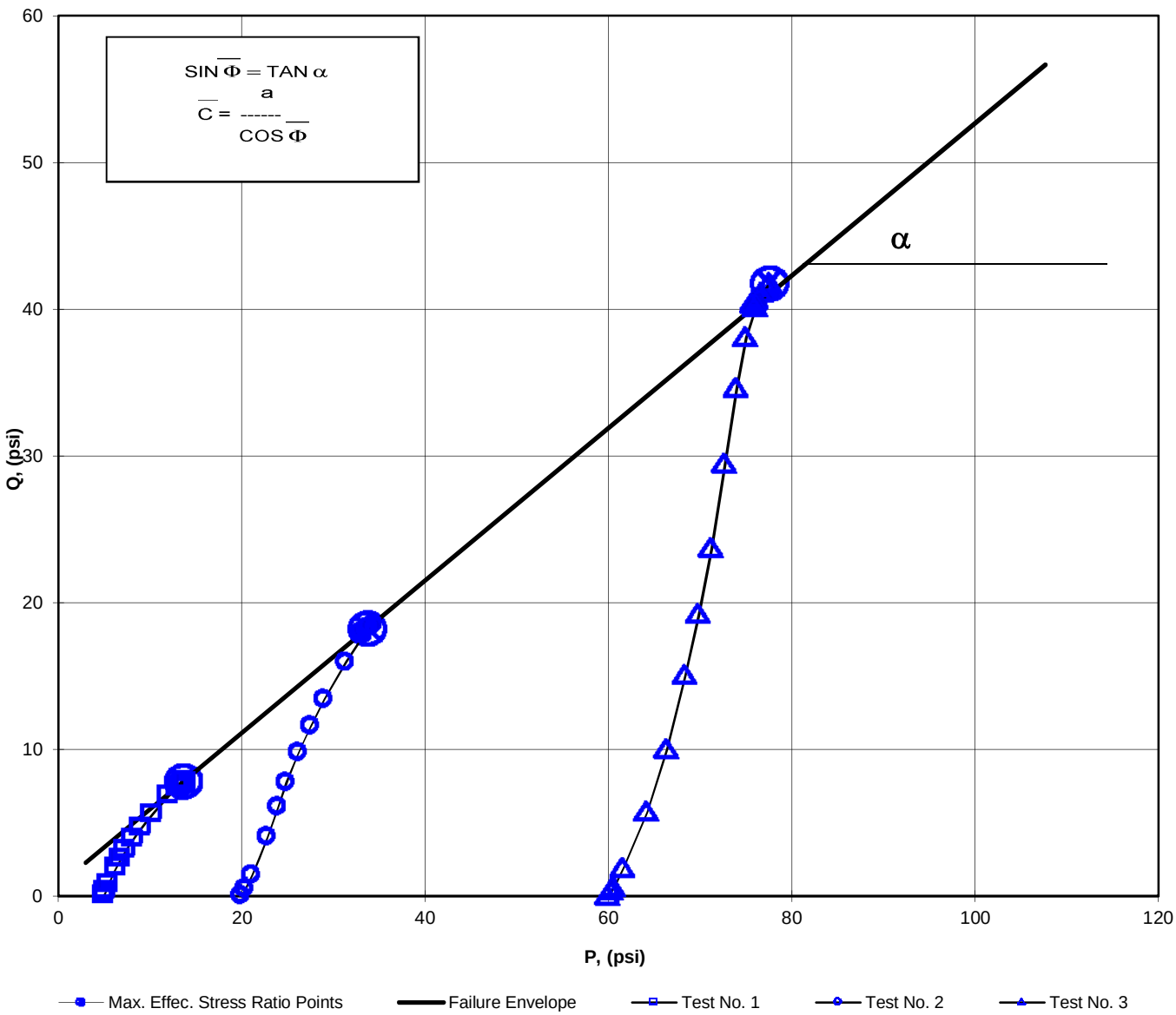
Client:	AMEC FOSTER WHEELER	Boring No.:	B324
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	25-35
Project No.:	2014-813-02	Sample No.:	BULK
Lab ID:	2014-813-02-01		

Consolidated Undrained Triaxial Test with Pore Pressure



a	=	**0.00**	**C̄**	=	**0.00**
α	=	**27.4**	**Φ̄**	=	**31.29**

Tested By: SFS Date: 1/13/15 Approved By: MPS Date: 6/3/15

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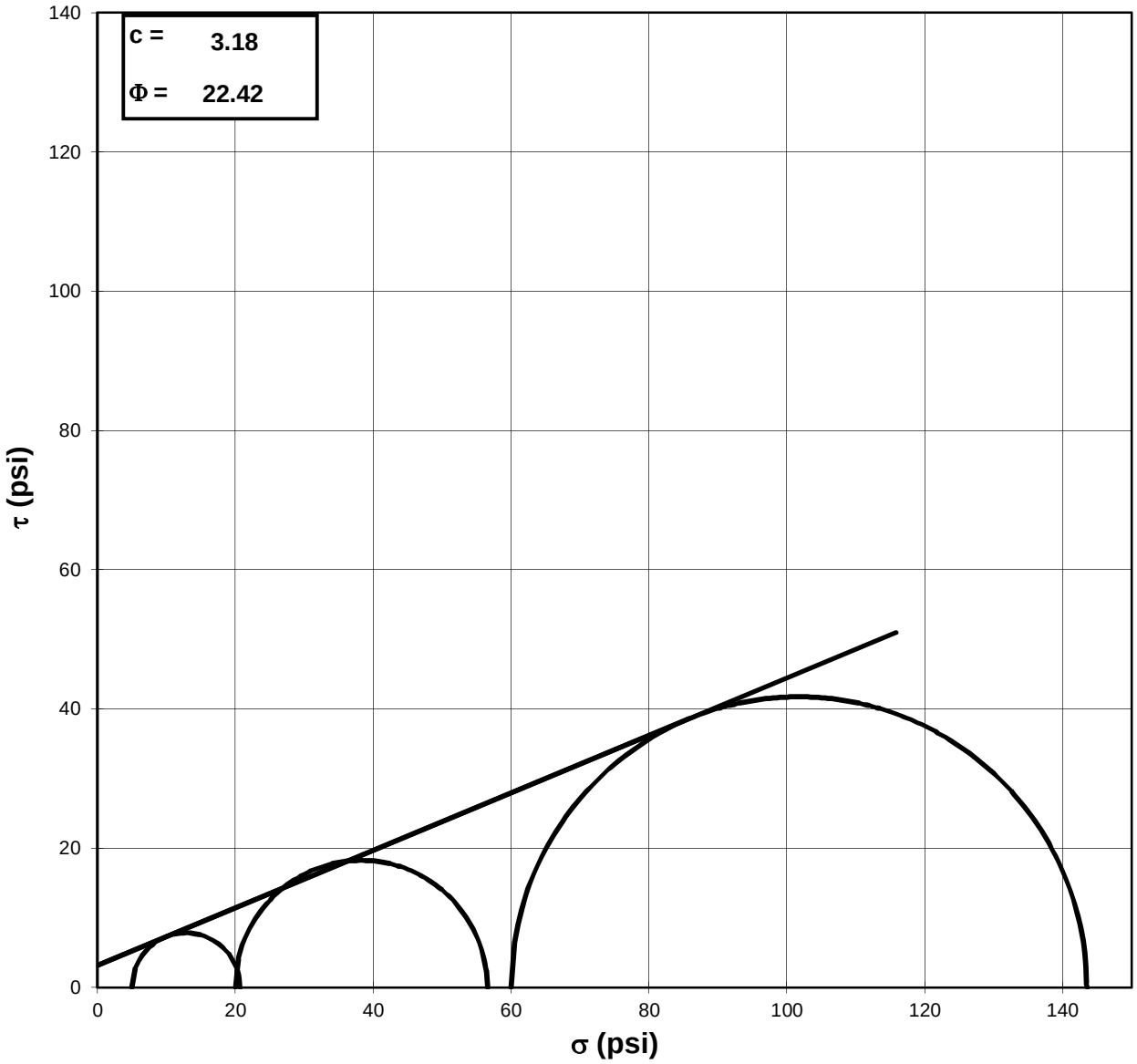
MOHR TOTAL STRENGTH ENVELOPE

ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B324
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	25-35
Project No.:	2014-813-02	Sample No.:	BULK
Lab ID:	2014-813-02-01		
Visual Description:	DARK GRAY SILT (REMOLDED)		



Failure Based on Maximum Effective Principal Stress Ratio

NOTE: GRAPH NOT TO SCALE

Tested By: SFS *Date:* 1/13/15 *Approved By:* MPS *Date:* 6/3/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
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ASTM D4767-11

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Client:	AMEC FOSTER WHEELER	Boring No.:	B324
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	25-35
Project No.:	2014-813-02	Sample No.:	BULK
Lab ID:	2014-813-02-01		

Visual Description: DARK GRAY SILT (REMOLDED)

Stage No.	1
Test No.	1

PRESSURES (psi)

Cell Pressure (psi)	55.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	5.0
Pore Pressure Response (%)	92

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	13.69
Q	=	7.84

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length:	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	20.6
Final Change (ml)	3.4

Initial Dial Reading (mil)	70
Dial Reading After Saturation (mil)	80
Dial Reading After Consolidation (mil)	86

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
8.9	0.000	50.0
12.9	0.001	50.1
18.9	0.002	50.3
33.5	0.007	50.6
41.7	0.013	50.7
48.9	0.018	50.8
59.2	0.026	50.7
68.3	0.035	50.5
80.6	0.046	50.3
97.4	0.067	49.8
110.8	0.096	49.2
107.7	0.132	49.3
107.6	0.168	49.3
107.4	0.209	49.3
107.2	0.237	49.3
108.3	0.279	49.3
109.4	0.336	49.3
109.8	0.394	49.2
110.4	0.437	49.2
111.8	0.498	49.1
113.3	0.542	49.1
115.0	0.586	49.0
117.6	0.630	49.0
117.1	0.660	48.9
118.3	0.689	48.9
119.2	0.719	48.8
120.2	0.749	48.8
121.4	0.793	48.8
123.8	0.836	48.8
124.3	0.866	48.7
124.9	0.896	48.7

Tested By: SFS Date: 1/13/15 Input Checked By: GEM Date: 6/3/15

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ASTM D4767-11

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Client:	AMEC FOSTER WHEELER	Boring No.:	B324
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	25-35
Project No.:	2014-813-02	Sample No.:	BULK
Lab ID:	2014-813-02-01		

Visual Description: DARK GRAY SILT (REMOLDED)

Effective Confining Pressure (psi)	5.0	*Stage No.*	1
		Test No	1

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	38.22
Length After Consolidation (in)	5.98
Area After Consolidation (in^2)	6.392

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.01	0.62	0.11	5.52	4.9	1.127	0.19	5.21	0.31
0.03	1.55	0.28	6.28	4.7	1.329	0.20	5.50	0.78
0.12	3.84	0.59	8.26	4.4	1.870	0.17	6.34	1.92
0.21	5.11	0.73	9.38	4.3	2.196	0.16	6.83	2.56
0.30	6.23	0.76	10.48	4.2	2.469	0.13	7.36	3.12
0.44	7.83	0.69	12.14	4.3	2.813	0.10	8.23	3.91
0.58	9.23	0.53	13.70	4.5	3.065	0.06	9.09	4.62
0.78	11.12	0.26	15.86	4.7	3.345	0.03	10.30	5.56
1.12	13.68	-0.25	18.93	5.3	3.605	-0.02	12.09	6.84
1.61	15.68	-0.85	21.53	5.9	3.680	-0.06	13.69	7.84
2.20	15.11	-0.75	20.86	5.8	3.627	-0.05	13.31	7.55
2.80	15.01	-0.73	20.75	5.7	3.616	-0.05	13.24	7.50
3.49	14.87	-0.67	20.54	5.7	3.623	-0.05	13.11	7.44
3.97	14.76	-0.67	20.43	5.7	3.602	-0.05	13.05	7.38
4.67	14.81	-0.70	20.51	5.7	3.599	-0.05	13.11	7.41
5.62	14.84	-0.75	20.59	5.8	3.580	-0.05	13.17	7.42
6.59	14.74	-0.79	20.53	5.8	3.543	-0.06	13.16	7.37
7.31	14.71	-0.82	20.53	5.8	3.526	-0.06	13.18	7.35
8.33	14.75	-0.88	20.63	5.9	3.504	-0.07	13.26	7.37
9.06	14.85	-0.94	20.80	5.9	3.499	-0.07	13.37	7.43
9.80	14.96	-0.99	20.96	6.0	3.495	-0.07	13.48	7.48
10.53	15.21	-1.06	21.28	6.1	3.509	-0.08	13.67	7.61
11.03	15.05	-1.10	21.15	6.1	3.466	-0.08	13.63	7.52
11.53	15.13	-1.14	21.28	6.1	3.464	-0.08	13.71	7.57
12.02	15.18	-1.17	21.35	6.2	3.459	-0.08	13.76	7.59
12.52	15.23	-1.19	21.43	6.2	3.458	-0.09	13.81	7.62
13.27	15.26	-1.22	21.48	6.2	3.450	-0.09	13.85	7.63
13.99	15.45	-1.25	21.71	6.3	3.471	-0.09	13.98	7.73
14.48	15.44	-1.27	21.71	6.3	3.459	-0.09	13.99	7.72
14.99	15.42	-1.30	21.73	6.3	3.446	-0.09	14.01	7.71

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B324
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	25-35
Project No.:	2014-813-02	Sample No.:	BULK
Lab ID:	2014-813-02-01		

Visual Description: DARK GRAY SILT (REMOLDED)

Stage No.	1
Test No.	2

PRESSURES (psi)

Cell Pressure (psi)	70.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	20.0
Pore Pressure Response (%)	93

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	33.77
Q	=	18.26

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	16.5
Final Change (ml)	7.5
Initial Dial Reading (mil)	113
Dial Reading After Saturation (mil)	120
Dial Reading After Consolidation (mil)	136

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
9.0	0.000	50.0
14.8	0.002	50.0
26.7	0.005	50.2
60.5	0.041	51.2
87.0	0.071	52.1
108.9	0.096	52.8
136.4	0.133	53.6
160.9	0.160	54.0
185.7	0.194	54.4
222.1	0.276	54.5
251.4	0.391	54.4
264.8	0.448	54.2
261.0	0.460	54.5
258.1	0.489	54.7
258.4	0.492	54.7
258.0	0.523	54.9
261.5	0.561	55.0
264.4	0.621	55.0
265.2	0.668	54.9
267.7	0.703	54.8
270.9	0.739	54.7
275.9	0.787	54.6
279.9	0.822	54.5
282.0	0.864	54.4
282.8	0.873	54.4
285.2	0.912	54.3

Tested By: SFS Date: 1/13/15 Input Checked By: GEM Date: 6/3/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B324
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	25-35
Project No.:	2014-813-02	Sample No.:	BULK
Lab ID:	2014-813-02-01		

Visual Description: DARK GRAY SILT (REMOLDED)

Effective Confining Pressure (psi)	20.0	*Stage No.*	1
		Test No	2

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	38.03
Length After Consolidation (in)	5.97
Area After Consolidation (in^2)	6.368

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.03	0.91	0.06	20.87	20.0	1.046	0.07	20.41	0.46
0.09	2.77	0.27	22.52	19.7	1.140	0.10	21.13	1.39
0.69	8.03	1.21	26.84	18.8	1.427	0.16	22.83	4.02
1.19	12.11	2.10	30.03	17.9	1.676	0.19	23.97	6.05
1.61	15.44	2.82	32.64	17.2	1.898	0.20	24.92	7.72
2.23	19.56	3.59	35.99	16.4	2.190	0.20	26.21	9.78
2.68	23.22	4.06	39.17	16.0	2.455	0.19	27.56	11.61
3.24	26.85	4.44	42.42	15.6	2.724	0.18	29.00	13.43
4.61	31.92	4.56	47.38	15.5	3.065	0.15	31.42	15.96
6.55	35.58	4.46	51.14	15.6	3.287	0.13	33.35	17.79
7.51	37.15	4.20	52.97	15.8	3.348	0.12	34.39	18.57
7.70	36.53	4.52	52.03	15.5	3.357	0.13	33.77	18.26
8.18	35.92	4.71	51.22	15.3	3.347	0.14	33.26	17.96
8.23	35.94	4.76	51.19	15.3	3.356	0.14	33.22	17.97
8.76	35.68	4.90	50.80	15.1	3.361	0.15	32.96	17.84
9.39	35.92	5.02	50.92	15.0	3.396	0.15	32.96	17.96
10.39	35.95	4.98	50.99	15.0	3.390	0.15	33.01	17.97
11.19	35.73	4.95	50.80	15.1	3.372	0.15	32.93	17.87
11.78	35.84	4.85	51.01	15.2	3.364	0.15	33.09	17.92
12.38	36.03	4.74	51.31	15.3	3.358	0.14	33.30	18.02
13.18	36.38	4.60	51.80	15.4	3.360	0.14	33.61	18.19
13.76	36.70	4.52	52.19	15.5	3.368	0.13	33.84	18.35
14.46	36.67	4.38	52.31	15.6	3.346	0.13	33.97	18.34
14.62	36.71	4.37	52.35	15.6	3.346	0.13	34.00	18.35
15.27	36.75	4.29	52.48	15.7	3.338	0.13	34.10	18.38

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B324
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	25-35
Project No.:	2014-813-02	Sample No.:	BULK
Lab ID:	2014-813-02-01		

Visual Description: DARK GRAY SILT (REMOLDED)

Stage No.	1
Test No.	3

PRESSURES (psi)

Cell Pressure (psi)	110.0
Back Pressure (psi)	50.0
Eff. Conf. Pressure (psi)	60.0
Pore Pressure Response (%)	92

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	77.68
Q	=	41.75

INITIAL SAMPLE DIMENSIONS (in)

Length 1:	5.995	Diameter 1:	2.864
Length 2:	5.995	Diameter 2:	2.864
Length 3:	5.995	Diameter 3:	2.864
Avg. Length:	5.995	*Avg. Diam.:*	2.864

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	10.8
Final Change (ml)	13.2

Initial Dial Reading (mil)	67
Dial Reading After Saturation (mil)	71
Dial Reading After Consolidation (mil)	107

LOAD (LB)	DEFORMATION (IN)	PORE PRESSURE (PSI)
14.8	0.000	50.0
18.9	0.001	50.0
21.9	0.002	50.0
38.8	0.008	50.2
87.5	0.013	51.5
142.1	0.019	53.6
206.2	0.027	56.6
259.8	0.036	59.3
317.9	0.048	62.5
392.4	0.069	66.7
460.8	0.098	70.6
508.5	0.134	73.0
538.2	0.169	74.0
560.1	0.211	74.2
566.3	0.241	74.1
561.8	0.283	74.4
562.2	0.341	74.5
565.5	0.401	74.6
569.6	0.446	74.6
576.3	0.505	74.6
580.5	0.551	74.6
584.4	0.595	74.6
590.4	0.641	74.6
594.2	0.670	74.6
598.2	0.701	74.6
602.3	0.730	74.5
604.5	0.760	74.6
609.4	0.805	74.6
611.5	0.850	74.5
615.3	0.881	74.5
619.0	0.911	74.5

Tested By: SFS Date: 1/13/15 Input Checked By: GEM Date: 6/3/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B324
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	25-35
Project No.:	2014-813-02	Sample No.:	BULK
Lab ID:	2014-813-02-01		

Visual Description: DARK GRAY SILT (REMOLDED)

Effective Confining Pressure (psi)	60.0	*Stage No.*	1
		Test No	3

INITIAL DIMENSIONS

Initial Sample Length (in)	6.00
Initial Sample Diameter (in)	2.86
Initial Sample Area (in^2)	6.44
Initial Sample Volume (in^3)	38.62

VOLUME CHANGE

Volume After Consolidation (in^3)	37.74
Length After Consolidation (in)	5.96
Area After Consolidation (in^2)	6.337

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.01	0.66	-0.05	60.71	60.1	1.011	-0.08	60.38	0.33
0.04	1.12	-0.03	61.15	60.0	1.019	-0.03	60.59	0.56
0.13	3.78	0.24	63.55	59.8	1.063	0.07	61.66	1.89
0.22	11.45	1.50	69.95	58.5	1.196	0.14	64.23	5.72
0.32	20.03	3.59	76.45	56.4	1.355	0.19	66.43	10.02
0.46	30.07	6.59	83.49	53.4	1.563	0.24	68.45	15.04
0.61	38.42	9.31	89.11	50.7	1.758	0.26	69.90	19.21
0.81	47.44	12.46	94.99	47.5	1.998	0.29	71.27	23.72
1.15	58.90	16.70	102.20	43.3	2.360	0.31	72.75	29.45
1.65	69.22	20.61	108.62	39.4	2.757	0.32	74.01	34.61
2.26	76.15	23.02	113.13	37.0	3.059	0.33	75.06	38.07
2.84	80.24	23.96	116.28	36.0	3.226	0.32	76.16	40.12
3.54	83.01	24.16	118.85	35.8	3.316	0.32	77.34	41.50
4.05	83.50	24.08	119.43	35.9	3.324	0.31	77.68	41.75
4.76	82.21	24.35	117.86	35.7	3.306	0.32	76.76	41.10
5.72	81.43	24.49	116.95	35.5	3.293	0.33	76.23	40.72
6.73	81.05	24.58	116.47	35.4	3.288	0.33	75.95	40.52
7.49	80.99	24.61	116.38	35.4	3.288	0.33	75.89	40.49
8.48	81.09	24.57	116.53	35.4	3.289	0.33	75.98	40.55
9.25	81.02	24.59	116.43	35.4	3.288	0.33	75.92	40.51
9.99	80.90	24.59	116.32	35.4	3.284	0.33	75.87	40.45
10.76	81.06	24.58	116.49	35.4	3.288	0.33	75.95	40.53
11.25	81.14	24.56	116.59	35.4	3.289	0.33	76.02	40.57
11.77	81.23	24.55	116.69	35.5	3.291	0.33	76.07	40.62
12.27	81.34	24.54	116.80	35.5	3.293	0.33	76.14	40.67
12.77	81.18	24.55	116.63	35.5	3.290	0.33	76.04	40.59
13.52	81.13	24.56	116.58	35.4	3.289	0.33	76.01	40.57
14.28	80.72	24.55	116.18	35.5	3.276	0.33	75.82	40.36
14.79	80.74	24.53	116.22	35.5	3.276	0.33	75.84	40.37
15.30	80.76	24.49	116.28	35.5	3.274	0.33	75.90	40.38

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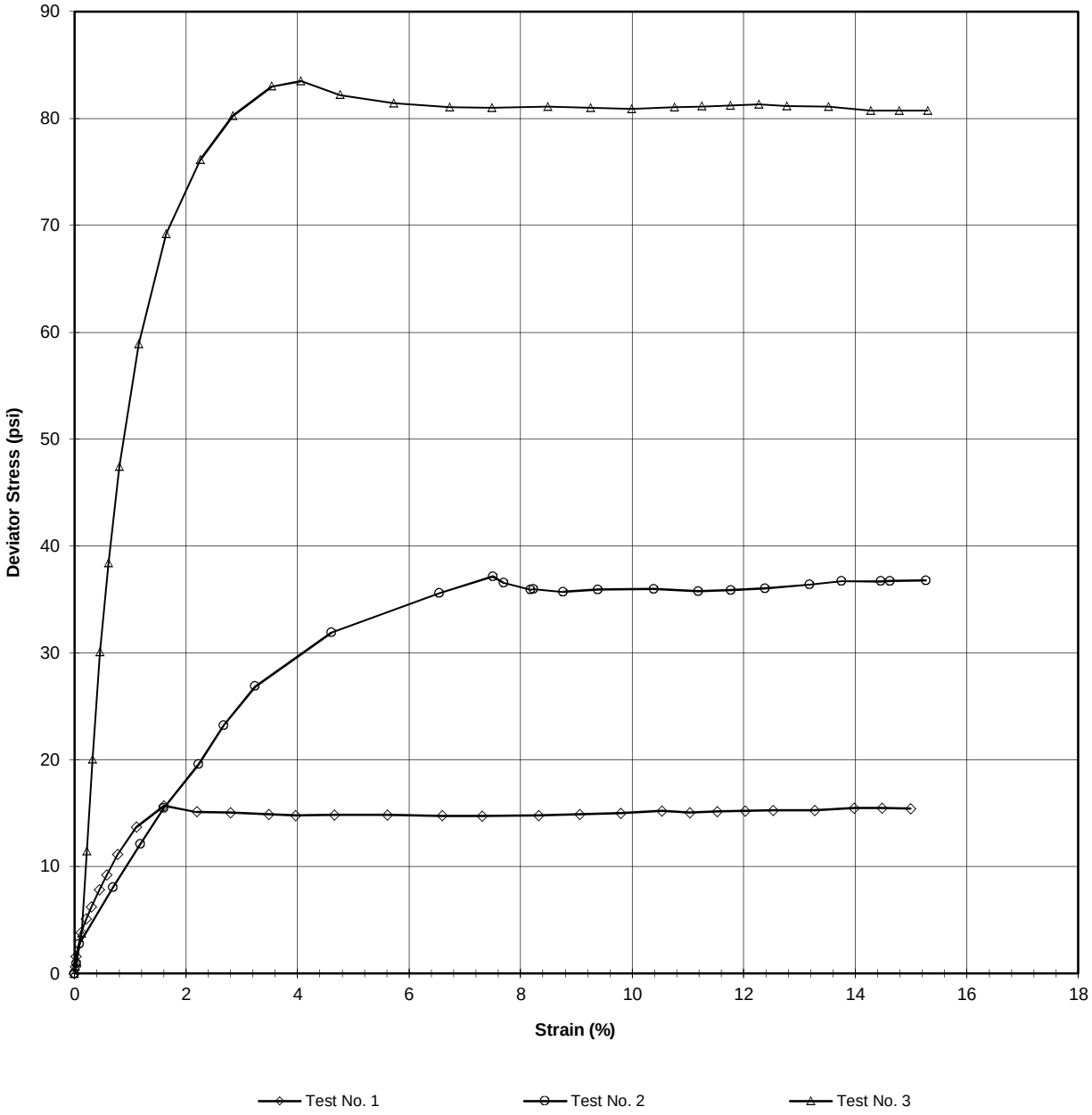
CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER	Boring No.:	B324
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	25-35
Project No.:	2014-813-02	Sample No.:	BULK
Lab ID:	2014-813-02-01		
Visual Description:	DARK GRAY SILT		



Tested By: SFS Date: 1/13/15 Approved By: MPS Date: 6/3/15

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

Client:	AMEC FOSTER WHEELER		
Client Reference:	Dan River Steam Station Ash Removal		
Project No.:	2014-813-02		
Lab ID:	2014-813-02-01	Specific Gravity (Measured)	2.23

Visual Description: DARK GRAY SILT (REMOLDED)

SAMPLE CONDITION SUMMARY

Boring No.:	B324	B324	B324
Depth (ft):	25-35	25-35	25-35
Sample No.:	BULK	BULK	BULK
Test No.	T1	T2	T3
Deformation Rate (in/min)	0.002	0.002	0.002
Back Pressure (psi)	50.0	50.0	50.0
Consolidation Time (days)	1	1	1
Moisture Content (%) (INITIAL)	32.3	32.3	32.3
Total Unit Weight (pcf)	92.5	92.6	92.9
Dry Unit Weight (pcf)	69.9	70.0	70.3
Moisture Content (%) (FINAL)	42.9	41.7	40.9
Initial State Void Ratio,e	0.991	0.989	0.981
Void Ratio at Shear, e	0.971	0.958	0.936

Tested By: SFS Date: 1/13/15 Input Checked By: GEM Date: 6/3/15

DCN: CT-S28 DATE: 4/12/13 REVISION: 3

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS

ASTM D4767-11

MOISTURE CONTENT

	T1	T2	T3
Tare Number	800	800	800
Weight of Tare & Wet Sample (g)	469.16	469.16	469.16
Weight of Tare & Dry Sample (g)	380.09	380.09	380.09
Weight of Tare (g)	103.92	103.92	103.92
Moisture Content (%) (INITIAL)	32.25	32.25	32.25
Tare Number	813	802	803
Weight of Tare & Wet Sample (g)	619.71	594	618.51
Weight of Tare & Dry Sample (g)	466.56	449.63	468.72
Weight of Tare (g)	109.5	103.52	102.16
Moisture Content (%) (FINAL)	42.89	41.71	40.86

UNIT WEIGHT

Weight of Tube & Wet Sample (g)	2491.26	2492.41	2496.09
Weight of Tube (g)	1554	1554	1554
Weight of Wet Sample (g)	937.26	938.41	942.09
Length 1 (in)	5.995	5.995	5.995
Length 2 (in)	5.995	5.995	5.995
Length 3 (in)	5.995	5.995	5.995
Top Diameter (in)	2.864	2.864	2.864
Middle Diameter (in)	2.864	2.864	2.864
Bottom Diameter (in)	2.864	2.864	2.864
Average Length (in)	5.995	5.995	5.995
Average Area (in)	6.442	6.442	6.442
Sample Volume (cm^3)	632.89	632.89	632.89
Unit Wet Weight (g/cm^3)	1.48	1.48	1.49
Unit Wet Weight (pcf)	92.45	92.57	92.93
Unit Dry Weight (pcf)	69.91	69.99	70.27
Unit Dry Weight (g/cm^3)	1.12	1.12	1.13
Initial Burette Reading	**24**	**24**	**24**
Final Burette Reading	**20.6**	**16.5**	**10.8**
Initial Dial Reading	**70**	**113**	**67**
Dial Reading After Saturation	**80**	**120**	**71**
Dial Reading After Consolidation	**86**	**136**	**107**
Volume Change during Consolidation	3.4	7.5	13.2
Volume Change during Saturation	3.17	2.22	1.27
Volume at Shear (cm^3) *These	626.32	623.17	618.42
Volume of Solids (cm^3) measurements	317.80	318.19	319.44
Volume of Voids (cm^3) are all	308.52	304.98	298.98
Volume of Water (cm^3) at	303.97	295.97	291.09
Void Ratio, e shear	0.971	0.958	0.936

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-11

geotechnics
geotechnical & geosynthetic testing

Client:	AMEC FOSTER WHEELER	Boring No.:	B324
Client Reference:	Dan River Steam Station Ash Removal	Depth (ft):	25-35
Project No.:	2014-813-02	Sample No.:	BULK
Lab ID:	2014-813-02-01		

TEST 1 INITIAL

N/A

TEST 1 FINAL

TEST 2 INITIAL

N/A

TEST 2 FINAL

TEST 3 INITIAL

N/A

TEST 3 FINAL

Tested By *SFS* *Date* *1/13/15* *Approved By* MPS *Date* 6/3/15

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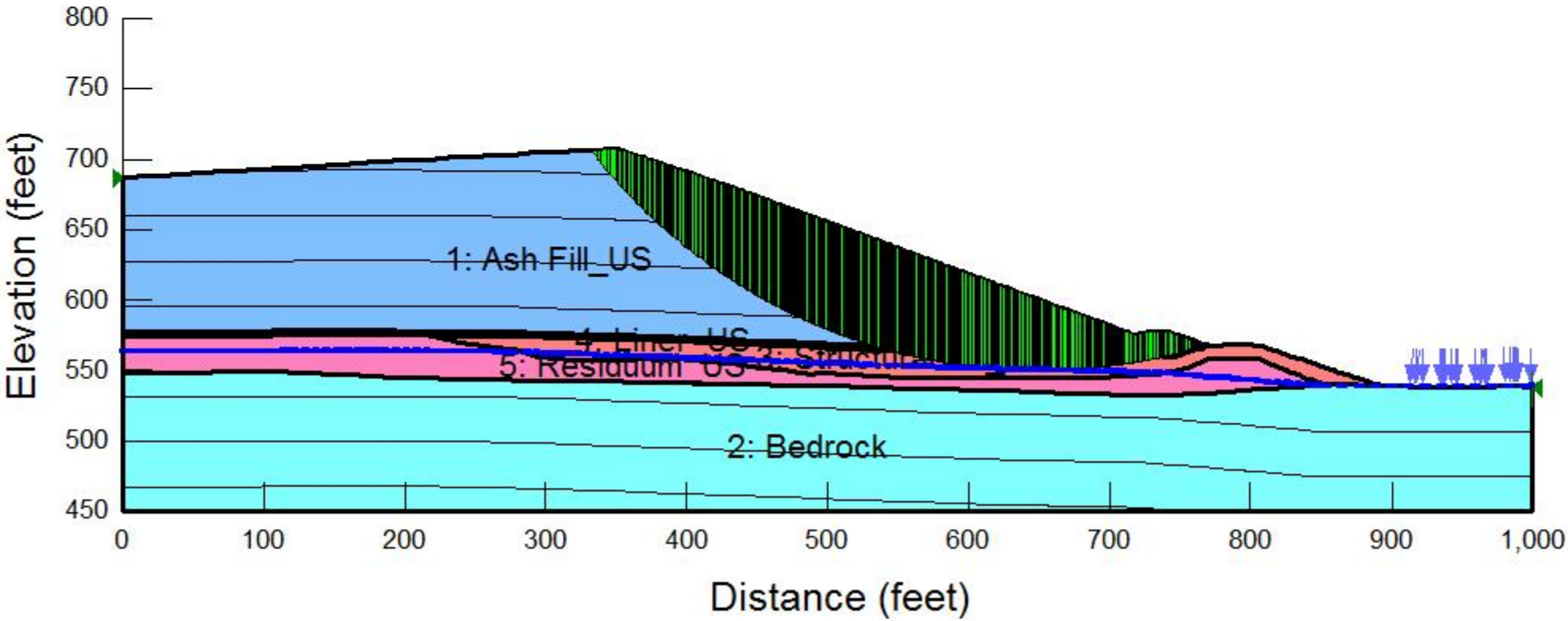
REFERENCE 4

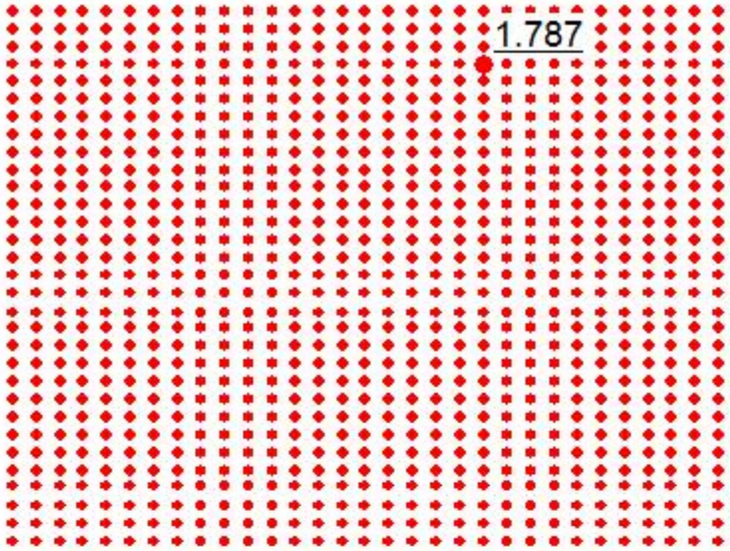
GEOSLOPE International (2013). GeoStudio 2012, Version 8.14.1.10087, December 2014 Release.

Name: Section 1 Pseudo-static Deep Stability

Name: Bedrock
Name: Ash Fill_US Unit Weight: 101.1 pcf Cohesion': 440 psf Phi': 29°
Name: Liner_US Unit Weight: 117.8 pcf Cohesion': 0 psf Phi': 16.5°
Name: Residuum_US Unit Weight: 122.7 pcf Cohesion': 800 psf Phi': 15°
Name: Structural Fill_US Unit Weight: 117.8 pcf Cohesion': 700 psf Phi': 20°

Horz Seismic Coef.: 0.12
Vert Seismic Coef.: 0.08





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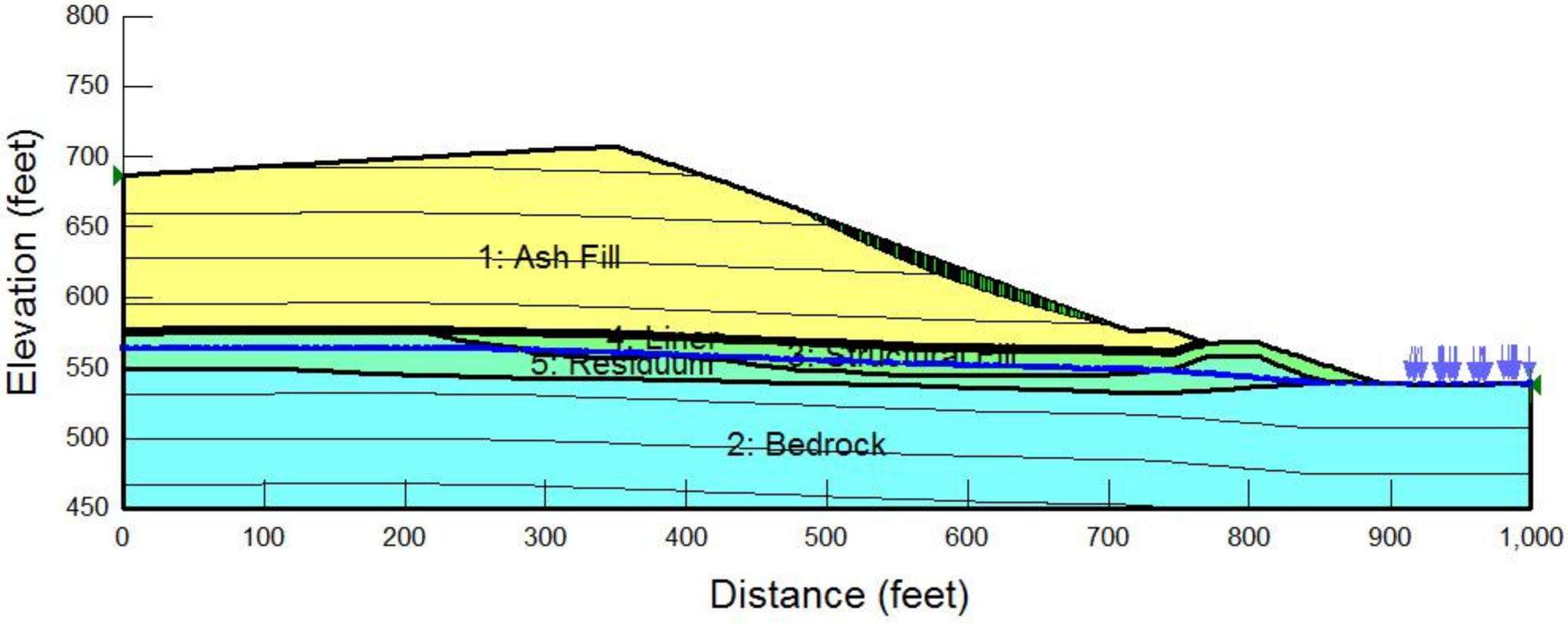
Name: Residuum Unit Weight: 122.7 pcf Cohesion': 150 psf Phi': 32 °
Name: Bedrock

Horz Seismic Coef.: 0
Vert Seismic Coef.: 0



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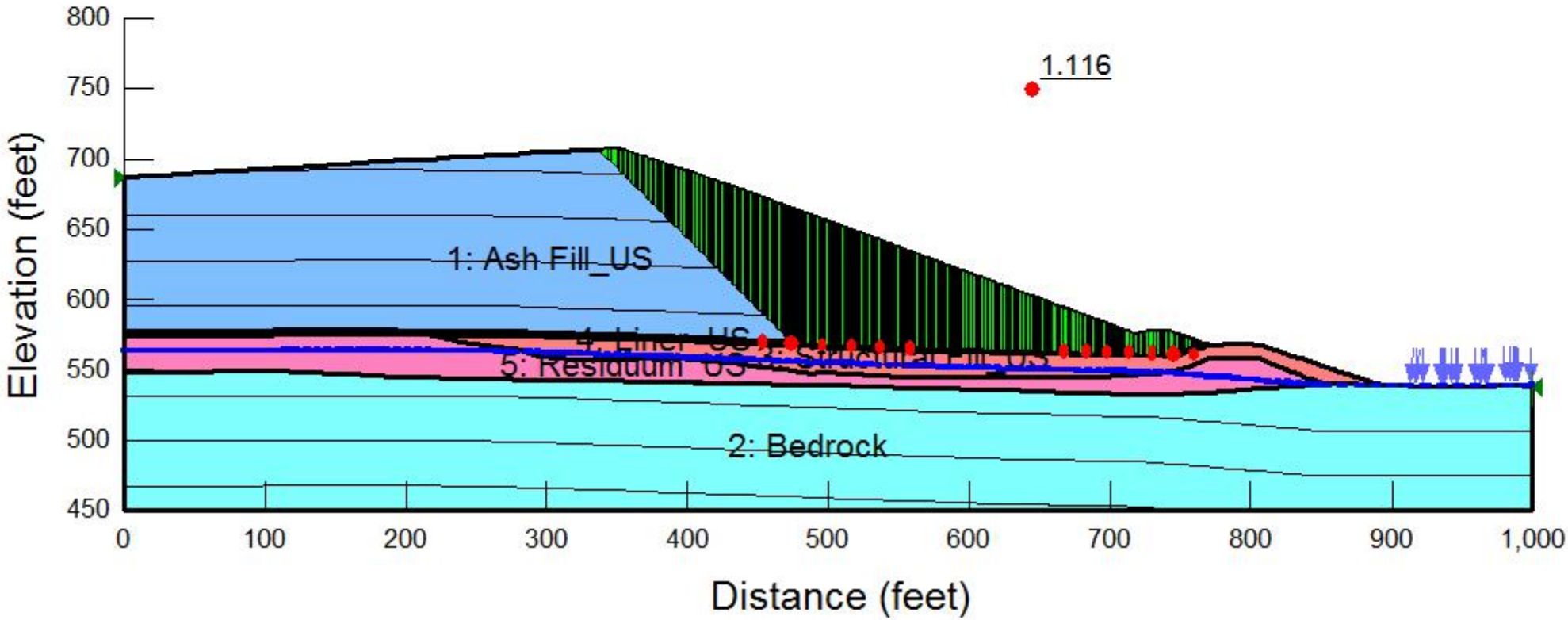
Vert Seismic Coef.: 0.08



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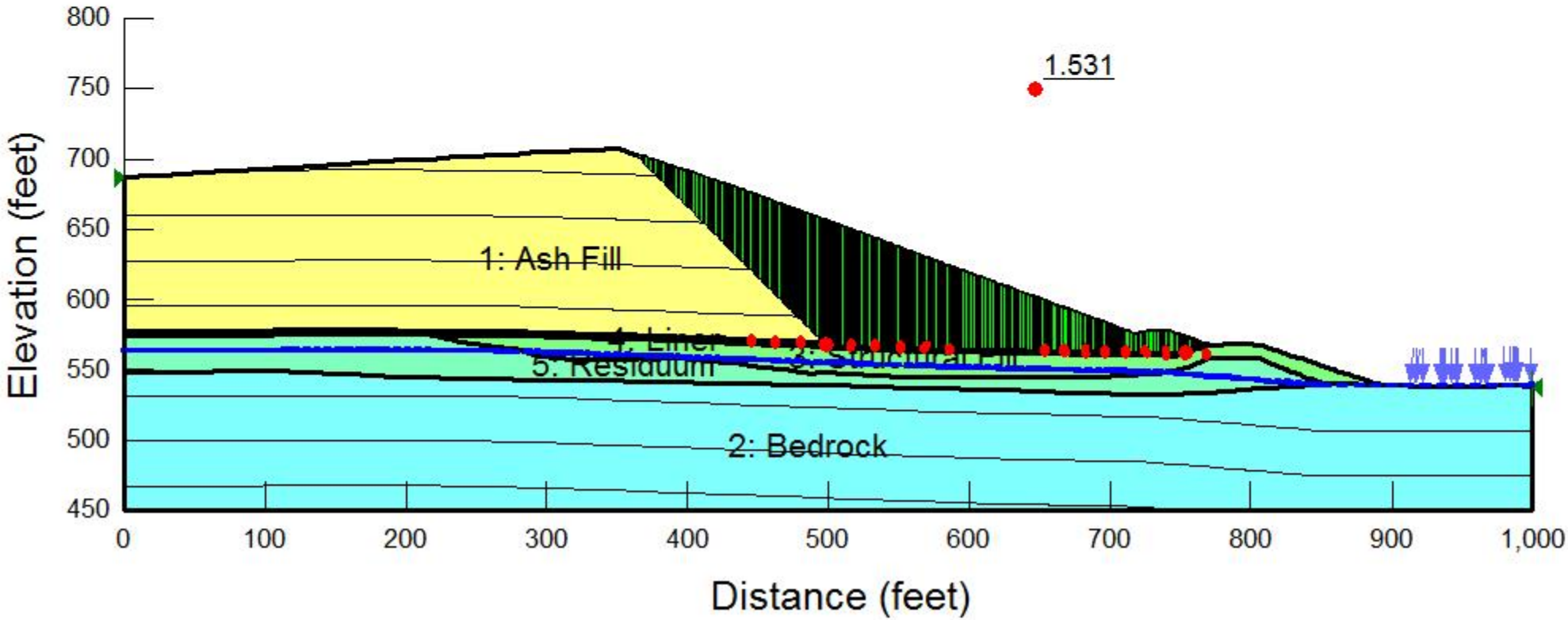
Name: Bedrock

Horz Seismic Coef.: 0
Vert Seismic Coef.: 0



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Name: Bedrock
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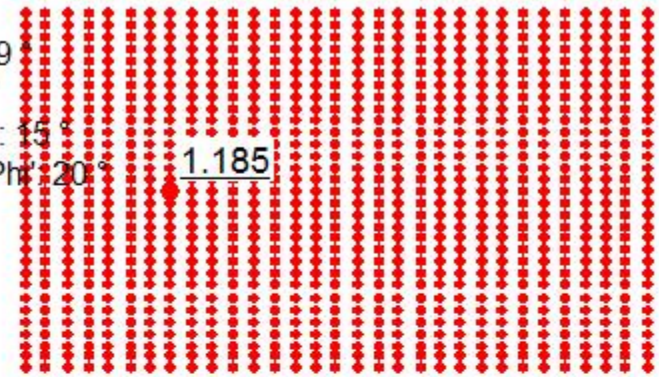
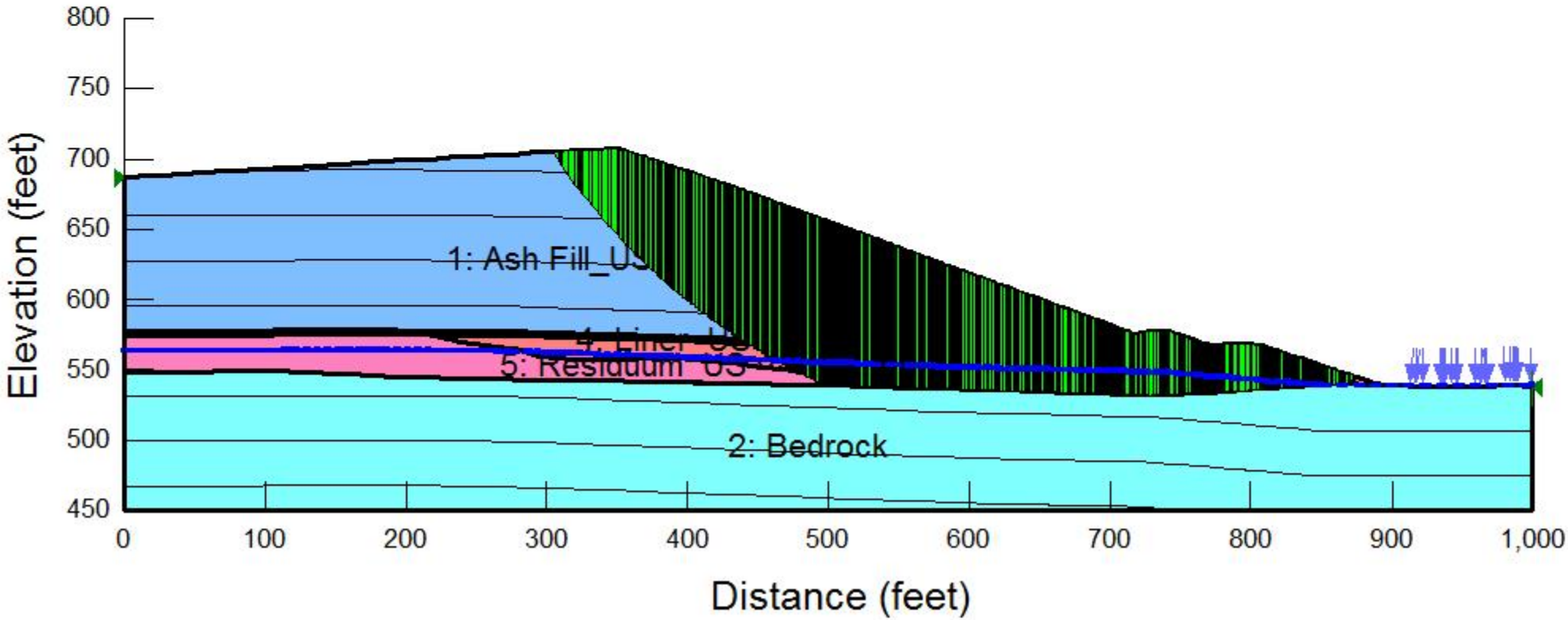
Horz Seismic Coef.: 0.12
Vert Seismic Coef.: 0.08





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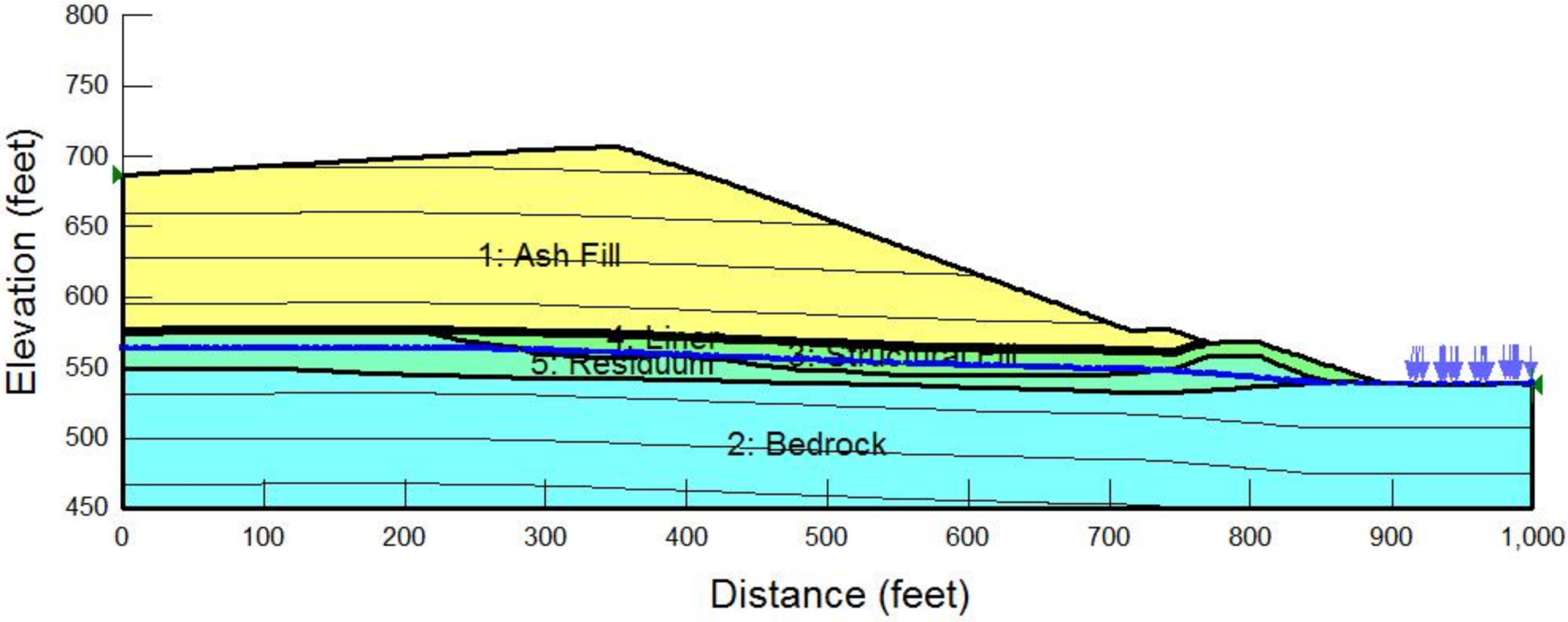
Name: Bedrock

Horz Seismic Coef.: 0
Vert Seismic Coef.: 0



Name: Section 2 Pseudo-static Deep Stability

Name: Bedrock
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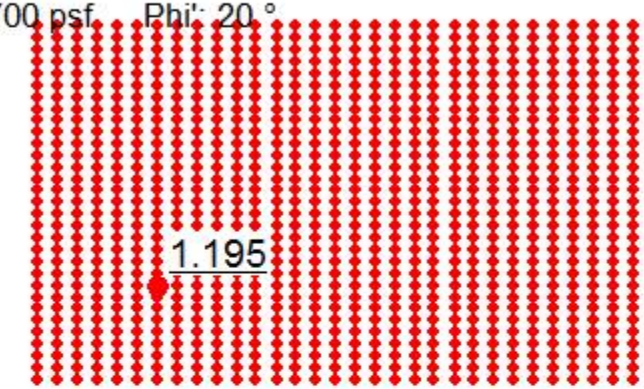
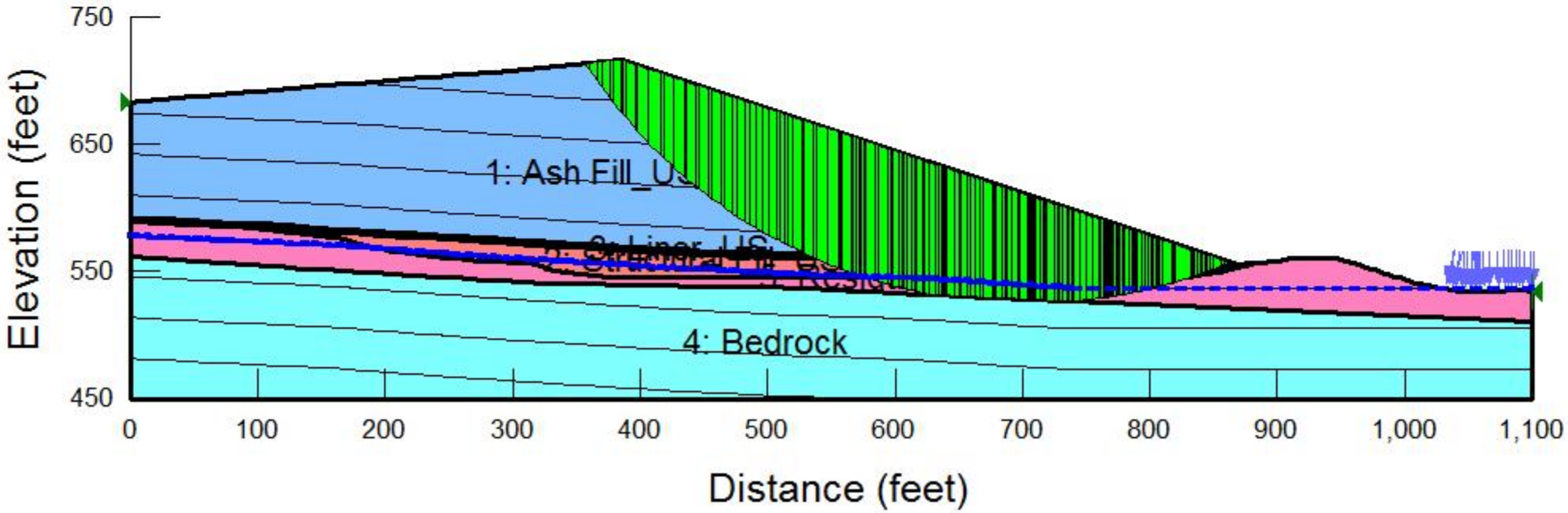
Name: Structural Fill_US Unit Weight: 117.8 pcf Cohesion': 700 psf Phi': 20 °

Horz Seismic Coef.: 0.12
Vert Seismic Coef.: 0.08





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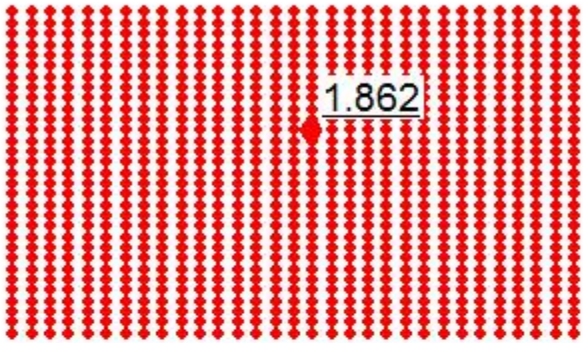
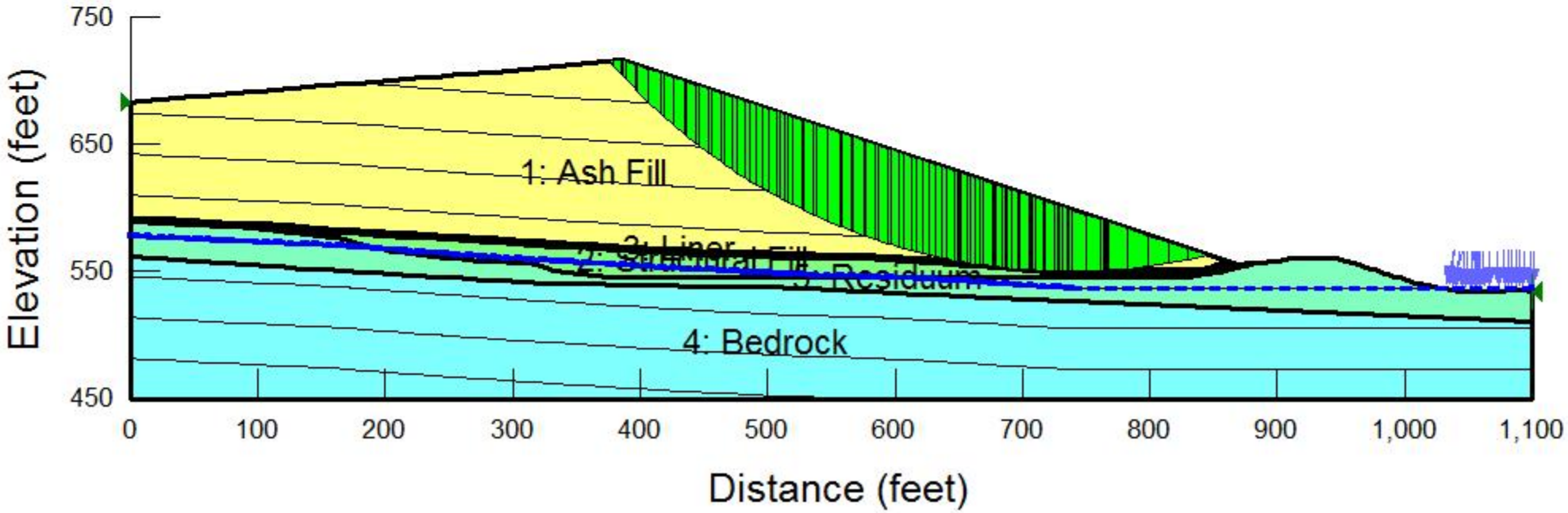
Name: Residuum Unit Weight: 122.7 pcf Cohesion': 150 psf Phi': 32 °
Name: Bedrock

Horz Seismic Coef.: 0
Vert Seismic Coef.: 0





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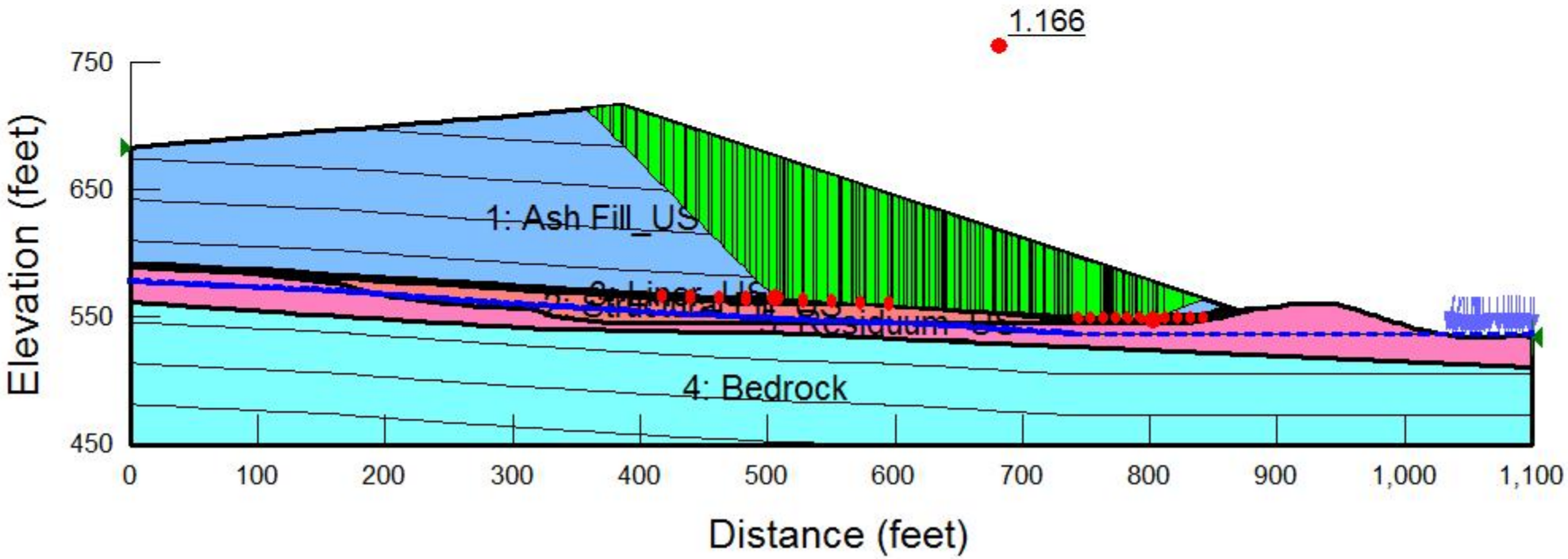
Horz Seismic Coef.: 0.12
Vert Seismic Coef.: 0.08



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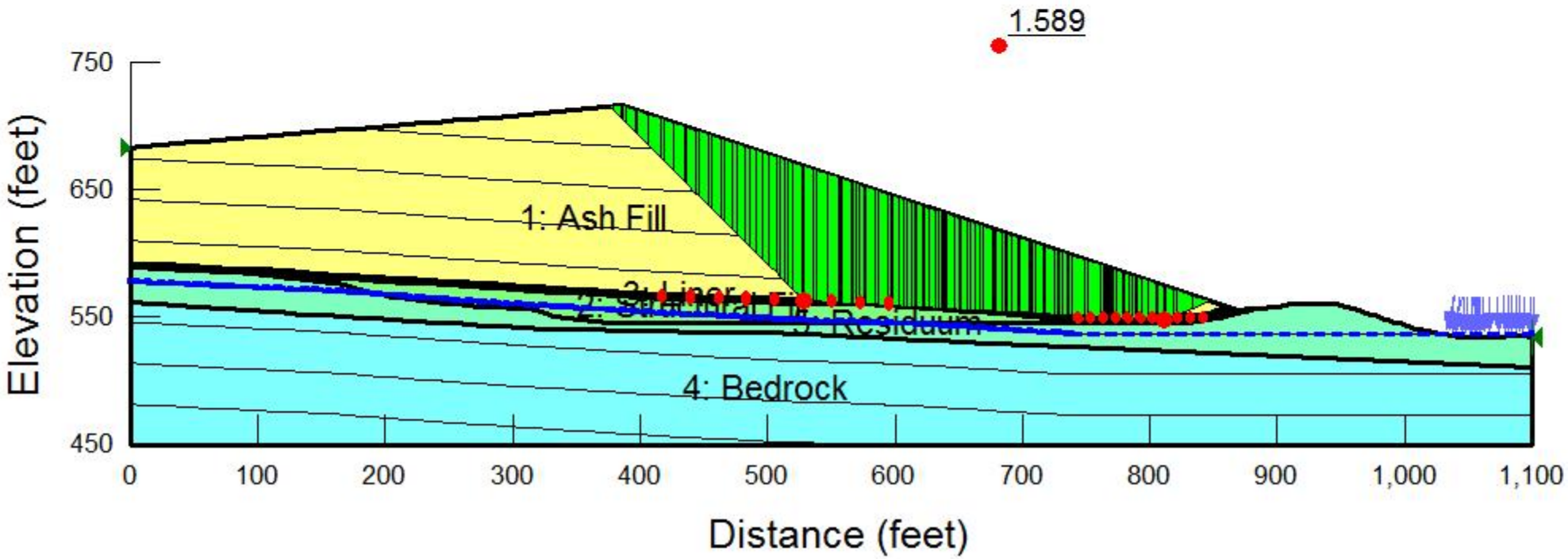
Name: Bedrock

Horz Seismic Coef.: 0
Vert Seismic Coef.: 0



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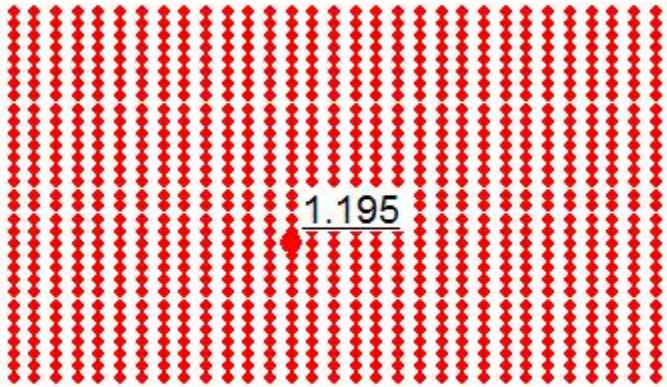
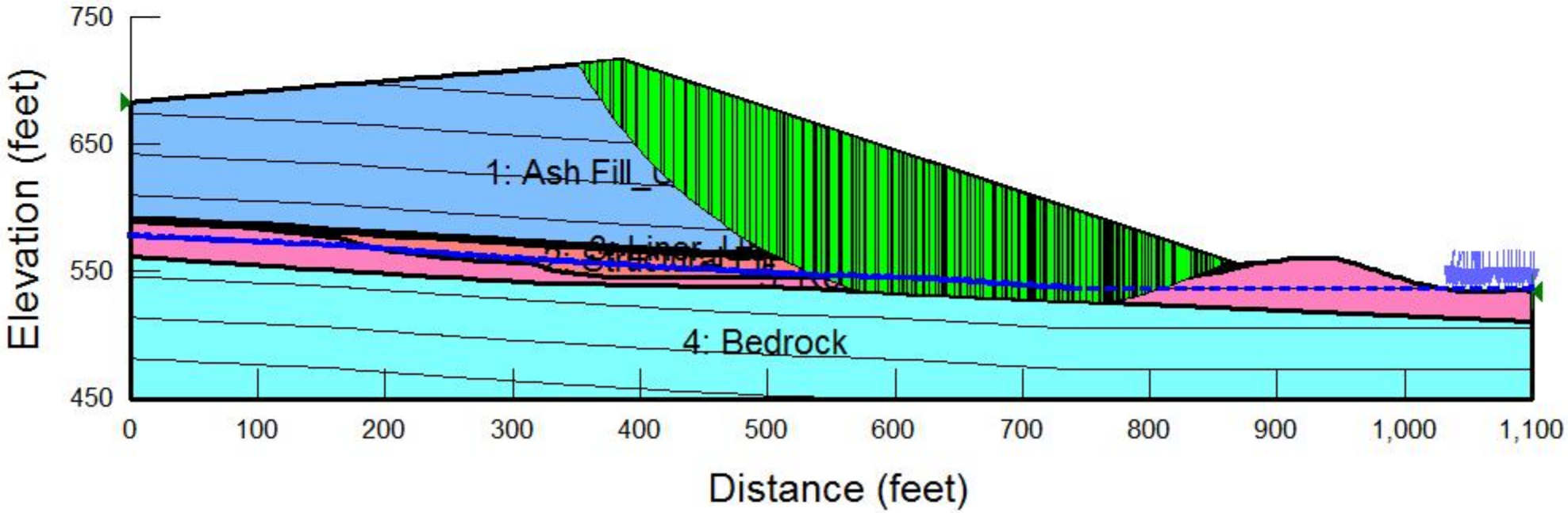
Horz Seismic Coef.: 0.12
Vert Seismic Coef.: 0.08





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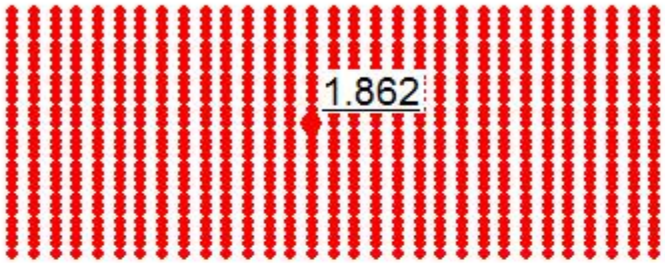
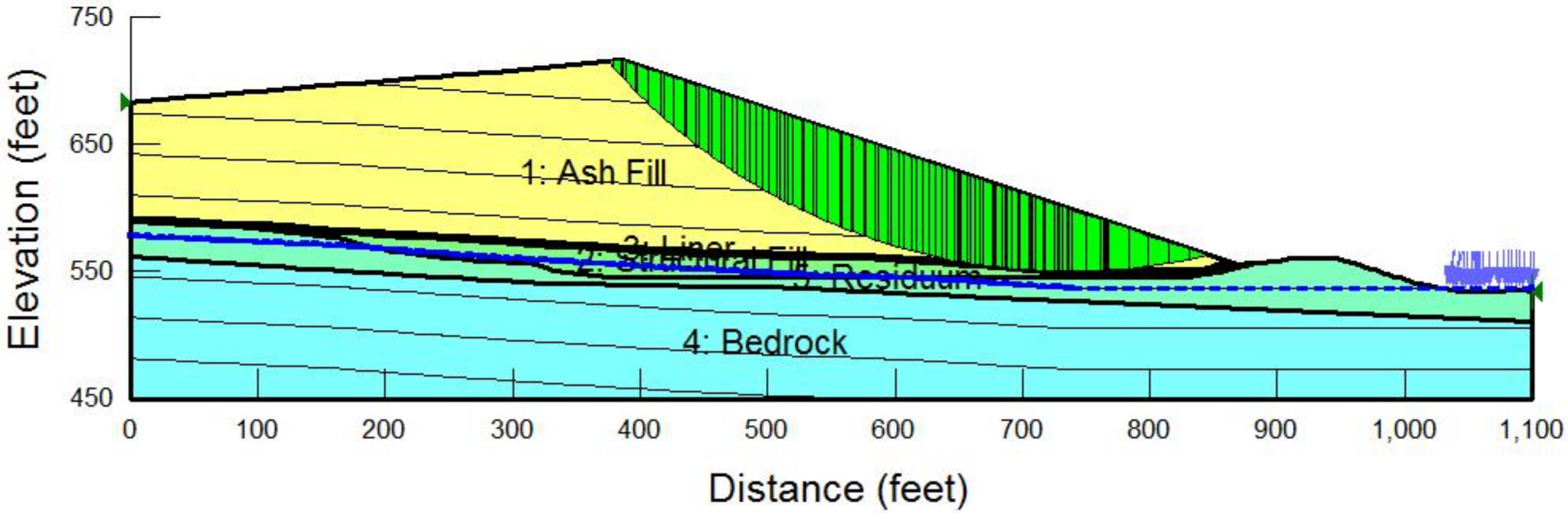
Name: Residuum Unit Weight: 122.7 pcf Cohesion': 150 psf Phi': 32 °
Name: Bedrock

Horz Seismic Coef.: 0
Vert Seismic Coef.: 0

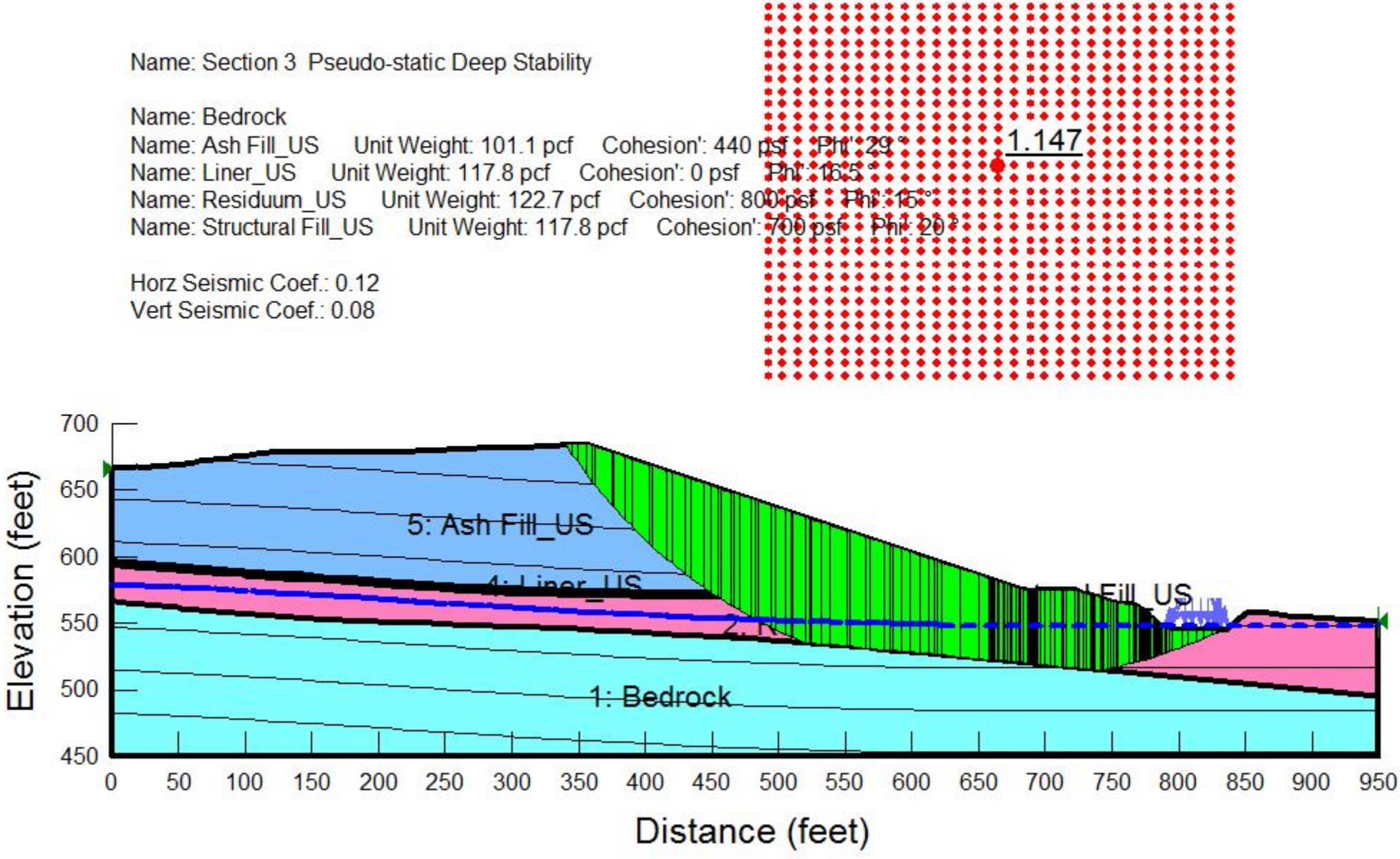


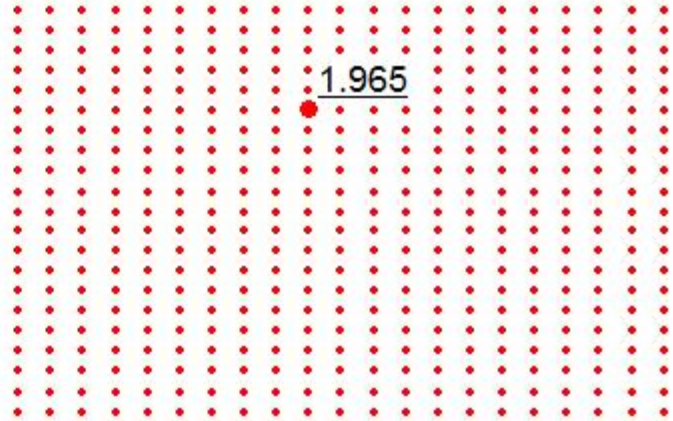


Name: Section 3 Pseudo-static Deep Stability

Name: Bedrock
Name: Ash Fill_US Unit Weight: 101.1 pcf Cohesion': 440 psf Phi': 29°
Name: Liner_US Unit Weight: 117.8 pcf Cohesion': 0 psf Phi': 16.5°
Name: Residuum_US Unit Weight: 122.7 pcf Cohesion': 800 psf Phi': 15°
Name: Structural Fill_US Unit Weight: 117.8 pcf Cohesion': 700 psf Phi': 20°

Horz Seismic Coef.: 0.12
Vert Seismic Coef.: 0.08





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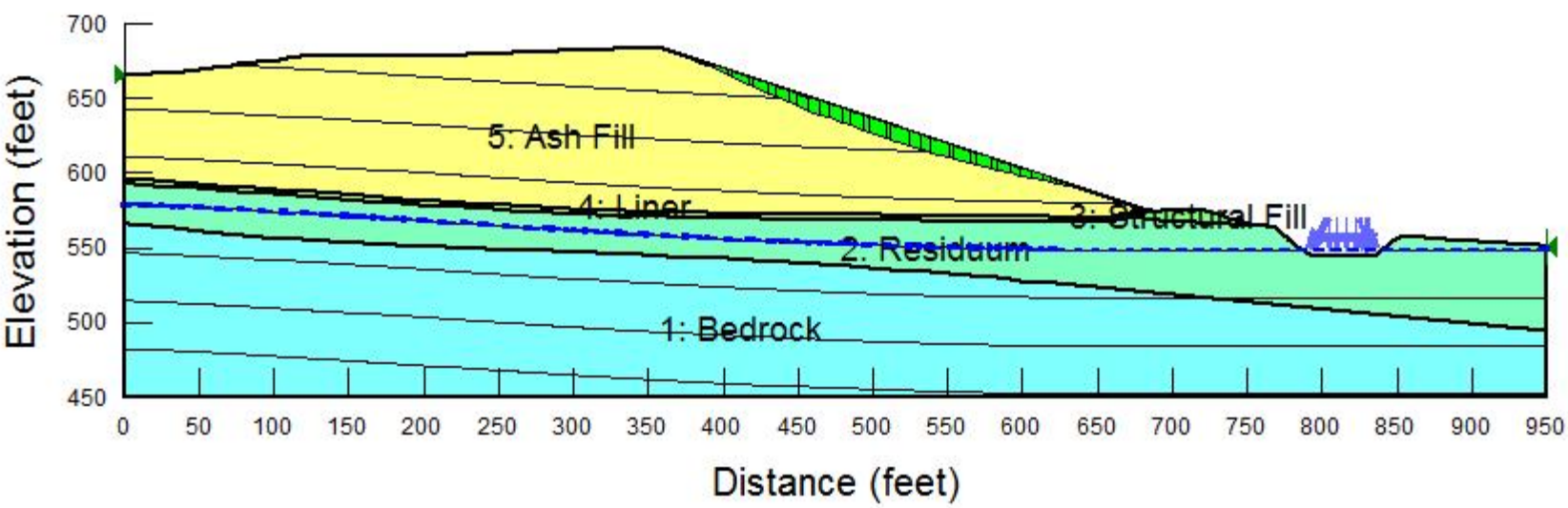
Name: Liner Unit Weight: 117.8 pcf Cohesion': 0 psf Phi': 16.5 °
Name: Structural Fill Unit Weight: 117.8 pcf Cohesion': 200 psf Phi': 27 °
Name: Residuum Unit Weight: 122.7 pcf Cohesion': 150 psf Phi': 32 °
Name: Bedrock

Horz Seismic Coef.: 0
Vert Seismic Coef.: 0



Name: Section 3 Pseudo-static Liner Stability

Name: Bedrock
Name: Ash Fill_US Unit Weight: 101.1 pcf Cohesion': 440 psf Phi': 29 °
Name: Liner_US Unit Weight: 117.8 pcf Cohesion': 0 psf Phi': 16.5 °
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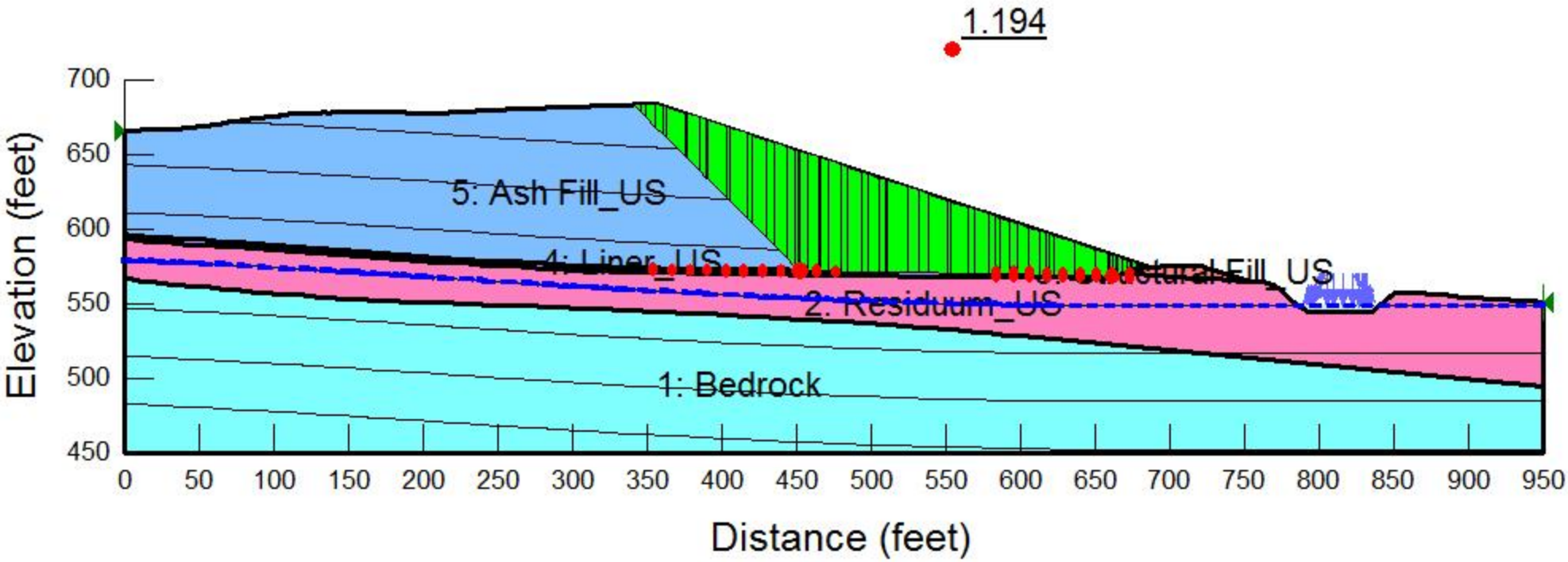
Name: Structural Fill_US Unit Weight: 117.8 pcf Cohesion': 700 psf Phi': 20 °

Horz Seismic Coef.: 0.12
Vert Seismic Coef.: 0.08



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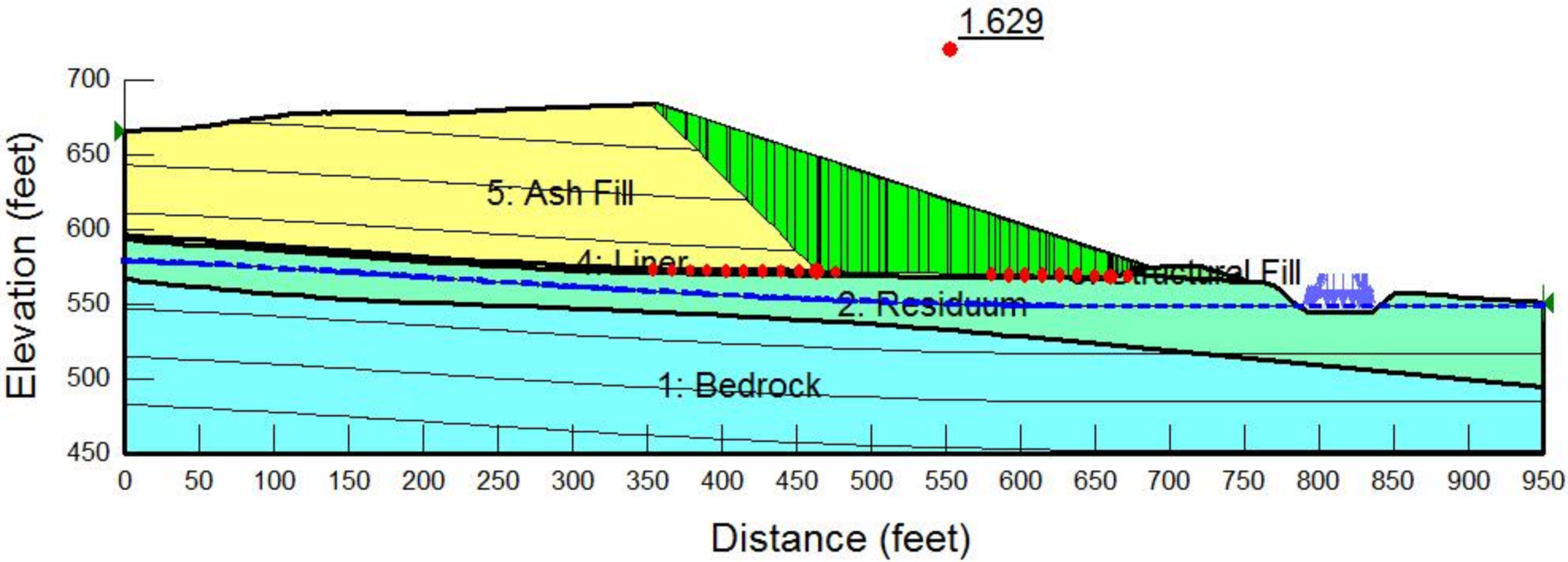
Name: Residuum Unit Weight: 122.7 pcf Cohesion': 150 psf Phi': 32 °
Name: Bedrock

Horz Seismic Coef.: 0
Vert Seismic Coef.: 0



Name: Section 3 Pseudo-static Shallow Stability

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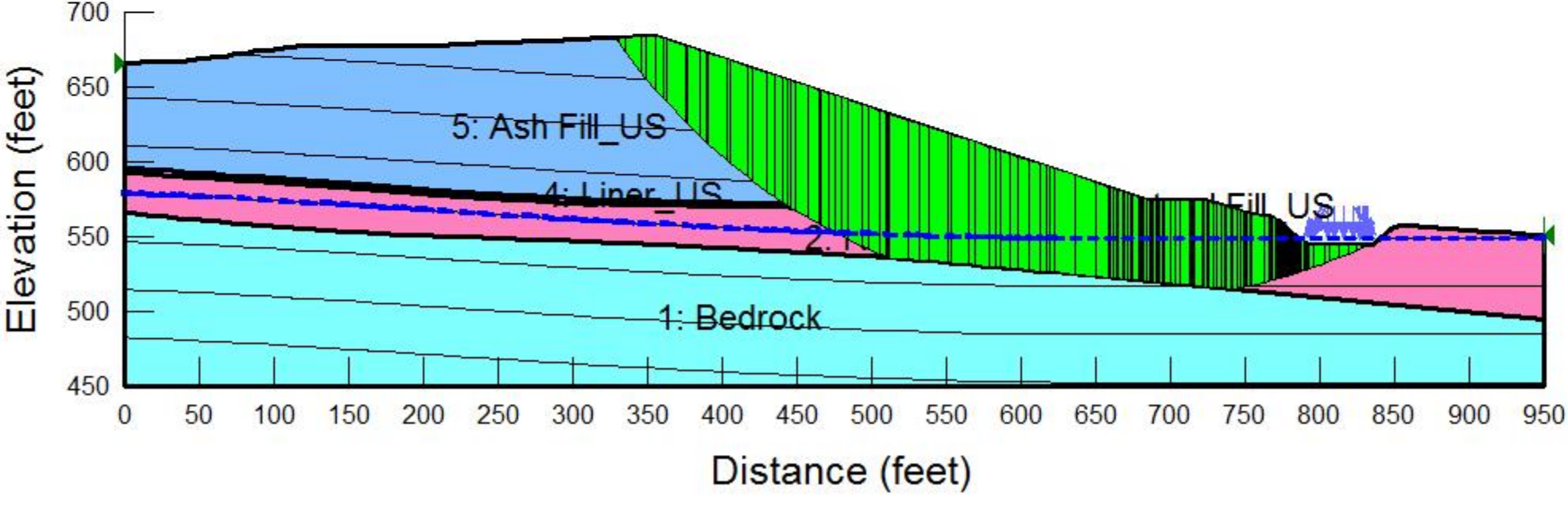
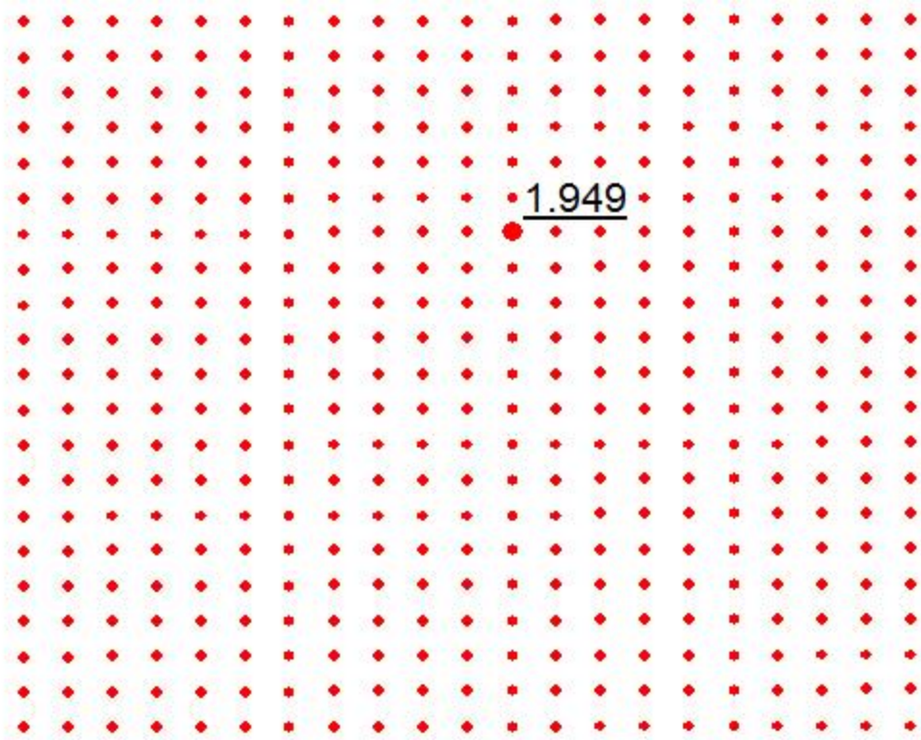
Horz Seismic Coef.: 0.12
Vert Seismic Coef.: 0.08





Name: Section 3 Static Shallow Stability

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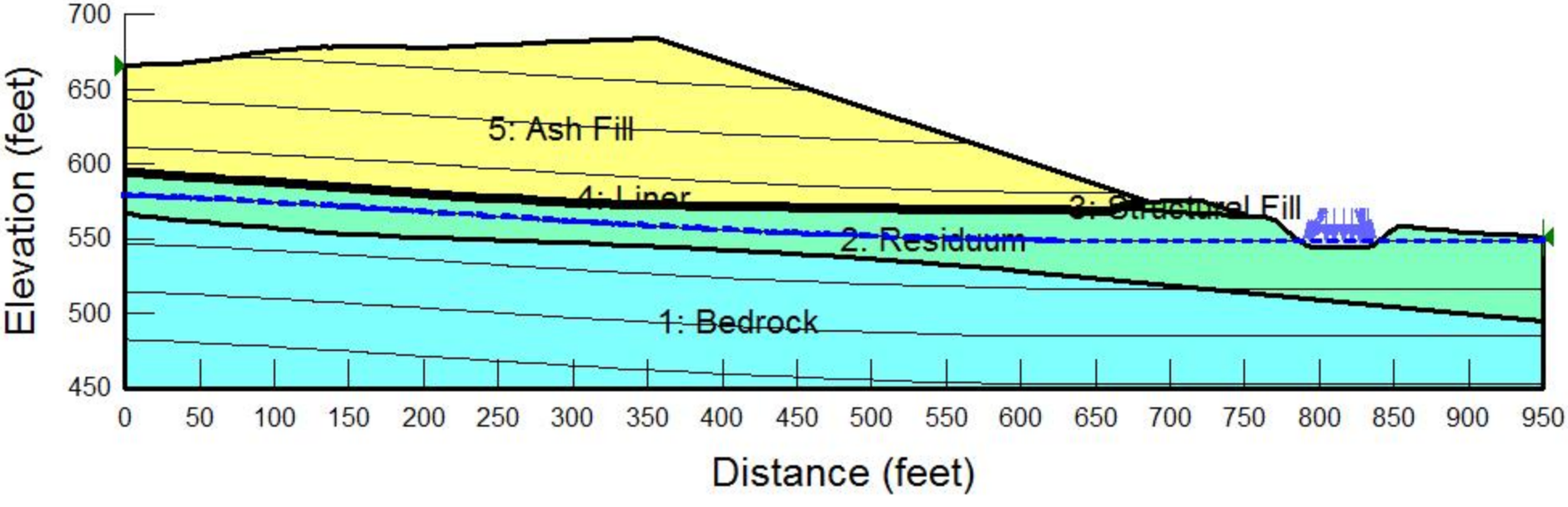
Name: Bedrock

Horz Seismic Coef.: 0
Vert Seismic Coef.: 0



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Name: Liner_US Unit Weight: 117.8 pcf Cohesion': 0 psf Phi': 16.5 °
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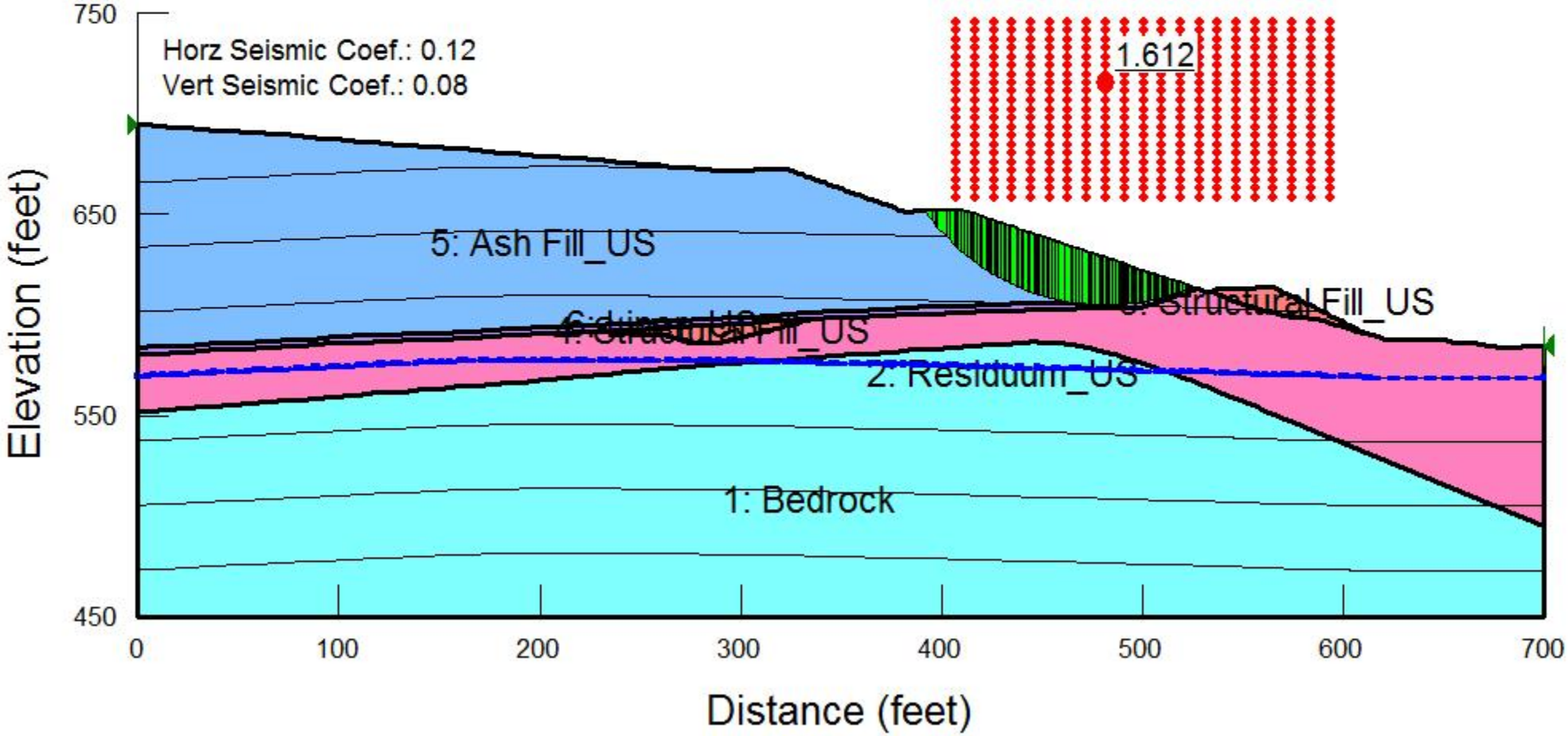
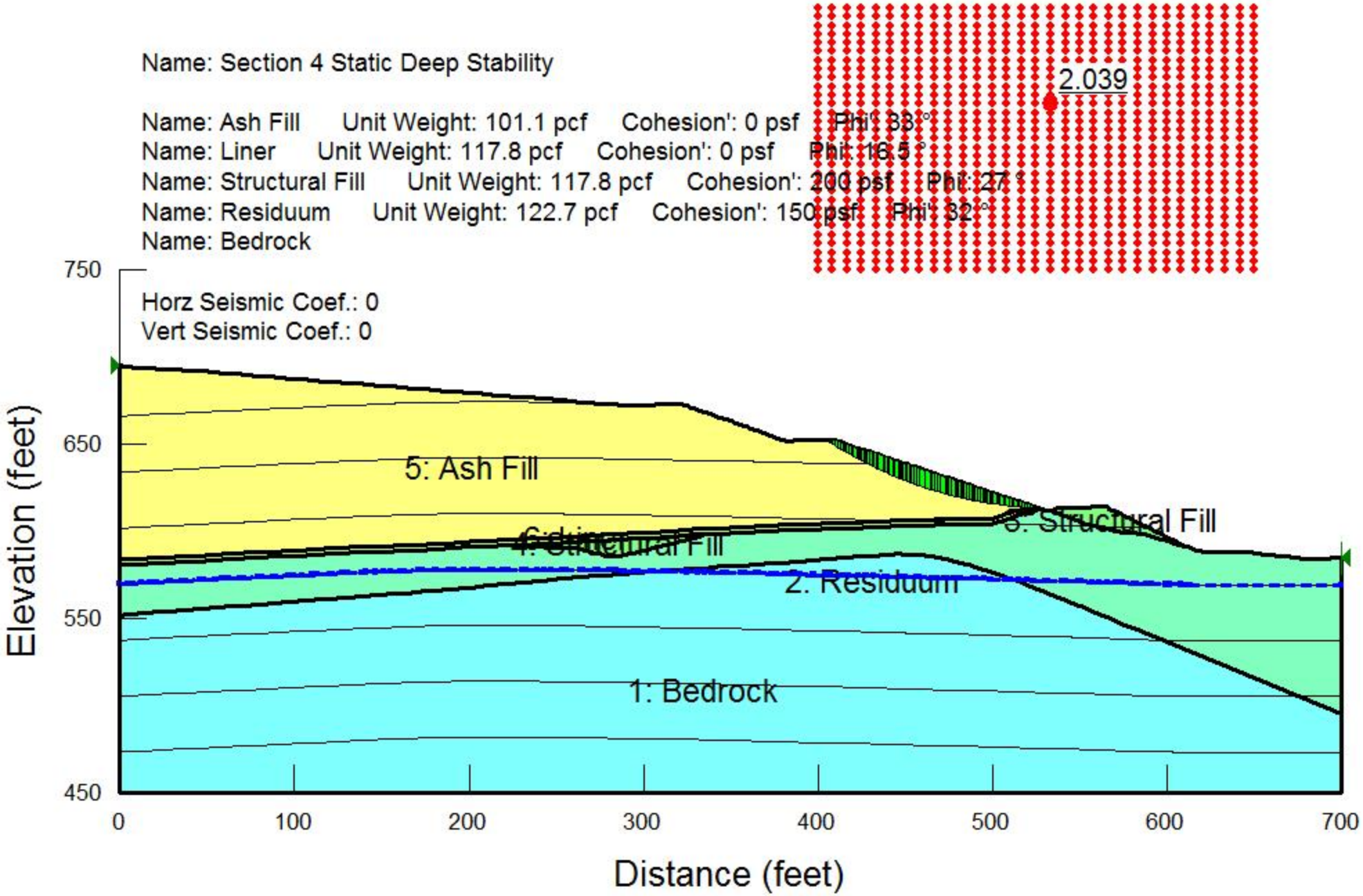
Name: Structural Fill_US Unit Weight: 117.8 pcf Cohesion': 700 psf Phi': 20 °

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Name: Residuum Unit Weight: 122.7 pcf Cohesion': 150 psf Phi': 32°
Name: Bedrock
2.039
Horz Seismic Coef.: 0
Vert Seismic Coef.: 0
5: Ash Fill
3: Structural Fill
4: Structural Fill
2: Residuum
1: Bedrock
Elevation (feet)
750
650
550
450
0
100
200
300
400
500
600
700
Distance (feet)

Name: Section 4 Pseudo-static Liner Stability

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Name: Liner_US Unit Weight: 117.8 pcf Cohesion': 0 psf Phi': 16.5 °
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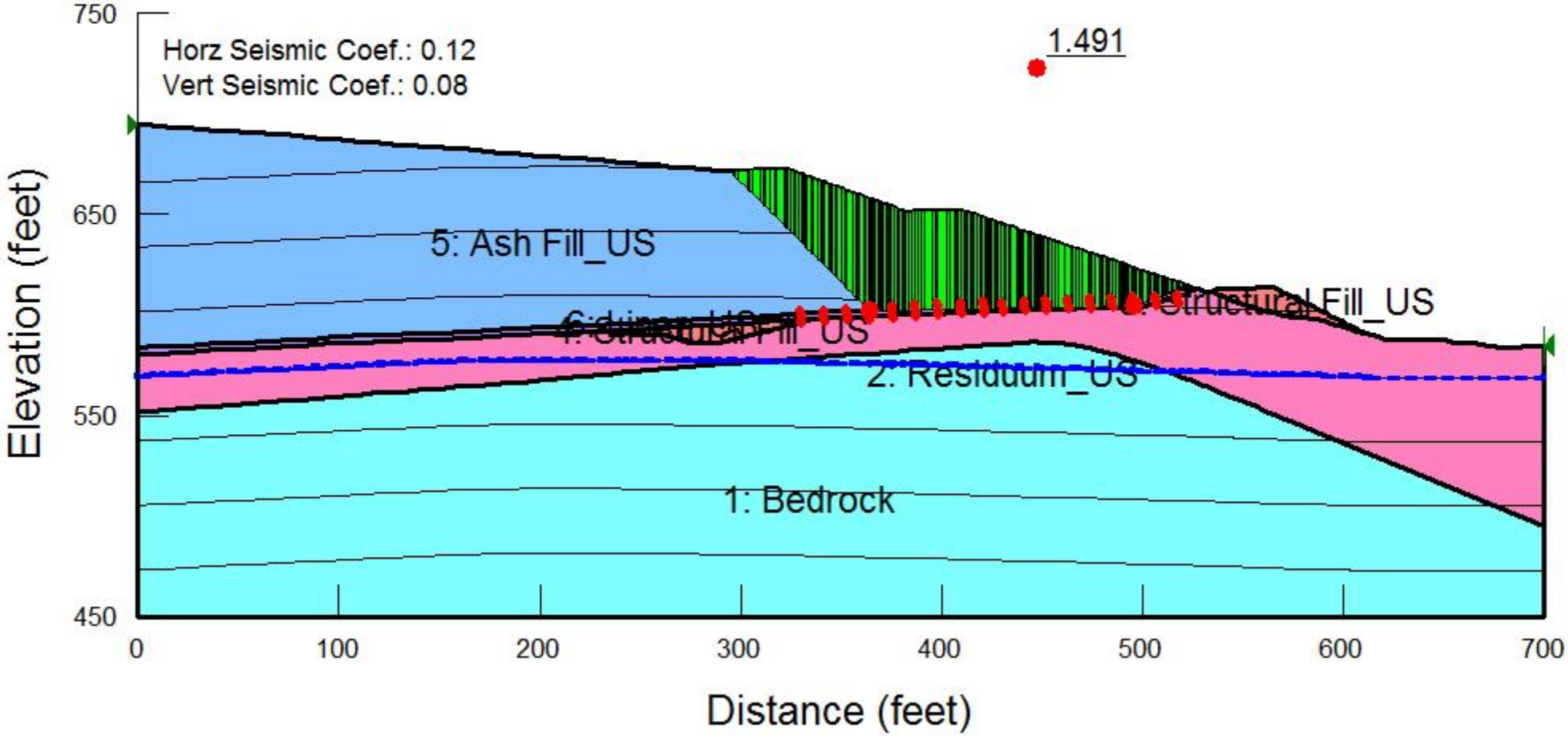
Name: Structural Fill_US Unit Weight: 117.8 pcf Cohesion': 700 psf Phi': 20 °



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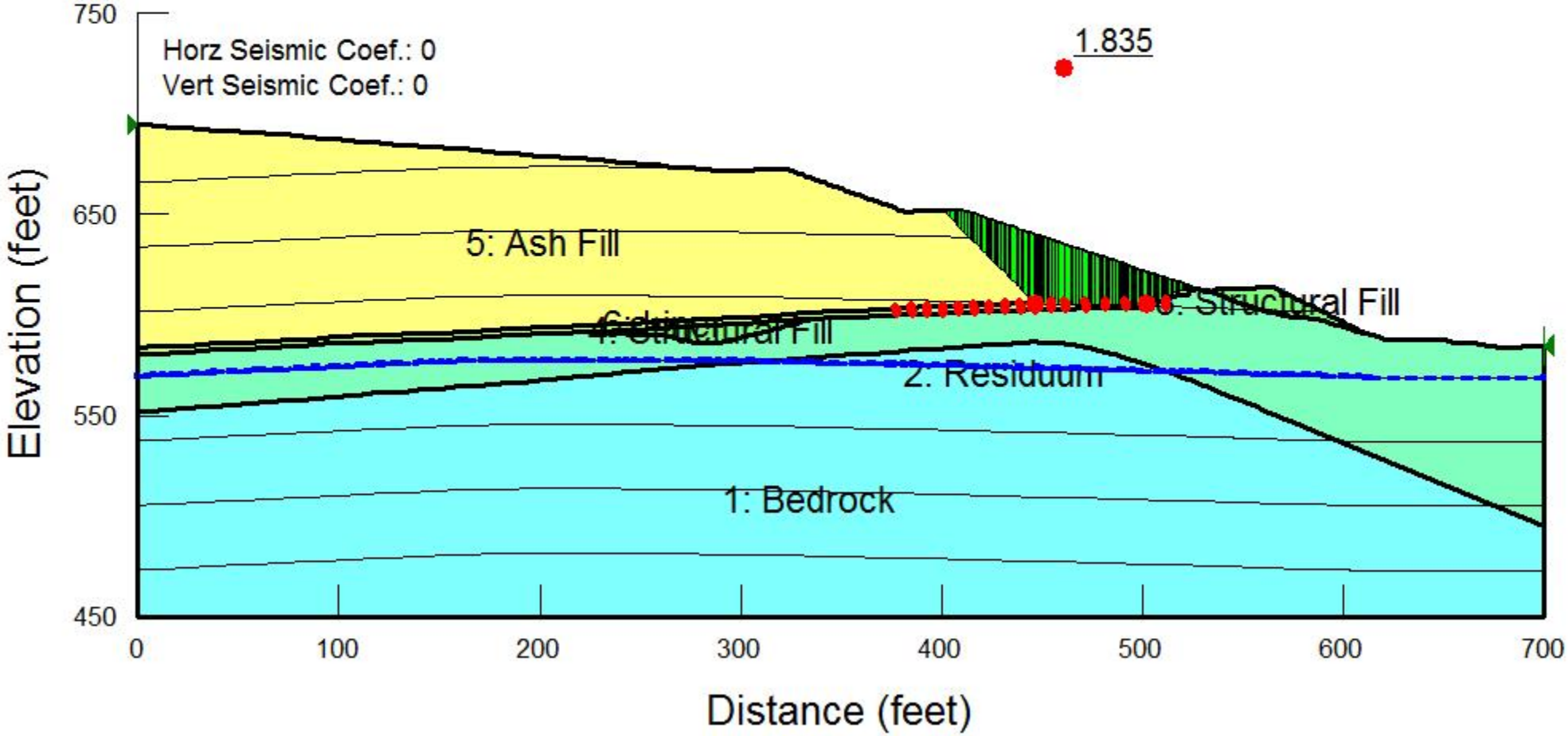
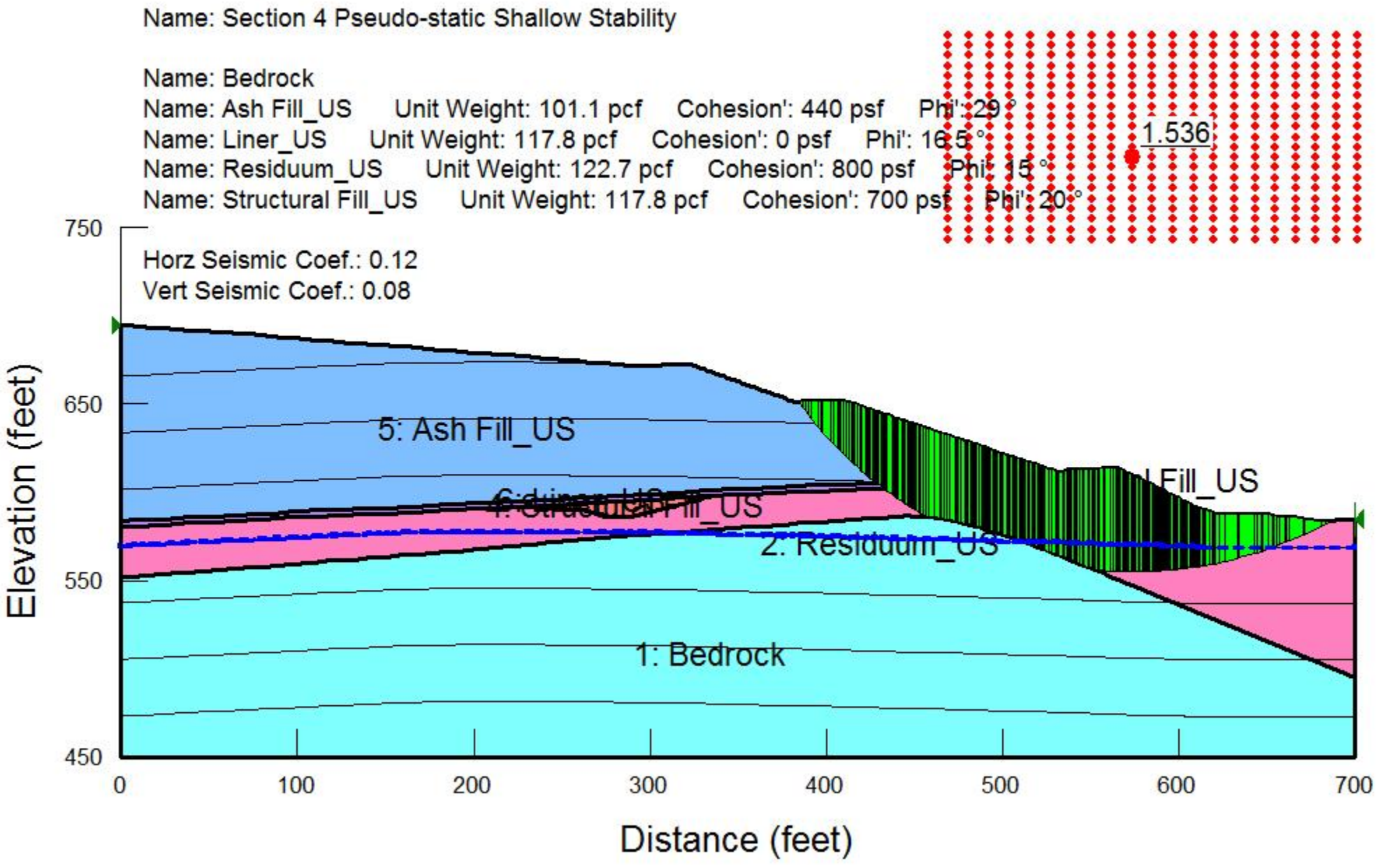
Name: Bedrock

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Name: Structural Fill_US Unit Weight: 117.8 pcf Cohesion': 700 psf Phi': 20 °
1.536
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Vert Seismic Coef.: 0.08
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1: Bedrock
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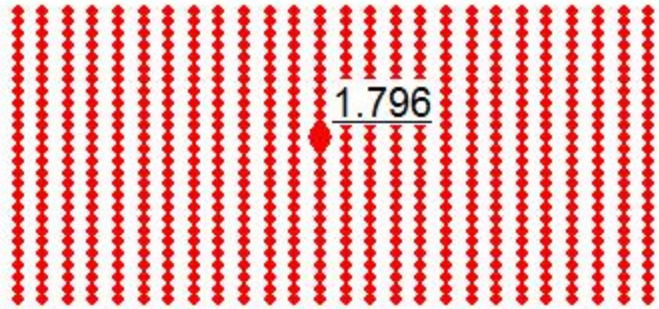
550
450
0
100
200
300
400
500
600
700
Distance (feet)



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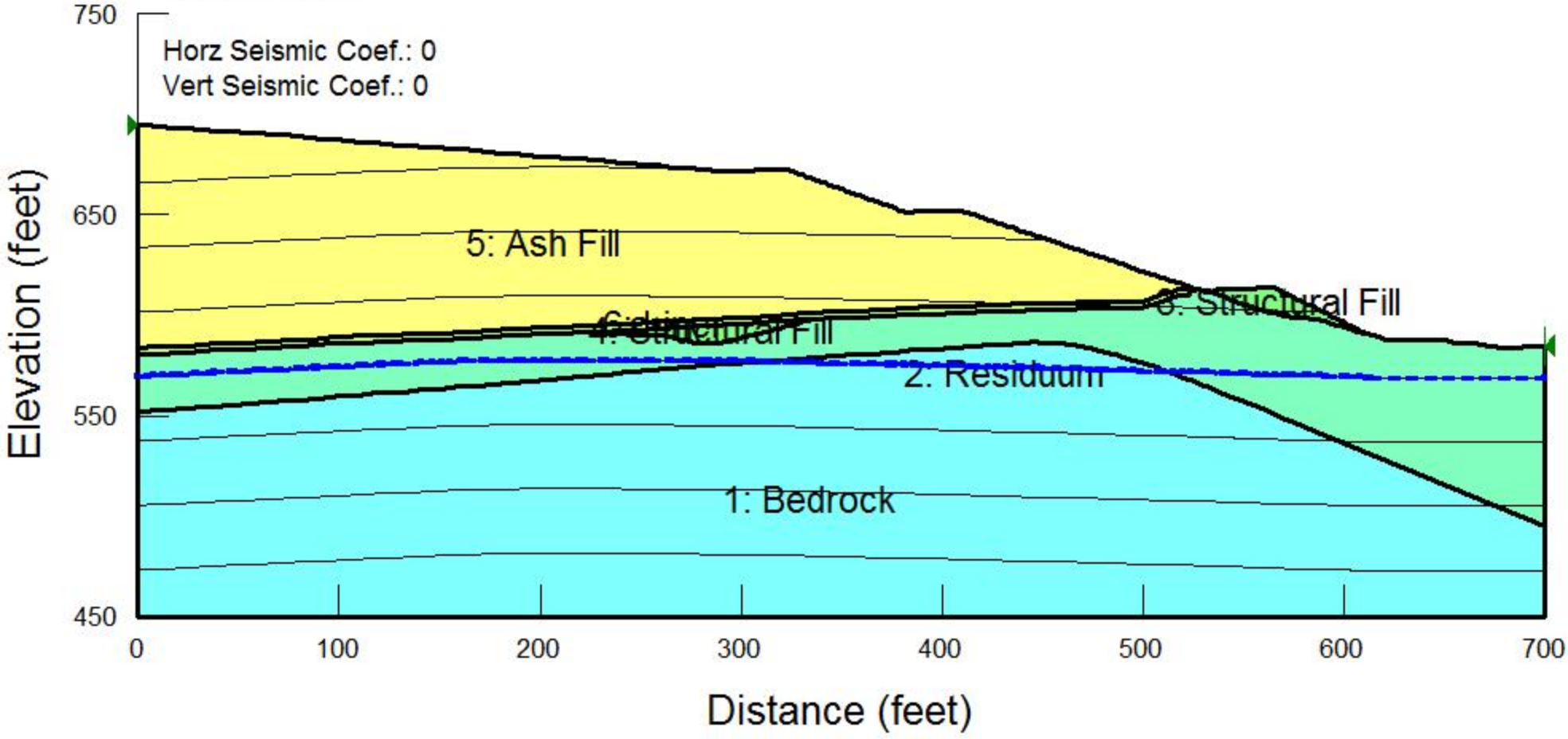
Name: Bedrock



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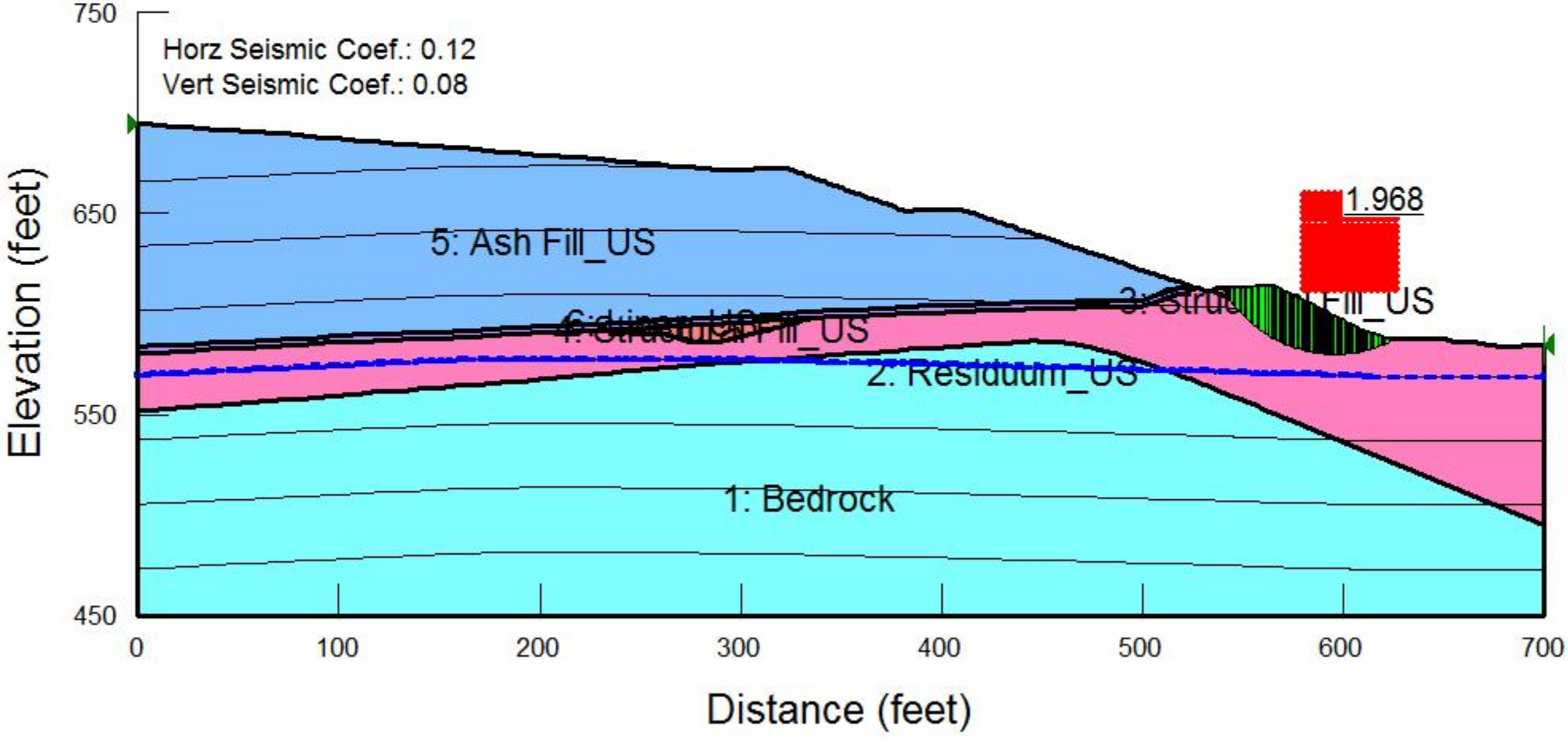

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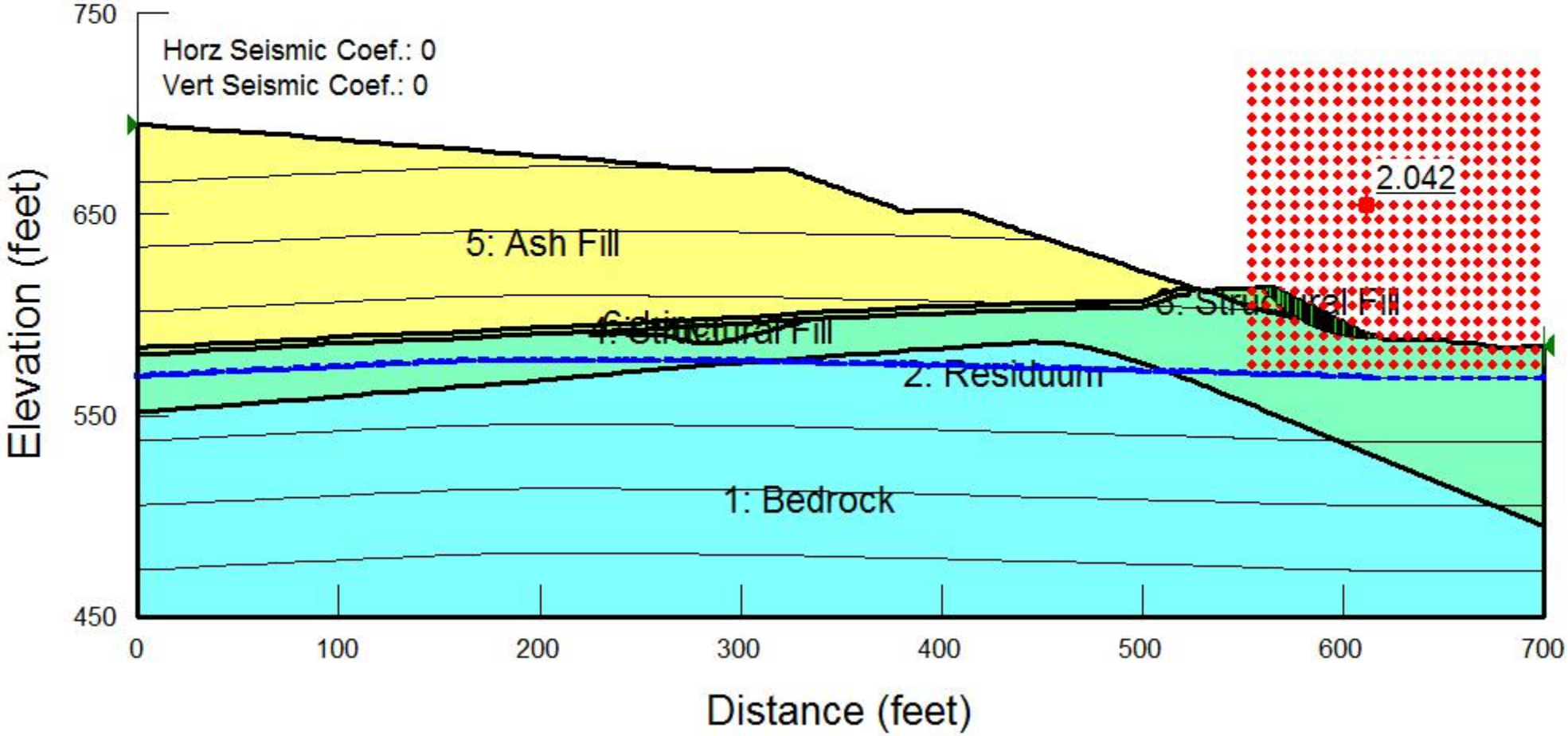
Name: Bedrock



APPENDIX III-3

Veneer Stability Calculation

Calculation Title:
Veneer Stability Calculation

Summary:
The minimum interface friction angle to achieve adequate safety factors for cover system veneer stability is 26.6 degrees. Interface friction testing should be performed prior to construction using site specific soils and the specified geosynthetic materials proposed for the cover system. The interface friction test conditions should be specified in accordance with the final conditions.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal	Chris Jordan	Lee Eaves	Cedric H. Ruhl

OBJECTIVE:

The objective of this calculation is to evaluate the static and pseudo-static veneer stability of the geosynthetic cover system for the Dan River Off-Site Landfill. Veneer stability will be evaluated for the following conditions:

1. Typical side slope (3H:1V slope, infinite slope method, unsaturated cover soil); and
2. Typical top deck (8 percent slope, infinite slope method, saturated cover soil).

The cover system will consist of the following components from bottom to top:

- Waste;
- Interim cover (12-in. thick);
- 40-mil double-sided textured LLDPE geomembrane;
- Geocomposite drainage layer;
- Final soil cover (18-in. thick); and
- Vegetative soil cover (6-in. thick).

METHOD:

Veneer stability was evaluated as described in Matasovic 1991 [Ref. 1]. Seismic coefficients used for this calculation were estimated in the "Seismic Coefficient Calculation" package.

DEFINITION OF VARIABLES:

β = slope angle;
γ = unit weight of cover soils;
γ_w = unit weight of water = 62.4 pcf;
Φ = interface friction angle;
c = cohesion of cover soils;
d_w = depth to water from ground surface;
FS = safety factor;
k_s = seismic coefficient; and
z = vertical depth of cover soil.

CALCULATIONS:

1.0 Define safety factors for veneer stability

For this calculation, the required safety factors (FS) were assumed to be 1.5 for static conditions and 1.0 for pseudo-static conditions, consistent with required safety factors reported in the "Slope Stability Calculation" package.

2.0 Calculate minimum friction angle for static stability

The cover system veneer stability is a function of several variables including interface friction angle. The minimum interface friction angle to achieve static stability was evaluated for the conditions as described in the following sections.

2.1 Condition 1 – typical side slope

The minimum interface friction angle for static stability for the typical side slope condition was estimated using the infinite slope method described in Matasovic 1991 [Ref. 1] and presented as follows:

$$FS = \frac{\frac{c}{\gamma z cos^2\beta} + tan\Phi\left[1-\gamma_w\frac{z-d_w}{\gamma z}\right] - k_s tan\beta tan\Phi}{k_s + tan\beta}$$ [Ref. 1]

The minimum interface friction angle can be estimated by re-arranging terms as follows:

$$\Phi_{min} = tan^{-1}\frac{FS(k_s+tan\beta)-\frac{c}{\gamma z cos^2\beta}}{1-\gamma_w\frac{z-d_w}{\gamma z}-k_s tan\beta}$$

The typical landfill cover system will be constructed at a 3H:1V side slope (β = 18.43 degrees). The seismic coefficient (k_s) equals 0 for static conditions. The geocomposite drainage layer (GCDL) has been designed to maintain hydraulic head within the geocomposite and prevent saturation of the overlying soil materials for this condition as calculated in the "Cover System Stormwater Calculation" package; therefore, depth to water from ground surface (d_w) equals the depth of the cover system (z). For the purposes of these analyses, the cover system soil was assumed to have a unit weight (γ) of 125 pcf and a cohesion (c) of 0 psf.

The minimum interface friction angle to achieve a static stability safety factor of 1.5 was estimated as shown in the following table:

Table 1: Minimum Interface Friction Angle for Typical Side Slope (Condition 1)

Required Safety Factor {FS}	Seismic Coefficient {k_s} (%g)	Slope Angle {β} (degrees)	Cover Soil Cohesion {c} (psf) [assumed]	Unit Weight of Cover Soil {γ} (pcf) [assumed]	Vertical Depth of Cover Soil {z} (ft)	Unit Weight of Water {γ_w} (pcf)	Depth to Water {d_w} (ft)	Minimum Interface Friction Angle {Φ} (degrees)
1.5	0.00	18.43	0	125	2	62.4	2	26.56

The minimum interface friction angle to achieve a safety factor of 1.5 for the typical side slope (Condition 1) is 26.56 degrees.

2.2 Condition 2 – typical top deck

The minimum interface friction angle for static stability for the typical top deck condition was estimated using the infinite slope method described above. The typical top deck will be constructed at a 8 percent slope (β = 4.57 degrees). The seismic coefficient (k_s) equals 0 for static conditions. Assuming the overlying cover soil materials are saturated, depth to water from

ground surface (d_w) equals 0. For the purposes of these analyses, the cover system soil was assumed to have a unit weight (γ) of 125 pcf and a cohesion (c) of 0 psf.

The minimum interface friction angle to achieve a static stability safety factor of 1.5 was estimated as shown in the following table:

Table 2: Minimum Interface Friction Angle for Typical Top Deck (Condition 2)

Required Safety Factor {FS}	Seismic Coefficient {k_s} (%g)	Slope Angle {β} (degrees)	Cover Soil Cohesion {c} (psf) [assumed]	Unit Weight of Cover Soil {γ} (pcf) [assumed]	Vertical Depth of Cover Soil {z} (ft)	Unit Weight of Water {γ_w} (pcf)	Depth to Water {d_w} (ft)	Minimum Interface Friction Angle {Φ} (degrees)
1.5	0.00	4.57	0	125	2	62	0	13.46

The minimum interface friction angle to achieve a safety factor of 1.5 for the typical top deck (Condition 2) is 13.46 degrees.

2.3 Minimum friction angle for static stability

The typical side slope condition controls, with a minimum required friction angle of 26.56 degrees. Prior to cover system construction, interface friction testing should be performed on the cover system materials to demonstrate that a minimum interface friction angle of 26.56 degrees is achieved. A description of interface friction testing requirements is provided in the Discussion section of this calculation.

3.0 Evaluate stability for pseudo-static conditions

The peak transverse crest acceleration equals 0.309 for pseudo-static conditions as described in the "Seismic Coefficient Calculation". Assuming that deformations of 1 foot are acceptable, the seismic coefficient "k_s" is equal to one-half the peak transverse crest acceleration [Ref. 2].

The cover system veneer stability for pseudo-static conditions was evaluated using the minimum friction angle calculated in Section 2.0 as described in the following sections.

3.1 Condition 1 – typical side slope

The cover system veneer stability safety factor for pseudo-static conditions for the typical side slope (Condition 1) was estimated as shown in the following table:

Table 3: Pseudo-Static Veneer Stability for Typical Side Slope (Condition 1)

Seismic Coefficient {k_s} (%g)	Slope Angle {β} (degrees)	Cover Soil Cohesion {c} (psf) [assumed	Unit Weight of Cover Soil {γ} (pcf)	Vertical Depth of Cover Soil {z} (ft)	Unit Weight of Water {γ_w} (pcf)	Depth to Water {d_w} (ft)	Minimum Interface Friction Angle {Φ}	Calculated Safety Factor {FS}
0.15	18.43	0	125	2	62.4	2	26.56	0.98

The calculated safety factor (0.98) is less than the minimum required safety factor for pseudo-static conditions (1.0); therefore, a Newmark deformation is required as shown in Section 4.0.

3.2 Condition 2 – typical top deck

The cover system veneer stability safety factor for pseudo-static conditions for the typical top deck (Condition 2) was estimated as shown in the following table:

Table 4: Pseudo-Static Veneer Stability for Typical Top Deck (Condition 2)

Seismic Coefficient {k_s} (%g)	Slope Angle {β} (degrees)	Cover Soil Cohesion {c} (psf) [assumed	Unit Weight of Cover Soil {γ} (pcf)	Vertical Depth of Cover Soil {z} (ft)	Unit Weight of Water {γ_w} (pcf)	Depth to Water {d_w} (ft)	Minimum Interface Friction Angle {Φ}	Calculated Safety Factor {FS}
0.15	4.57	0	125	2	62.4	0	26.56	1.06

The calculated safety factor (1.06) is greater than the minimum required safety factor for pseudo-static conditions (1.0).

4.0 Deformation analysis for pseudo-static conditions typical side slope

A Newmark deformation analysis is performed by following these steps [Ref. 2]:

1. Calculate yield acceleration;
2. Calculate permanent seismic deformation; and
3. Compare calculated permanent seismic deformation to allowable maximum permanent displacement.

4.1 Calculate yield acceleration

The yield acceleration is defined as the seismic coefficient that provides a safety factor of 1.00. The seismic coefficient was iteratively modified to achieve a safety factor of 1.00 or greater as shown in the following table:

Table 5: Calculate Yield Acceleration

Yield Acceleration {k_s} (%g)	Slope Angle {β} (degrees)	Cover Soil Cohesion {c} (psf) [assumed	Unit Weight of Cover Soil {γ} (pcf)	Vertical Depth of Cover Soil {z} (ft)	Unit Weight of Water {γ_w} (pcf)	Depth to Water {d_w} (ft)	Minimum Interface Friction Angle {Φ}	Calculated Safety Factor {FS}
0.14	18.43	0	125	2	62.4	2	26.56	1.01

4.2 Calculate permanent seismic deformation

The permanent seismic deformation was estimated using the Hynes and Franklin method as presented in Reference 2 and summarized in the following table:

Table 6: Estimate Permanent Displacement

Yield Acceleration (%g)	Maximum Acceleration (%g)	Ratio	Permanent Displacement (cm) [Ref. 2]	Permanent Displacement (ft)
0.14	0.15	0.93	10	0.33

The estimated seismic deformation is approximately 0.3 feet which is less than the 0.5 to 1 feet typically allowable for liner systems; larger permanent deformations are typically acceptable for cover systems [Ref. 2].

DISCUSSION:

The minimum interface friction angle is 26.6 degrees to achieve slope stability safety factor criteria for the conditions analyzed. The conditions analyzed are generally conservative because the following factors were not considered in the calculation: cohesion of the cover soil materials, and adhesion between the cover system components.

Interface friction testing should be performed prior to construction using site specific soils and the specified geosynthetic materials proposed for the cover system to verify that the minimum interface friction angle of 26.6 degrees can be achieved. Interface friction testing should be performed at each interface including a geosynthetic, anticipated to include:

- Intermediate soil cover to geomembrane;
- Geomembrane to geocomposite; and
- Geocomposite to final cover soil.

Geosynthetic products may have different texturing or surface treatments on each side. If such a geosynthetic is proposed for the cover system, all possible interfaces should be tested.

The interface friction test conditions should be specified in accordance with the final conditions. For instance, the intermediate and final cover soils should be tested at the compaction rate anticipated for final conditions. Testing should be performed at the highest anticipated moisture content as this condition coincides with the weakest material shear strength. The specified testing normal loads should be consistent with anticipated final conditions. Assuming 2 feet of final cover soil materials with a unit weight of 125 pcf, the interface friction testing normal loads would be on the order of 125 psf, 250 psf, and 500 psf.

Accurate interpretation of interface friction test results is important. Some interfaces may exhibit adhesion and friction angle shear strength components. In these instances it is appropriate to draw a straight line from the origin to the shear interface at the anticipated normal load. The slope of the line is the effective interface friction angle for the anticipated normal load. The effective interface friction angle can then be compared to the minimum interface friction angle of 26.6 degrees.

REFERENCES:

1. Matasovic, Neven. “Selection of Method for Seismic Slope Stability Analysis”, Proceedings: Second International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, March 11-15, 1991, St. Louis, MO, Paper No. 7.20.
2. USEPA. “RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities”, EPA/600/R-95-051, April 1995.

REFERENCE 1

Matasovic, Neven. “Selection of Method for Seismic Slope Stability Analysis”, Proceedings: Second International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, March 11-15, 1991, St. Louis, MO, Paper No. 7.20.

- the magnitude of acceleration is constant in the soil mass above the sliding surface, i.e. free field acceleration is applied at the bottom of the slice
- there is no pore pressure increase in the soil mass during shaking.

The influences of the vertical acceleration component and the pore pressure increase during shaking (flysch is partially saturated cohesive material) are neglected because it is believed they are small in this particular case.

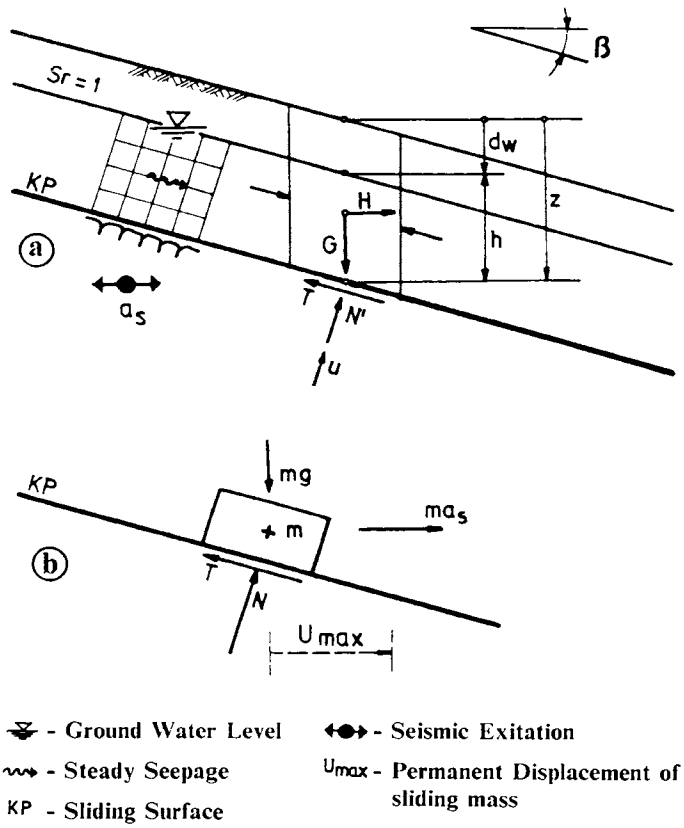


Fig. 2 Model of an infinite slope

Based on the above assumptions, the principles of limit equilibrium and the notation introduced in Figure 2, the following expression for the factor of safety, F_s, has been derived (Matasovic, 1989):

$$F_s = \frac{c/(\gamma z \cos^2 ß) + \tan \Phi[1 - \gamma_w(z-d_w)/(\gamma z)] - k_s \tan ß \tan \Phi}{k_s + \tan ß} \quad (1)$$

where γ, γ_w, c and Φ are the unit weight of slope material, the unit weight of water, cohesion and the angle of internal friction respectively.

Equation (1) defines the factor of safety for a general case of infinite slope stability. A similar expression, but for stability of cohesionless materials with pore pressure increase due to seismic loading, has been used by Hadj-Hamou and Kavazanjian (1985).

It should be noted that the value of factor of safety calculated by Equation (1) diminishes with depth in cohesive ($c \neq 0$, $\varphi \neq 0$) materials. Also, since the equation has been set for a case of limit equilibrium when $F_s = 1$, it is assumed that slope will generally resist seismic loading and will be stable if $F_s > 1.0$.

Analysis by sliding block method

The sliding block method (Newmark, 1965) has been universall applied in dam engineering. Basic elements of slope stabilit analysis by this method are shown on an idealized model of a: infinite slope in Figure 2b. According to D' Alembert's principle under seismic excitation of the base a_s, the reaction of the slidin weight G would be the pseudo-static inertial force $m\,a_s = k\,G$. Th limiting value of that inertial force, i.e. the limiting value of th acceleration because the mass is constant, which leads mass to th state of the limit equilibrium, depends on the shear resistance o material on a sliding surface. This acceleration is called critica acceleration, a_{sc} and can be expressed as $a_{sc} = k_c\,g$, where g is th acceleration of gravity and k_c is the factor of proportionality calle *coefficient of critical acceleration.* According to the premises of thi method, if the critical acceleration is exceeded, a sliding of the mas will occur. After each increment of shaking with acceleration greate than a_{sc} and associated down slope sliding, the mass will stop in new position with respect to its original location. At the end o shaking such increments of dislocation will amount to a final anc maximum permanent displacement of the sliding mass, u_{max}.

To estimate u_{max}, it is necessary, as a first step, to determine a_s expressed by the product $k_c\,g$. The coefficient k_c can be determinec iteratively by varying the amount of horizontal force until it reache the value that gives the $F_s = 1$. However, for the model of infinite slope the coefficient of critical acceleration can be expressec explicitly by inserting $F_s = 1$ in Equation (1) and rearranging the variables:

$$k_c = \frac{c / (\gamma z \cos^2 ß) + \tan \Phi [1 - \gamma_w(z - d_w)/(\gamma z)] - \tan ß}{1 + \tan ß \tan \Phi} \quad (2)$$

For a case without steady state seepage in the slope (if we insert $d_w = z$), Equation (2) becomes the expression for k_c used by Chang et Al. (1984).

After the critical acceleration has been determined, permanent displacements can be estimated by using various close form solutions available (e.g., Ambraseys and Menu, 1988), or by treating the appropriate accelerogram using the Makdisi and Seed (1978) procedure based on Newmark's (1965) approach.

The main practical problem related to the application of sliding block method in analysis of natural slopes is how to define the allowable permanent displacement. The limits on calculated values could be related to functionality of structures on the slope or to the stability of the slope itself after the earthquake. For example, if an earthquake has caused cracking of the slope, water percolation in earthquake opened cracks can significantly change the static stability. One of a very few tentative criteria set for natural slopes is the one established by the State of Alaska's Geotechnical Evaluation Criteria Committee, given in Table 1 (based on 1964 Great Alaskan Earthquake, quoted in Idriss, 1985).

TABLE 1. Orientational stability criteria for the sliding block seismic stability analysis of natural slopes

Failure Category (State of Alaska Criteria)	Amount of Corresponding Perm. Lat. Displacement
I Catastrophic Ground Failure	300 cm
II Major Ground Adjustment	90 cm
III Moderate Ground Adjustment	30 cm
IV Minor Ground Adjustment	15 cm
V Little or no Ground Adjustment	< 3 cm

REFERENCE 2

USEPA. “RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities”, EPA/600/R-95-051, April 1995.

OII landfill. . Observations of the satisfactory performance of the OII landfill slopes in recent earthquakes combined with this plot indicate that the dynamic shear strength of MSW mobilized during seismic loading is greater than the values indicated in Figure 6.3.

6.1.6 Sensitivity Studies

It is strongly recommended that all stability analyses of MSW landfills be performed using parametric studies to clearly identify the sensitivity of the performance of the landfill to the material properties used in the analysis. If performance depends significantly on a given parameter, then additional laboratory or field testing may be required to better define appropriate properties for design.

6.2 Seismic Stability and Deformation Analysis

A prerequisite for performing a seismic slope stability and deformation analysis is performance of a static slope stability analysis. The seismic stability and deformation analysis is carried out using the same basic model(s) of landfill (waste mass and foundation) and containment system used in the static analysis. The following steps are used in a typical seismic slope stability and deformation analysis:

Step 1: Reinterpret the cross-sections analyzed in the static stability analysis and assign appropriate dynamic strength parameters. In cases where it is not clear whether drained or undrained shear strength parameters are appropriate for the dynamic analysis, follow guidelines presented in Duncan (1992).

Step 2: Evaluate the seismic coefficient, k_s. There are many different views on how to define k_s (e.g., Seed and Martin, 1966; Seed, 1979; Marcuson, 1981; Hynes and Franklin, 1984). The most reasonable definition appears to be one that regards the seismic coefficient as an empirical factor. This definition recognizes the limitations of the pseudo-static slope stability analysis in representing the actual effects of an earthquake on the slope. Unfortunately, this definition provides no guidance to selection of an appropriate value of k_s. Seed (1979) reports that clay slopes and embankments designed with a minimum pseudo-static factor of safety of 1.15 using a seismic coefficient of 0.15 have experienced "acceptable" deformations in earthquakes of magnitude less than 7.5 and intensity less than 0.75 g. However, Seed's definition of acceptable deformations appears to include deformations of over one meter in some cases.

Figure 6.5 shows the results of Newmark seismic deformation analyses performed by Hynes and Franklin (1984) using 387 strong motion records and 6 artificial accelerograms. Based upon this data and their experience with seismic response analyses of slopes and embankments, Hynes and Franklin (1984) concluded that slopes and embankments with a yield acceleration equal to half the peak ground acceleration would experience permanent seismic deformations of less than one meter (3 ft) in any earthquake, even for embankments where amplification of acceleration by a factor of three occurs. In the absence of amplification, or if amplification is taken into account in determining the peak acceleration, the Hynes and Franklin data suggest that deformations will remain less than 0.3 m (1 ft) for yield accelerations less than or equal to one-half the peak acceleration. Therefore, based upon the work of Hynes and Franklin, it appears that the maximum value of k_s may be determined as $k_s = 0.5 \cdot a_{max}/g$ to limit permanent seismic deformations to less than 0.3 m (1 ft), where a_{max} is peak horizontal acceleration at the ground surface for analyses of the liner system and at the top of the landfill for analyses of the cover system. a_{max} can be estimated either using the simplified methods presented in Section 4 of this guidance document or from the results of a seismic response analysis.

Step 3: Perform the pseudo-static stability analysis. If the minimum factor of safety, FS_{min}, exceeds 1.0 and 0.3 m (1 ft) of deformation is acceptable, the seismic stability analysis is completed.

Step 4: If the pseudo-static factor of safety is less than 1.0 or the acceptable deformation is less than 0.3 m (1 ft), perform a Newmark deformation analysis. This is done with the following three steps:

1) Calculate the yield acceleration, k_y. The yield acceleration is usually calculated in pseudo-static analyses using a trial and error procedure in which the seismic coefficient is varied until $FS_{min} = 1.0$ is obtained. The lowest yield acceleration for all possible failure surfaces passing through the liner, cover, and/or waste mass should be evaluated.

2) Calculate the permanent seismic deformation. The permanent seismic deformation may be calculated using either simplified design charts (e.g., Hynes and Franklin, 1984; Makdisi and Seed, 1978) or a formal time-history analysis in which the excursions of the average acceleration time history above the yield acceleration are double integrated.

3) Compare the calculated permanent seismic deformation to the allowable maximum permanent displacement, u_{max}. Seed and Bonaparte (1992) report that u_{max} values of 0.15 to 0.3 meters (0.5 to 1.0 feet) are typically used in practice for design of geosynthetic liner systems. For cover systems, where permanent seismic deformations may be observed in post-earthquake inspections and damage to components can be repaired, larger permanent deformations may be considered acceptable. In fact, some regulatory agencies consider seismic deformations of the landfill cover system primarily a maintenance problem.

Several investigators have presented simplified charts based upon the results of Newmark deformation analyses for estimating permanent seismic deformations. Makdisi and Seed (1978) developed the chart shown in Figure 6.6 from the results of two-dimensional finite element analyses of embankments founded upon rock. This chart includes the effect of amplification of seismic motions by an embankment and provides upper and lower bounds on the permanent deformation as a function of magnitude. Hynes and Franklin (1984) developed the chart shown in Figure 6.5 from classical Newmark "sliding block on a plane" analyses. The Hynes and Franklin chart does not consider amplification or magnitude effects but includes time histories which encompass a wide range of soil conditions. Due to the uncertainties in using a simplified design chart and the characteristics and limitations discussed above, the use of the upper bound curves from Makdisi and Seed (Figure 6.6) for simplified analysis of the permanent seismic deformation potential of the waste mass and liner system. The *mean* + curve from Hynes and Franklin (Figure 6.5) is recommended for simplified permanent seismic deformation analysis of the cover system.

If a seismic response analysis has been performed, a formal Newmark seismic deformation analysis can be performed by using the acceleration or shear stress time histories from the response analysis. Jibson (1993) describes the analytical procedure for performing such an analysis. To evaluate the permanent displacement of the landfill mass, the average acceleration time history of mass above the critical failure plane (the failure surface with the lowest yield acceleration) should be used. The average acceleration time history may be calculated as the average of the acceleration time history of each layer above the interface weighted according to the unit weight and thickness of each layer. Alternatively, the average acceleration time history may be calculated from the shear stress at the interface divided by the total vertical stress above the interface, as described by Repetto et al. (1993). To calculate the permanent deformation of the landfill final cover, either the average acceleration time history of the cover or the shear stress time history at the cover-waste interface divided by the total vertical stress at the interface should be used in the Newmark analysis. Particularly for landfills in the eastern United States, where the earthquake acceleration time history may contain relatively enriched high frequencies, the

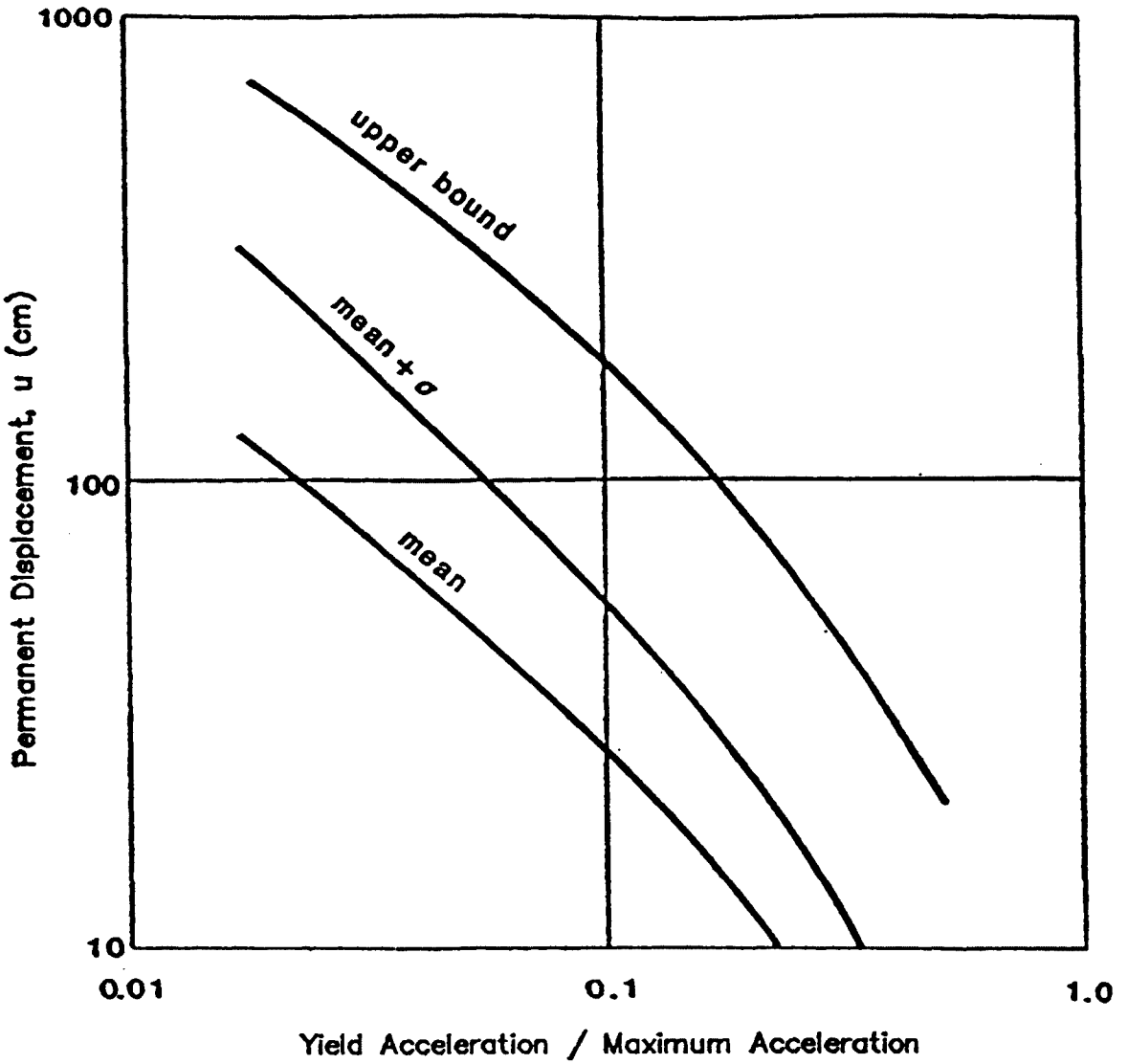


Figure 6.5 Hynes and Franklin Permanent Seismic Displacement Chart (Hynes and Franklin, 1984).

APPENDIX III-4

Anchor Trench Calculation

Calculation Title:
Anchor Trench Calculation

Summary:
Assuming a protective cover soil friction angle of 28 degrees, the protective cover soil will not slough off of the side slopes.

A minimum effective interface friction angle of 22.6 degrees is required between the protective cover soil and the geocomposite drainage layer.

The summation of forces acting on the anchor trench is less than the allowable geomembrane strength; therefore, stability is satisfied.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal	Chris Jordan	Lee Eaves	Cedric H. Ruhl

OBJECTIVE:

The anchor trench will be designed to achieve the following objectives:

1. Maintain stability of the protective cover soil from sloughing;
2. Maintain stability at the interface between the cover soil and the geocomposite drainage layer; and
3. The forces acting on the anchor trench should be less than the yield strength of the geomembrane.

METHOD:

Stability of the cover soil from sloughing and the stability at the interface between the cover soil and the geocomposite drainage layer will be evaluated using the infinite slope method. The forces acting on the anchor trench and the yield strength of the geomembrane will be compared using the methods presented in Koerner's "Designing with Geosynthetics", 6th. Ed. [Ref. 1].

DEFINITION OF VARIABLES:

β = side slope angle = 3H:1V = 18.43 degrees [assumed]
δ = effective interface friction angle
γ_{AT} = unit weight of anchor trench soil = 115 pcf [assumed]
φ = friction angle of soil = 28 degrees [assumed]
σ_N = applied normal stress from cover soil
d_{AT} = depth of anchor trench turndown = 1.5 feet [assumed]
d_{cover} = depth of cover soil over turndown = 2 feet [assumed]
$F_{L\sigma}$ = shear force below geosynthetics due to cover soil
F_{LT} = shear force below geosynthetics due to vertical component of T_{allow}
$F_{U\sigma}$ = shear force above geosynthetics due to cover soil
FS = safety factor
K_A = coefficient of active earth pressure
K_P = coefficient of passive earth pressure
L_{RO} = length of anchor trench runout = 2 feet [assumed]
P_A = active earth pressure against the backfill side of the anchor trench
P_P = passive earth pressure against the in-situ side of the anchor trench
T_{allow} = allowable force in the geosynthetics

CALCULATIONS:

1.0 Evaluate stability of the protective cover soil from sloughing

During landfill liner construction, two feet of protective cover soil will be placed over the liner system to protect the liner system during landfill operation. Prior to landfill operation, the protective cover soil will be at a slope inclination equal to the landfill cell side slope. During landfill operation, waste will be placed against the landfill side slope, forming a buttress and preventing the protective cover soil from sloughing. Thus, the failure mechanism of protective

cover soil sloughing is a temporary condition and a safety factor of 1.25 is appropriate based on engineering judgment.

The stability of the protective cover soil against sloughing was evaluated using the infinite slope method, presented as follows:

$$FS = \frac{tan\varphi}{tan\beta}$$ [Ref. 1]

The estimated stability of the protective cover soil against sloughing was compared to the minimum required safety factor from sloughing as shown in the following table:

Table 1: Stability of the Protective Cover Soil Against Sloughing

Friction Angle of Soil {φ} (degrees) [assumed]	Side Slope Angle {β} (degrees) [assumed]	Estimated Safety Factor {FS}	Minimum Required Safety Factor {FS_{min}} [assumed]	Check
28	18.43	1.60	1.25	stability satisfied

The estimated safety factor of the protective cover soil against sloughing is greater than the minimum required safety factor from sloughing.

2.0 Evaluate stability at the protective cover soil / geocomposite interface

One possible failure mechanism is that the cover soil slides along the geocomposite interface. As previously described, during landfill operation waste will be placed against the landfill side slope; thus, the failure mechanism of protective cover sliding along the geocomposite interface is a temporary condition and a safety factor of 1.25 is appropriate.

Interface friction testing will be performed upon selection of liner system materials; therefore, the interface friction angle between the protective cover soil to geocomposite interface is currently unknown. The minimum required interface friction angle between the protective cover soil to geocomposite interface was evaluated using the infinite slope method by re-arranging terms as follows:

$$\delta_{CS/GCDL} = tan^{-1}(FStan\beta)$$

The minimum required interface friction angle between the protective cover soil to geocomposite interface was evaluated as shown in the following table:

Table 2: Stability of the Protective Cover Soil to Geocomposite Interface

Side Slope Angle {β} (degrees) [assumed]	Minimum Required Safety Factor {FS_{min}}	Minimum Required Interface Friction Angle {$\delta_{CS/GCDL}$} (degrees)
18.43	1.25	22.6

The minimum required interface friction angle between the protective cover soil to geocomposite interface is 22.6 degrees. Refer to the Discussion portion of the calculation for a description of interface friction testing requirements.

3.0 Compare forces acting on the anchor trench to the material strength

It is preferable for the geomembrane to pull out of the anchor trench rather than rupture the geomembrane. Thus, the resistive forces acting on the anchor trench should be less than the yield strength of the geomembrane.

3.1 Describe forces acting on the anchor trench

The forces acting on the anchor trench are presented in the following figure:

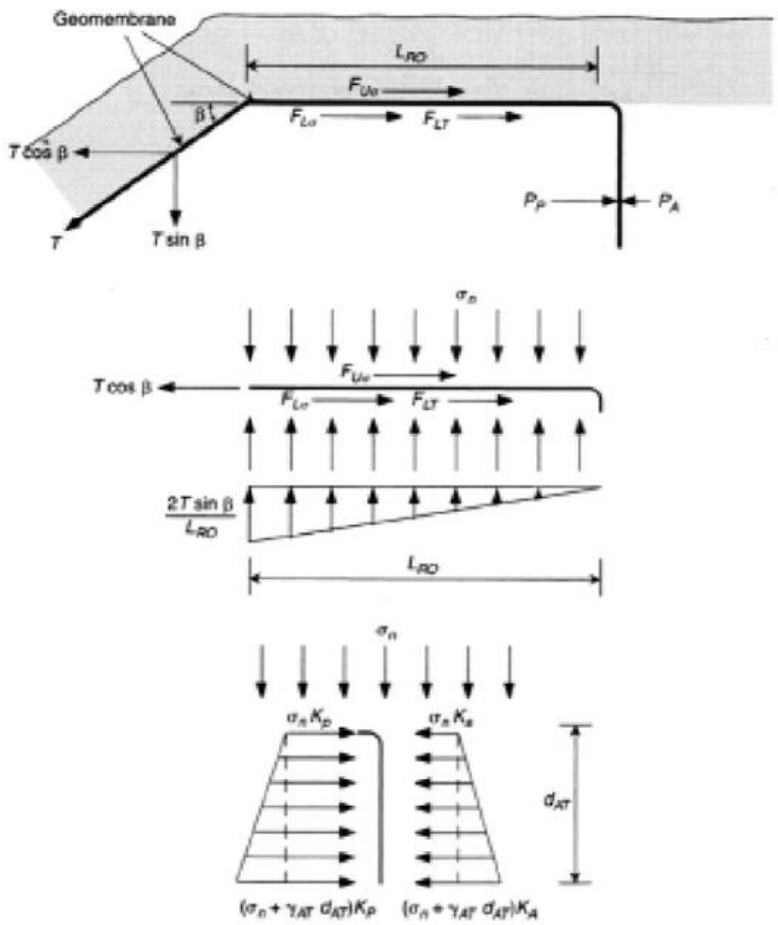


Figure 1: Force diagram for anchor trench [Ref. 2]

The forces involved are presented in the following equation:

$$T_{allow}cos(\beta) \geq F_{U\sigma} + F_{L\sigma} + F_{LT} - P_A + P_P$$ [Ref. 2]

As shown in Figure 1 and the equation above, the strength of the geomembrane is compared to forces accounting for the runout portion of the anchor trench and the turndown portion of the anchor trench.

3.2 Evaluate the strength of the geomembrane

The strength of the geomembrane (T_{allow}) is assumed to be the required yield strength of a 60-mil textured geomembrane [Ref. 3]. The allowable force in the geomembrane was calculated in the following table:

Table 3: Allowable Force in the Geomembrane			
Allowable Force in the Geomembrane {T_{allow}} (lb/in) [Ref. 3]	Allowable Force in the Geomembrane {T_{allow}} (lb/ft)	Side Slope Angle {β} (degrees) [assumed]	T_{allow} x cosβ
126	1,512	18.43	1,434

3.3 Evaluate the forces on the runout portion of the anchor trench

The forces acting on the runout portion of the anchor trench are the shear force above the geomembrane due to cover soil ($F_{U\sigma}$), shear force below the geomembrane due to cover soil ($F_{L\sigma}$), and shear force below the geomembrane due to vertical component of T_{allow} (F_{LT}). The equations for the forces on the runout portion of the anchor trench are presented as follows:

$$F_{U\sigma} = \sigma_N tan\delta_U (L_{RO})$$ [Ref. 2]

$$F_{L\sigma} = \sigma_N tan\delta_L (L_{RO})$$ [Ref. 2]

$$F_{LT} = 0.5\left(\frac{2T_{allow} sin\beta}{L_{RO}}\right)(L_{RO}) tan\delta_L = T_{allow} sin\beta\ tan\delta_L$$ [Ref. 2]

The depth of cover soil over the anchor trench is 2 feet and can be assumed to crack during failure; therefore, the friction angle above the geomembrane due to cover soil (δ_U) is negligible [Ref. 2]. The minimum required interface friction angle within the liner system was evaluated in the "Slope Stability Calculation". For the purposes of this calculation it was assumed that the friction angle below the geomembrane due to cover soil (δ_L) is equal to the minimum required interface friction angle evaluated in the "Slope Stability Calculation".

The applied normal stress from cover soil (σ_N) is a product of the cover soil depth (d_{cover}) and the unit weight of the soil (γ_{AT}) and was calculated in the following table:

Table 4: Applied Normal Stress from Cover Soil		
Cover Soil Depth {d_{cover}} (ft) [assumed]	Unit Weight of Soil {γ_{AT}} (pcf) [assumed]	Applied Normal Stress from Cover Soil {σ_N} (psf)
2	115	230

The interface friction angle below the geomembrane was selected in accordance with the interface friction requirements estimated in the "Slope Stability Calculation". The forces acting on the runout portion of the anchor trench were calculated as shown in the following table:

Table 5: Forces Acting on the Runout Portion of the Anchor Trench

Applied Normal Stress from Cover Soil {σ_N} (psf)	Interface Friction Angle Above Geomembrane {δ_U} (degrees) [assumed]	Interface Friction Angle Below Geomembrane {δ_L} (degrees)	Length of Anchor Trench Runout {L_{RO}} (feet) [assumed]	Allowable Force in the Geomembrane {T_{allow}} (lb/ft)	Side Slope Angle {β} (degrees) [assumed]	Shear Force Above Geomembrane Due to Cover Soil {$F_{U\sigma}$} (lb/ft)	Shear Force Below Geomembrane Due to Cover Soil {$F_{L\sigma}$} (lb/ft)	Shear Force Below Geomembrane Due to Vertical Component of T_{allow} {F_{LT}} (lb/ft)
230	0	16.5	2	1,512	18.43	0	136	142

3.4 Evaluate the forces on the turndown portion of the anchor trench

The forces acting on the turndown portion of the anchor trench are the active earth pressure against the backfill side of the anchor trench (P_A) and the passive earth pressure against the in-situ side of the anchor trench (P_P). The equations for the forces on the turndown portion of the anchor trench are presented as follows:

$$P_A = (0.5\gamma_{AT} d_{AT} + \sigma_n) K_A d_{AT}$$ [Ref. 2]

$$P_P = (0.5\gamma_{AT} d_{AT} + \sigma_n) K_P d_{AT}$$ [Ref. 2]

$$K_A = tan^2\left(45 - \frac{\varphi}{2}\right)$$ [Ref. 2]

$$K_P = tan^2\left(45 + \frac{\varphi}{2}\right)$$ [Ref. 2]

The forces acting on the turndown portion of the anchor trench P_A and P_P were calculated as shown in the following table:

Table 6: Forces Acting on the Turndown Portion of the Anchor Trench

Friction Angle of Soil {φ} (degrees) [assumed]	Coefficient of Active Earth Pressure {K_A}	Coefficient of Passive Earth Pressure {K_P}	Unit Weight of Soil {γ_{AT}} (pcf) [assumed]	Depth of Anchor Trench Turndown {d_{at}} (ft) [assumed]	Applied Normal Stress from Cover Soil {σ_N} (psf)	Active Earth Pressure {P_A} (lb/ft)	Passive Earth Pressure {P_P} (lb/ft)
28	0.36	2.77	115	1.5	230	171	1,314

3.5 Compare forces acting on the anchor trench to the material strength

The available resistive forces acting on the anchor trench should be less than the yield strength of the geomembrane. The forces acting on the anchor trench and the material strength were estimated in Steps 3.1 through 3.4 and compared in the following table:

Table 7: Compare Forces Acting on the Anchor Trench and the Material Strength							
Forces Acting on the Runout Portion of the Anchor Trench			Forces Acting on the Turndown Portion of the Anchor Trench		Summation of Forces Acting on the Anchor Trench (lb/ft)	T_{allow} x cosβ (lb/ft)	Check
Shear Force Above Geomembrane Due to Cover Soil $\{F_{U\sigma}\}$ (lb/ft)	Shear Force Below Geomembrane Due to Cover Soil $\{F_{L\sigma}\}$ (lb/ft)	Shear Force Below Geomembrane Due to Vertical Component of T_{allow} $\{F_{LT}\}$ (lb/ft)	Active Earth Pressure $\{P_A\}$ (lb/ft)	Passive Earth Pressure $\{P_P\}$ (lb/ft)			
0	136	142	171	1,314	1,421	1,434	stability satisfied

The summation of forces acting on the anchor trench is less than the allowable geomembrane strength; therefore, stability is satisfied.

DISCUSSION:

The anchor trench as designed satisfies stability requirements for the conditions analyzed. Assuming a protective cover soil friction angle of 28 degrees, the protective cover soil should not slough off of the side slopes.

Interface friction testing should be performed using site specific and project specific materials for the following interfaces:

- Compacted clay liner to geosynthetic clay liner (GCL);
- GCL to geomembrane;
- Geomembrane to geocomposite drainage layer; and
- Geocomposite drainage layer to protective cover material.

Geosynthetic materials may have different texturing on each side of the material, such as a GCL with nonwoven geotextile on one side and a woven geotextile on the opposite side. Should such a material be selected for inclusion in the liner system, all possible interfaces should be tested (i.e. GCL-nonwoven side to compacted clay liner, GCL-woven side to compacted clay liner, GCL-nonwoven side to geomembrane, and GCL-woven side to geomembrane).

Interface friction testing should be performed over the anticipated range of normal loads on the liner system. For the purposes of anchor trench stability, the anticipated range of normal loads is equal to the applied normal stress from cover soil, estimated to be 240 psf. Additional interface friction testing normal load requirements are described in the “Slope Stability Calculation”.

During interface friction testing, the normal load is plotted on the x-axis and the shear stress is plotted on the y-axis. The resulting shear strength relationship often has an adhesion component (y-intercept) and a friction angle component (slope of the line). The effective interface friction angle for a given normal load can be obtained by first drawing a vertical line at the desired normal load; then drawing a second line from the origin to the point where the first line intersects the interface friction curve. The effective interface friction angle for the given normal load is the slope angle of the second line. A minimum effective interface friction angle of

22.6 degrees is required between the protective cover soil and the geocomposite drainage layer.

The summation of forces acting on the anchor trench is less than the allowable geomembrane strength; therefore, stability is satisfied.

REFERENCES:

1. Murthy, V.N.S. "Geotechnical Engineering – Principles and Practices of Soil Mechanics and Foundation Engineering", 2003.
2. Koerner, Robert M. "Designing with Geosynthetics", 6th. Ed., 2012 (electronic version).
3. Geosynthetic Institute. "Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes", GRI Test Method GM13, December 14, 2012.

REFERENCE 1

Murthy, V.N.S. “Geotechnical Engineering – Principles and Practices of Soil Mechanics and Foundation Engineering”, 2003.

or $\tan\beta = \tan\phi'$ (10.5a)

Equation (10.5a) indicates that the maximum value of β is limited to ϕ' if the slope is to be stable. This condition holds true for cohesionless soils whether the slope is completely dry or completely submerged under water.

The factor of safety of infinite slopes in sand may be written as

$$F_s = \frac{\tan\phi'}{\tan\beta} \tag{10.5b}$$

10.5 STABILITY ANALYSIS OF INFINITE SLOPES IN CLAY

The vertical stress σ_v acting on plane AB (Fig. 10.3) where

$$\sigma_v = \gamma z \cos\beta$$

is represented by OC in Fig. 10.3 in the stress diagram. The normal stress on this plane is OE and the shearing stress is EC. The line OC makes an angle β with the σ-axis.

The Mohr strength envelope is represented by line FA whose equation is

$$s = c' + \sigma' \tan\phi'$$

According to the envelope, the shearing strength is ED where the normal stress is OE.

When β is greater than ϕ' the lines OC and FD meet. In this case the two lines meet at A. As long as the shearing stress on a plane is less than the shearing strength on the plane, there is no danger of failure. Figure 10.3 indicates that at all depths at which the direct stress is less than OB, there is no possibility of failure. However at a particular depth at which the direct stress is OB, the

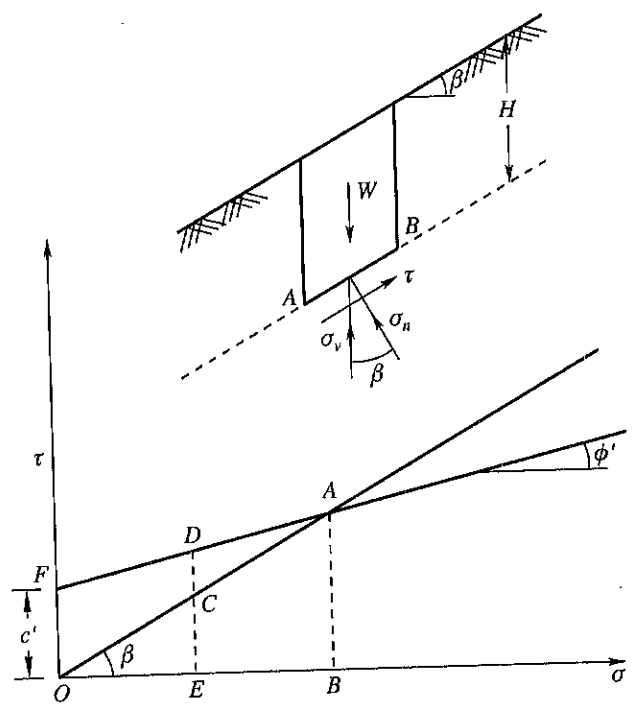


Figure 10.3 Stability analysis of infinite slopes in clay soils

REFERENCE 2

Koerner, Robert M. "Designing with Geosynthetics", 6th. Ed., 2012.

$$W_p = \frac{\gamma}{2\tan\omega}\left[\left(L - \frac{D}{\sin\beta} - h_c\tan\beta\right)(\sin\beta - \cos\beta\tan\omega) + \frac{h_c}{\cos\beta}\right]^2$$

$$= \frac{18}{2\tan 16}\left[\left(30 - \frac{0.30}{\sin 18.4} - 1.28\tan 18.4\right)(\sin 18.4 - \cos 18.4\tan 16) + \frac{0.15}{\cos 18.4}\right]^2$$

$$= 65.1\,\text{kN/m}$$

$$a = (W_A - N_A\cos\beta)\cos\left(\frac{\omega+\beta}{2}\right)$$

$$= (390 - 370\cos 18.4)\cos\left(\frac{16+18.4}{2}\right)$$

$$= 37.2\,\text{kN/m}$$

$$b = -\left[(W_A - N_A\cos\beta)\sin\left(\frac{\omega+\beta}{2}\right)\tan\phi + (N_A\tan\delta + C_a)\sin\beta\cos\left(\frac{\omega+\beta}{2}\right)\right.$$

$$\left. + \sin\left(\frac{\omega+\beta}{2}\right)(C + W_p\tan\phi)\right]$$

$$= -\left[(390 - 370\cos 18.4)\sin\left(\frac{16+18.4}{2}\right)\tan 30 + (370\tan 22 + 0)\sin 18.4\cos\left(\frac{16+18.4}{2}\right)\right.$$

$$\left. + \sin\left(\frac{16+18.4}{2}\right)(0 + 65.1\tan 30)\right]$$

$$= -62.8\,\text{kN/m}$$

$$c = (N_A\tan\delta + C_a)\sin\beta\sin\left(\frac{\omega+\beta}{2}\right)\tan\phi$$

$$= (370\tan 22 + 0)\sin 18.4\sin\left(\frac{16+18.4}{2}\right)\tan 30$$

$$= 8.07\,\text{kN/m}$$

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{62.8 + \sqrt{(-62.8)^2 - 4(37.2)(8.07)}}{2(37.2)}$$

$FS = 1.55$ (vs. 1.25 for the constant thickness cross section)

Example 5.12 has also been extended to a set of design curves, as seen in figure 5.19b. The anticipated trends are again noted, as is the agreement with the worked out example. Clearly, this type of stabilizing solution can be used if space at the toe of the slope is available. Often, it is not or it occupies valuable air space and then geogrid reinforcement as discussed in chapter 3 is the alternative solution.

5.3.6 Runout and Anchor Trench Design

For geomembrane-lined reservoirs, the liner coming up from the bottom of the facility covers the side slopes and then runs horizontally over the top a short distance. It often terminates vertically down into an anchor trench. This anchor trench is typically dug by a small backhoe or trenching machine; the liner is draped over the edge, and then the trench is backfilled with the same soil that was there originally. The backfilled soil should be properly compacted as the backfilling proceeds. Although concrete has been used in the past as an anchorage block, it is rarely justified, at least on the basis of calculations, as will be seen in this section.

Regarding design, two separate cases will be analyzed: one with geomembrane runout only and no anchor trench at all (as is often used with canal liners), and the other as described above, with both runout and anchor trench considerations (as with reservoirs and landfills). Figure 5.20 defines the first situation, together with the forces and stresses involved. Note that the cover soil applies normal stress due to its weight, but does not contribute frictional resistance above the geomembrane. This is due to the fact that the soil moves along with the geomembrane as it deforms and undoubtedly cracks, thereby losing its integrity.

From figure 5.20, the following horizontal force summation results, which leads to the appropriate design equation:

$$\Sigma F_x = 0$$

$$T_{allow}\cos\beta = F_{U\sigma} + F_{L\sigma} + F_{LT}$$

$$= \sigma_n\tan\delta_U(L_{RO}) + \sigma_n\tan\delta_L(L_{RO}) + 0.5\left(\frac{2T_{allow}\sin\beta}{L_{RO}}\right)(L_{RO})\tan\delta_L$$

$$L_{RO} = \frac{T_{allow}(\cos\beta - \sin\beta\tan\delta_L)}{\sigma_n(\tan\delta_U + \tan\delta_L)}$$

(5.26)

where

$Tallow$ = allowable force in geomembrane = $\sigma allow\ t$, where

$\sigma allow$ = allowable stress in geomembrane, and

t = thickness of geomembrane;

β = side slope angle;

FU_σ = shear force above geomembrane due to cover soil (note that for thin cover soils tensile cracking with occur and this value will be negligible);

FL_σ = shear force below geomembrane due to cover soil;

FLT = shear force below geomembrane due to vertical component of $Tallow$;

σn = applied normal stress from cover soil;

δ = angle of shearing resistance between geomembrane and adjacent material (i.e., soil or geotextile); and

LRO = length of geomembrane runout.

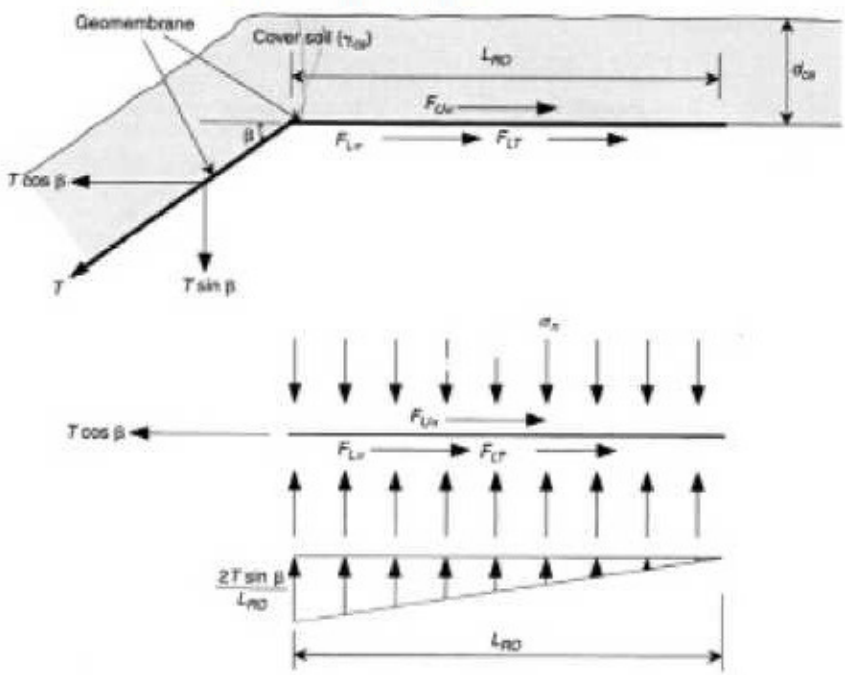


Figure 5.20 Cross section of geomembrane runout section and related stresses and forces involved.

Example 5.13 illustrates the use of the concept and equations just developed.

Example 5.13

Consider a 1.0 mm thick LLDPE geomembrane with a mobilized allowable stress of 5000 kPa, which is on a 3(H) to 1(V) side slope. Determine the required runout length to resist this stress without use of a vertical anchor trench. In this analysis use 300 mm of cover soil weighing 16.5 kN/m3 and a friction angle of 30° with the geomembrane.

Solution: From the design equations just presented,

$$T_{allow} = \sigma_{allow} t$$
$$= (5000)(0.001)$$
$$T_{allow} = 5.0\,kN/m$$

and

$$L_{RO} = \frac{T_{allow}(\cos\beta - \sin\beta\tan\delta_L)}{\sigma_n(\tan\delta_U + \tan\delta_L)}$$
$$= \frac{(5.0)[\cos 18.4 - (\sin 18.4)(\tan 30)]}{(16.5)(0.30)[\tan 0 + 30]}$$
$$= \frac{3.83}{2.86}$$
$$L_{RO} = 1.34m$$

Note that this value is strongly dependent on the value of allowable stress used in the analysis. To mobilize the full failure strength of the geomembrane (= 7600 kPa from table 5.5b) would require a 2.0 m runout length or embedment in an anchor trench. This, however, might not be desirable. *Pullout without geomembrane failure might be a preferable phenomenon, e.g., in seismic areas and this possibility should always be kept in mind.* It is a site-specific situation left up to the designer.

The situation with an anchor trench at the end of the runout section is illustrated in figure 5.21. The configuration requires some important assumptions regarding the state of stress within the anchor trench and its resistance mechanism. In order to provide lateral

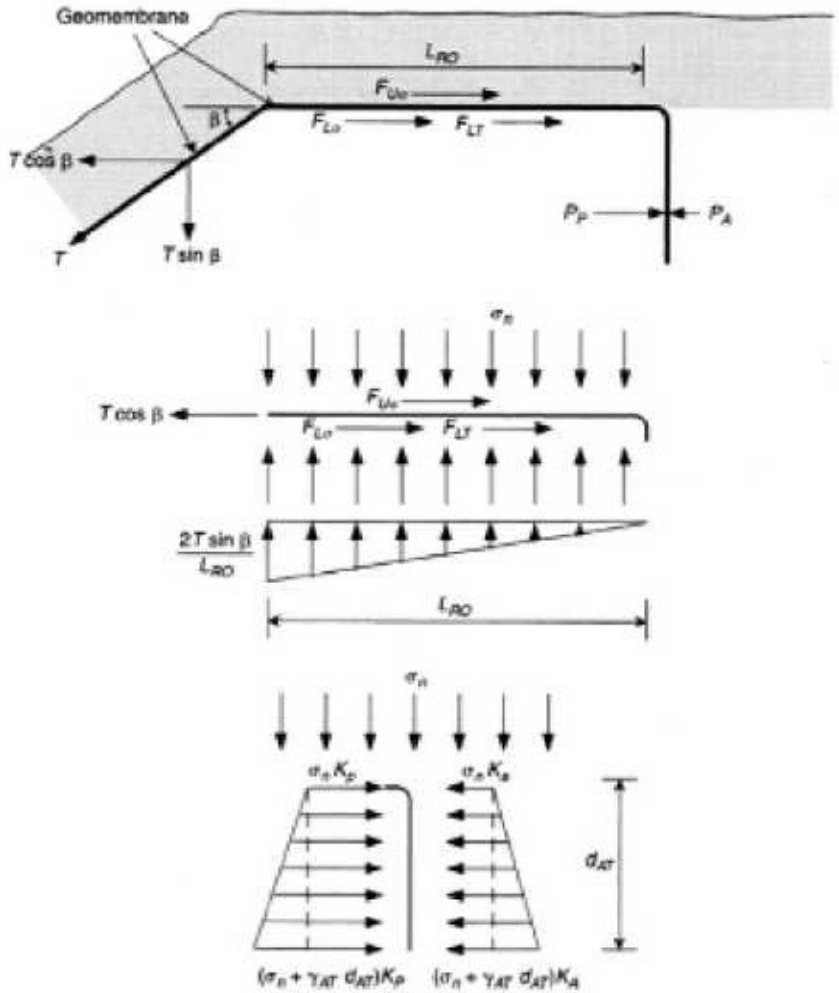


Figure 5.21 Cross section of geomembrane runout section with anchor trench and related stresses and forces involved.

resistance, the vertical portion within the anchor trench has lateral forces acting on it. More specifically, an active earth pressure (*PA*) is tending to destabilize the situation, whereas a passive earth pressure (*PP*) is tending to resist pullout. As will be shown, this passive earth pressure is very effective in providing a resisting force. Using the free-body diagram of figure 5.21,

$\sum F_x = 0$

$$T_{allow} \cos\beta = F_{U\sigma} + F_{L\sigma} + F_{LT} - P_A + P_{P(5.27)}$$

where

Tallow = allowable force in geomembrane = *σallowt*, where

σallow = allowable stress in geomembrane, and

t = thickness of geomembrane;

β = side slope angle;

FU_σ = shear force above geomembrane due to cover soil (note that for thin cover soils, tensile cracking will occur, and this value will be negligible);

FL_σ = shear force below geomembrane due to cover soil;

FLT = shear force below geomembrane due to vertical component of *Tallow*;

PA = active earth pressure against the backfill side of the anchor trench; and

PP = passive earth pressure against the in-situ side of the anchor trench.

The values of FU_σ, FL_σ, and *FLT* have been defined previously. The values of *PA* and *PP* require the use of lateral earth-pressure theory (see Holtz and Kovacs [50]);

$$P_A = \frac{1}{2}(\gamma_{AT} d_{AT})K_A d_{AT} + (\sigma_n)K_A d_{AT}$$

$$P_A = (0.5\gamma_{AT} d_{AT} + \sigma_n)K_A d_{AT} \quad (5.28)$$

$$P_P = (0.5\gamma_{AT} d_{AT} + \sigma_n)K_P d_{AT} \quad (5.29)$$

where

γAT = unit weight of soil in anchor trench,

dAT = depth of the anchor trench,

σn = applied normal stress from cover soil,

KA = coefficient of active earth pressure = $\tan^2(45 - \varphi/2)$,

KP = coefficient of passive earth pressure = $\tan^2(45 + \varphi/2)$, and

φ = angle of shearing resistance of respective soil.

This situation results in one equation with two unknowns; thus, a choice of either *LRO* or *dAT* is necessary to calculate the other. As with the previous situation, the factor of safety is placed on the geomembrane force *T*, which is used as an allowable value, *Tallow*. Example 5.14 illustrates the procedure.

Example 5.14

Consider a 1.5 mm thick HDPE geomembrane extending out of a facility as shown in figure 5.21. What depth anchor trench is needed if the runout distance is limited to 1.0 m? In the solution, use a geomembrane allowable stress of 16,000 kPa on a 3(H) to 1(V) side slope. Cover soil at 16.5 kN/m3 and 300 mm thick is placed over the geomembrane runout and anchor trench (this is also the unit weight of the anchor trench soil). The friction angle of the geomembrane to the soil is 30° (although assume 0° for the top of the geomembrane under a soil cracking assumption) and the soil itself is 35°. Also, develop a design chart for this example assuming that the runout length is not limited to 1.0 m.

Solution: Using the previously developed design equations based on figure 5.21,

$$\begin{aligned} T_{allow} &= \sigma_{allow} t \\ &= 16000(0.0015) \\ &= 24.0 \text{ kN/m} \end{aligned}$$

and

$$\begin{aligned} F_{U\sigma} &= \sigma_n \tan\delta_U (L_{RO}) \\ &= (0.3)(16.5)\tan 0 (L_{RO}) \\ &= 0 \\ F_{L\sigma} &= \sigma_n \tan\delta_L (L_{RO}) \\ &= (0.3)(16.5)\tan 30 (L_{RO}) \\ &= 2.86\, L_{RO} \\ F_{LT} &= T_{allow} \sin\beta \tan\delta_L \\ &= (24.0)\sin 18.4 \tan 30 \\ &= 4.37 \text{ kN/m} \end{aligned}$$

$$\begin{aligned} P_A &= (0.5\gamma_{AT} d_{AT} + \sigma_n) K_A d_{AT} \\ &= [(0.5)(16.5)d_{AT} + (0.3)(16.5)]\tan^2(45 - 35/2) d_{AT} \\ &= [8.25 d_{AT} + 4.95](0.271) d_{AT} \\ &= 2.24 d_{AT}^2 + 1.34 d_{AT} \\ P_P &= (0.5\gamma_{AT} d_{AT} + \sigma_n) K_P d_{AT} \\ &= [(0.5)(16.5)d_{AT} + (0.3)(16.5)]\tan^2(45 + 35/2) d_{AT} \\ &= [8.25 d_{AT} + 4.95](3.69) d_{AT} \\ &= 30.4 d_{AT}^2 + 18.3 d_{AT} \end{aligned}$$

This is substituted into the general force (equation 5.27) to arrive at the solution in terms of the two variables *LRO* and *dAT*:

$$T_{allow} \cos\beta = F_{U\sigma} + F_{L\sigma} + F_{LT} - P_A + P_P$$

$$(24.0)\cos 18.4 = 0 + 2.86 L_{RO} + 4.37 - 2.24 d_{AT}^2 - 1.34 d_{AT} + 30.4 d_{AT}^2 + 18.3 d_{AT}$$

$$18.4 = 2.86 L_{RO} + 17.0 d_{AT} + 28.2 d_{AT}^2$$

Since *LRO* = 1.0 m, the equation can be solved for the unknown *dAT*.

dAT = 0.50m

Using this formulation we develop the following *design chart* for a wide range of geomembrane strengths and thicknesses as characterized by different values of *Tallow*. For the specific conditions of this particular example, we obtain

β = 18.4°, i.e., 3(*H*) – to –1(*V*)

σn = *dcs* γcs

= (0.30)(16.5)

= 4.95kN/m2

δU = 0°

δL = 30°

φ = 35°

γAT = 16.5kN/m3

REFERENCE 3

Geosynthetic Institute. “Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes”, GRI Test Method GM13, December 14, 2012.

ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	D 7466	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	63 lb/in. 45 lb/in. 12% 100%	84 lb/in. 60 lb/in. 12% 100%	105 lb/in. 75 lb/in. 12% 100%	126 lb/in. 90 lb/in. 12% 100%	168 lb/in. 120 lb/in. 12% 100%	210 lb/in. 150 lb/in. 12% 100%	252 lb/in. 180 lb/in. 12% 100%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb	45,000 lb
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM10
Carbon Black Content (range)	D 4218 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	20,000 lb
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(7), (8)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	D 7238 D 3895 D 5885	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	per each formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils; also see Note 6.
(2) Alternate the measurement side for double sided textured sheet
(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches
(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
(5) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.
(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3
(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

APPENDIX III-5

Liner System Settlement Calculation

Calculation Title:
Liner System Settlement Calculation

Summary:
This calculation provides an analysis of the settlement due to the proposed ash landfill at Dan River Steam Station. The settlement calculations were based on consolidation theory.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal			
		Tryambak Kaushik	**C. Lee Eaves**	**Cedric H. Ruhl**

OBJECTIVE:

The objective of this calculation is to estimate the settlement of the proposed liner system of the proposed ash landfill.

METHOD:

The liner system settlement was calculated using a three step method. Step 1 was to estimate the elevations of the surface layers for the different subsurface soil strata based on geotechnical boring information. Step 2 was to estimate the existing pressure exerted on the subgrade soils by the materials composing Ash Fill 1, then to estimate the expected increase in pressure due to the proposed landfill. Step 3 was to evaluate the total settlement based on consolidation theory. After the settlement was evaluated, the post-settlement slopes of the subgrade due to settlement were calculated. Long-term creep settlement of the liner system was assumed to be minimal.

DEFINITION OF VARIABLES:

C_r = coefficient of soil recompression;
C_c = coefficient of soil compression;
DEM = digital elevation model;
e_0 = initial void ratio;
E_{bed} = elevation of the top of bedrock (ft);
E_{boa} = elevation of the bottom of ash in Ash Fill 1 (ft);
E_{eg} = elevation of existing grade (ft);
E_{fc} = elevation of the top of final cover (ft);
E_{sg} = elevation of subgrade surface (ft);
H = thickness of subgrade layer;
I = the point where settlement is calculated;
p_0 = initial pressure (lb/ft^2);
p_c = pre-consolidation pressure (lb/ft^2);
S_i = subgrade soil settlement at ith location (ft);
γ_{moist_95} = moist unit weight of soil compacted at 95% maximum dry density and 5% wet of optimum moisture content of standard proctor (lb/ft^3);
γ_{sg} = average subgrade material unit weight (lb/ft^3);
γ_{waste} = average waste material unit weight (lb/ft^3);
Δp_0 = overburden pressure increase (lb/ft^2)

CALCULATIONS:

1. Estimate surface layers for subgrade and bedrock

The geotechnical boring exploration that was performed at Dan River Steam Station was used to estimate extents of subsurface layers [Ref. 1]. AutoCAD was used to generate digital elevation models (DEMs) for the elevations of the final cover, subgrade, bedrock, and existing bottom of ash grades, and existing grades. The subgrade elevation grades are presented in Figure 1.

2. Estimate Vertical Pressure

The settlement of the subgrade below the proposed landfill was evaluated within the limits of waste (LOW). The initial pressure (p_0) exerted on the subgrade layer was assumed to be from the self-weight and was evaluated by the equation:

$$p_0 = \gamma_{sg} * (E_{sg} - E_{bed})$$

The variables E_{sg} and E_{bed} correspond to the elevations of the design subgrade and bedrock. However, some parts of the subgrade are subjected to a pre-consolidation pressure (p_c) due to the load exerted by the existing Ash Fill 1. The areas that were subjected to this pre-consolidation pressure are expected to experience less settlement than the areas that were not subjected to this pressure. The pre-consolidation pressure at these subgrade locations was evaluated as:

$$p_c = \gamma_{waste} * (E_{eg} - E_{boa})$$

The variables E_{eg} and E_{boa} correspond to the elevations of the existing grade and bottom of ash and were assumed to represent the vertical bounds of Ash Fill 1. The expected increase in overburden pressure (Δp) on the subgrade due to the estimated waste to be contained by the proposed landfill was estimated by the following equation:

$$\Delta p = \gamma_{waste} * (E_{fc} - E_{sg})$$

The variable E_{fc} corresponds to the elevations of the proposed final cover of the landfill. The unit weight of waste was defined by γ_{waste}. The stress distribution within the subgrade layer was ignored. Bedrock was assumed to be incompressible and the settlement of this material was neglected from this calculation.

Table 1 below shows the unit weights of the materials used in the settlement calculation.

TABLE 1: UNIT WEIGHT OF SOIL LAYERS

Material	Moist Unit Weight {γ_{moist}} (pcf)	Moist Unit Weight @ 95% {γ_{moist_95}} (pcf)
Ash (existing Ash Fill 1 and proposed landfilled ash)	-NA-	101.1
Subgrade	122.7	-NA-

The ash fill was assumed to be compacted to 95% of the standard proctor value, while the subgrade material was assumed to be at in-situ moist unit weight. The unit weights assumed for the current settlement analysis are further discussed in the “Slope Stability Calculation” package.

3. Estimate Subgrade Soil Settlement

The settlement of the subgrade layer was estimated using one-dimensional consolidation theory. According to this theory, the settlement at the i_{th} location (S_i) is dependent on the thickness of subgrade (H) and the initial void ratio (e_0) at that location. The thickness of the subgrade layer varied across the limits of waste (LOW) of the proposed new landfill and was calculated as the difference in the elevation of the top of bedrock to top of the subgrade layer in ArcGIS. Similarly, the initial void ratio was also expected vary across LOW with a relatively lower initial void ratio below the existing the ash fill relative to the areas that did not experience the same pre-consolidation pressure. However, due to the limited soil exploration and laboratory test data available, the initial void ratio was assumed to be a uniform value of 0.851 across all locations within LOW as presented in Table 2.

The consolidation settlement was assumed to depend on pre-consolidation pressure (p_c) and change in overburden pressure (Δp). The governing equations are presented as:

$$S_i = \frac{C_r \times H}{1+e_0} \log\left(\frac{p_0+\Delta p}{p_o}\right) \qquad \text{if } p_0+\Delta p < p_c \qquad \text{[Ref. 2]}$$

$$S_i = \frac{C_r \times H}{1+e_0} \log\left(\frac{p_c}{p_o}\right) + \frac{C_c \times H}{1+e_0} \log\left(\frac{p_0+\Delta p - p_c}{p_o}\right) \qquad \text{if } p_c < p_0+\Delta p \qquad \text{[Ref. 2]}$$

The coefficient of recompression (C_r) and coefficient of compression (C_c) were evaluated using the laboratory data from the one-dimensional consolidation performed on undisturbed soil samples [Ref. 1] obtained during the geotechnical exploration. Table 2 presents the summary of consolidation parameters for the subgrade material.

TABLE 2: CONSOLIDATION MATERIAL PROPERTIES OF SUBGRADE MATERIAL

Sample No.	Sample [Ref. 2]	In-situ void ratio {e_0} (-) [Ref. 1]	Coefficient of re-compression {C_r} (-) [Ref. 1]	Coefficient of compression {C_c} (-) [Ref. 1]
1	OW407	0.712	0.053	0.010
2	OW417	0.991	0.081	0.016
	Average =	0.851	0.067	0.013

RESULTS:

Figure 1 presents the pre-settlement grades. The maximum predicted subgrade settlement was 0.64 ft, and the minimum predicted subgrade settlement was 0.02 ft (Figure 2). Hand calculations performed at discrete points indicate that the GIS model accurately estimated settlement.

The predicted settlement was used to evaluate post-settlement elevation of the subgrade layer (Figure 3) and generate post-settlement subgrade slopes (Figure 4). The predicted minimum post-settlement subgrade slope is generally greater than 2%, which is the minimum slope allowable per the North Carolina .1600 rules. Discrete locations indicated post-settlement slopes less than 2% which is a product of edge effects and raster size interpolation. The current analyses

were based one-dimensional consolidation theory and did not account for three-dimensional effects.

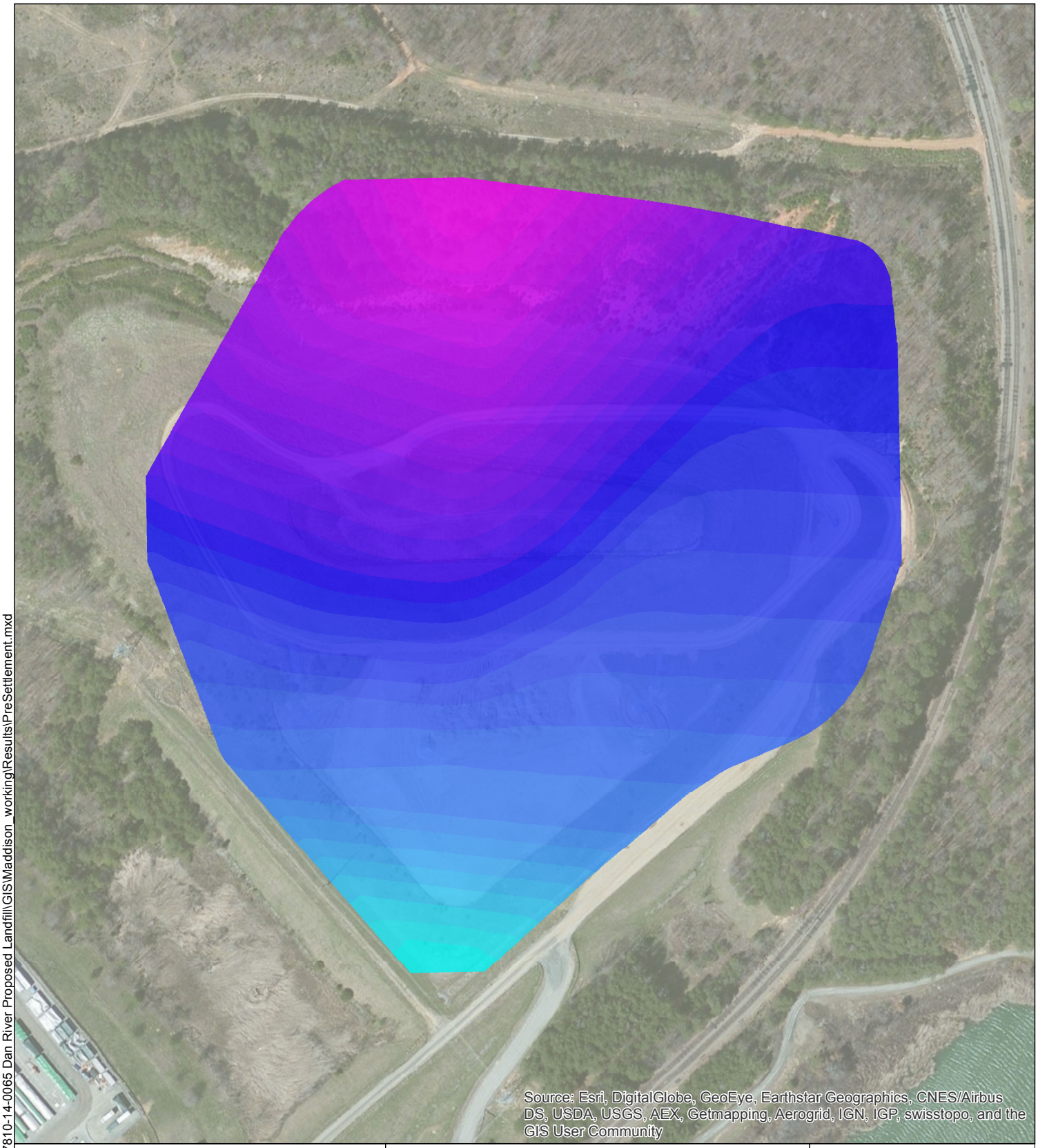
FIGURES:

1. Dan River Steam Station Landfill pre-settlement subgrade elevation
2. Dan River Steam Station Landfill subgrade settlement
3. Dan River Steam Station Landfill post-settlement subgrade elevation
4. Dan River Steam Station Landfill post-settlement subgrade slopes

REFERENCES:

1. "Hydrogeologic Study – Dan River Landfill", Amec Foster Wheeler, July 15, 2015.
2. Holtz, Robert D., and William D. Kovacs. "An introduction to geotechnical engineering", 1981.

FIGURES



DUKE ENERGY®

Elevation (ft)

High : 604

Low : 543

Dan River Steam Station Landfill Subgrade

Pre-Settlement

0 100 200 Feet

N

amec foster wheeler

PREPARED BY:	MS
DATE:	8/17/2015
CHECKED BY:	TK
DATE:	8/17/2015
PROJECT NO:	7810-14-0065
FIGURE NO:	1

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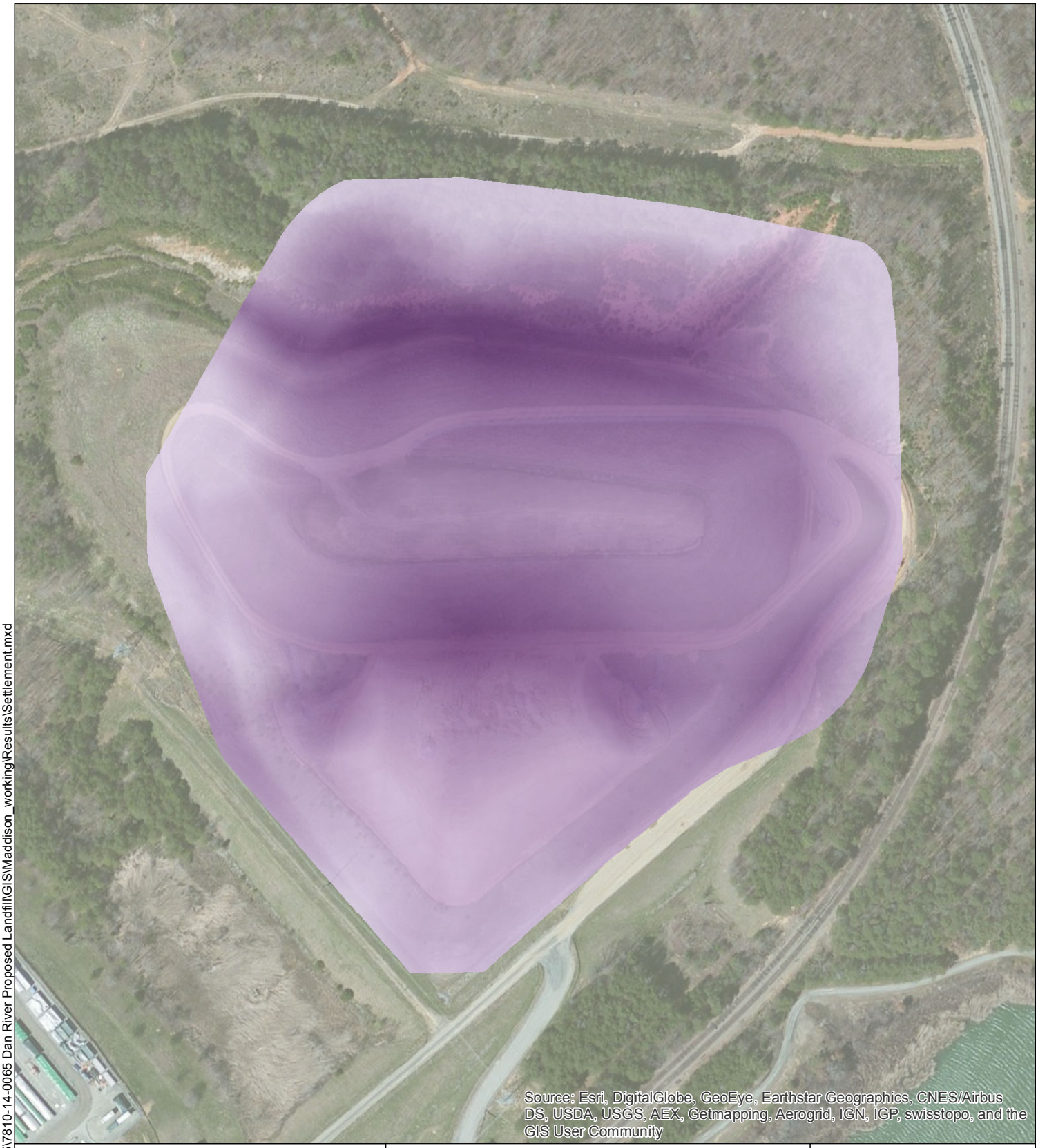

DUKE ENERGY

Settlement (ft)

High : 0.64

Low : 0.02

Dan River Steam Station Landfill Subgrade

Settlement

0 100 200 Feet

N

amec foster wheeler

PREPARED BY:	MS
DATE:	8/17/2015
CHECKED BY:	TK
DATE:	8/17/2015
PROJECT NO:	7810-14-0065
FIGURE NO:	2

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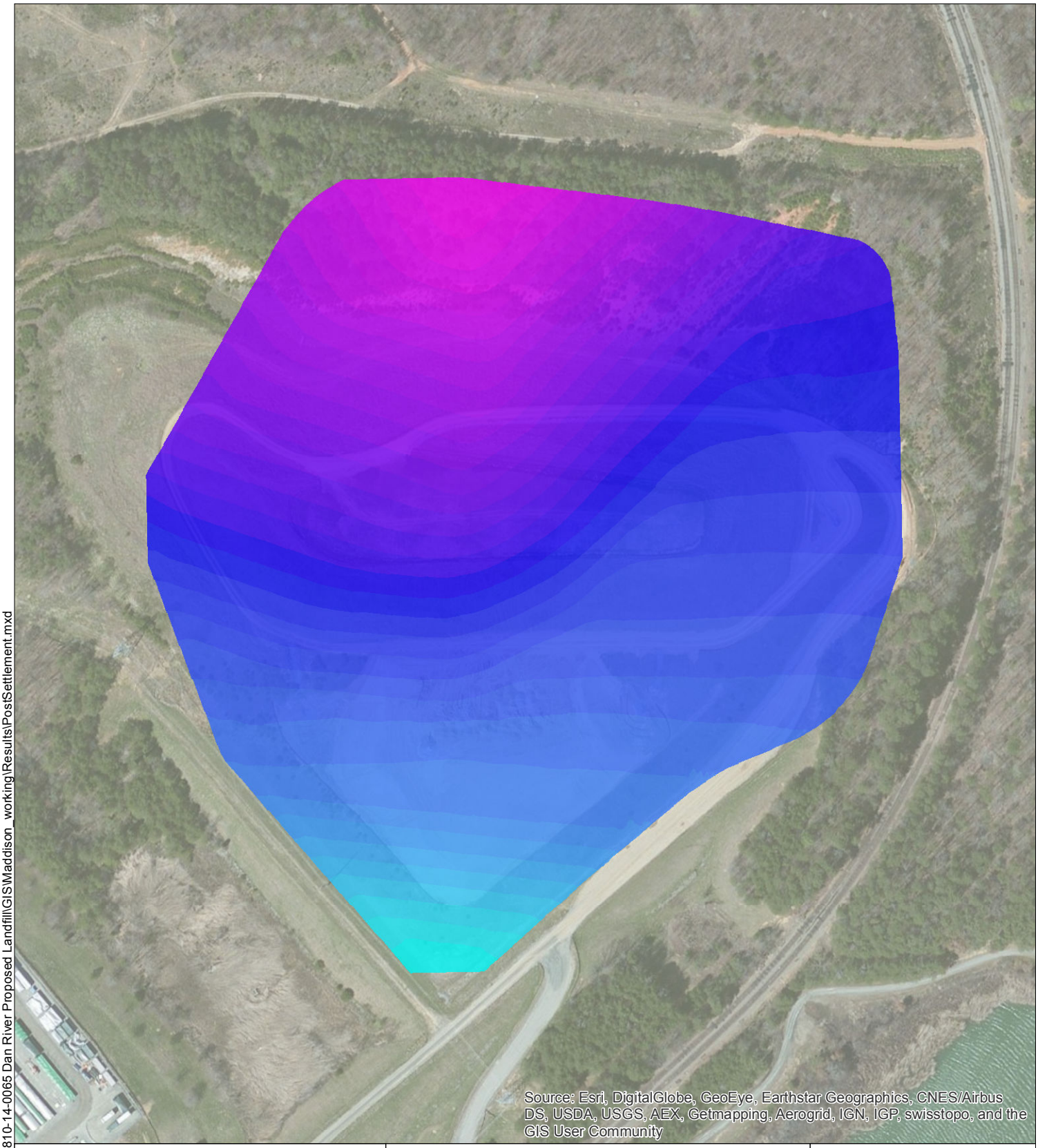

DUKE ENERGY

Elevation (ft)

High : 604

Low : 543

Dan River Steam Station Landfill Subgrade

Post-Settlement

0 100 200 Feet

N

amec foster wheeler

PREPARED BY:	MS
DATE:	8/17/2015
CHECKED BY:	TK
DATE:	8/17/2015
PROJECT NO:	7810-14-0065
FIGURE NO:	3

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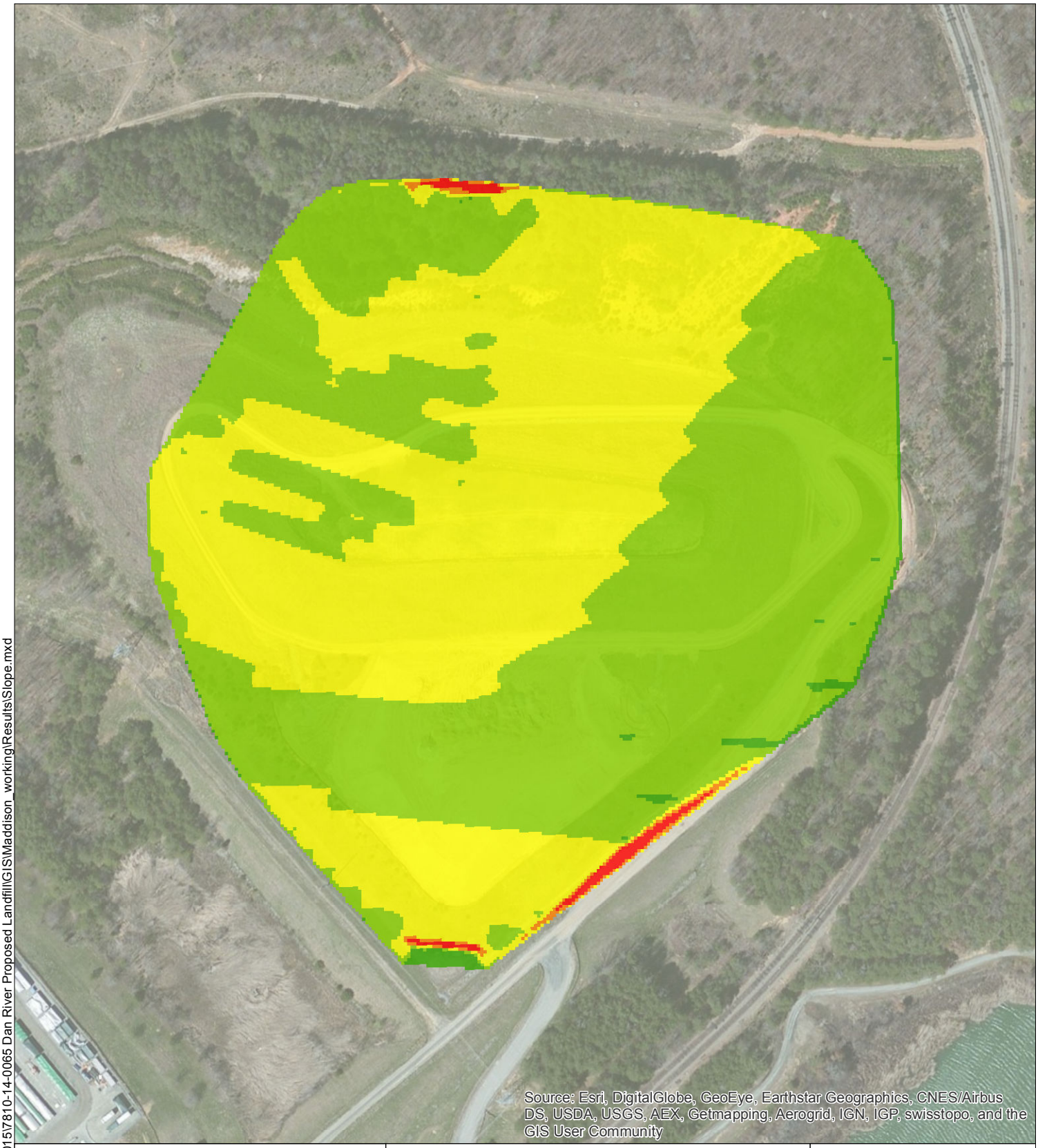


DUKE ENERGY

Slope

- <2%
- 2% - 5%
- 5% - 10%
- 10% - 15%
- 15% - 30%

Dan River Steam Station Landfill Subgrade

Slope

0 100 200 Feet

N

amec foster wheeler

PREPARED BY:	MS
DATE:	8/17/2015
CHECKED BY:	TK
DATE:	8/17/2015
PROJECT NO:	7810-14-0065
FIGURE NO:	4

Document Path: F:\AMEC_Projects\2015\7810-14-0065 Dan River Proposed Landfill\GIS\Maddison_working\Results\Slope.mxd

REFERENCE 1

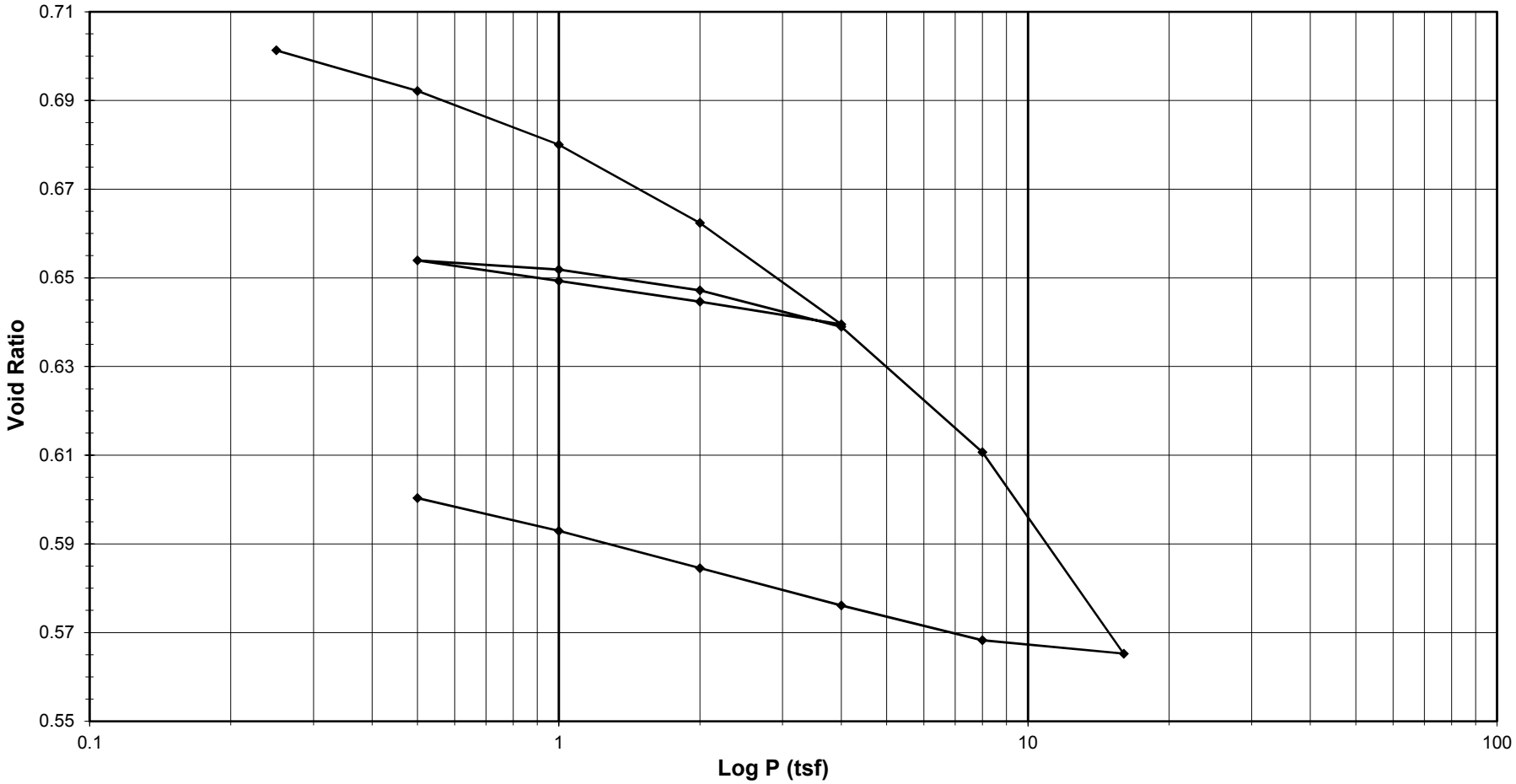
“Hydrogeologic Study – Dan River Landfill”, Amec Foster Wheeler, July 15, 2015.

ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-11

Client	Amec Foster Wheeler	Boring No.	OW-407D
Client Reference	Dan River Steam Station Ash Removal	Depth (ft)	45.3-45.5
Project No.	2015-616-02	Sample No.	UD
Lab ID	2015-616-02-02	Visual Description	YELLOW BROWN & GRAY SANDY LEAN CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Tested By SFS *Date* 4/30/2015 *Approved By* MPS *Date* 6/4

DCN: CT-24E Date: 5/3/12 Revision: 6

R:\2015 PROJECTS\2015-616 AMEC - DAN RIVER\[2015-616-02-02 GEOJAC-16TSF TEMPLATE1.xlsm]STEP 1

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ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-11

Client	Amec Foster Wheeler	Boring No.	OW-407D
Client Reference	Dan River Steam Station Ash Removal	Depth (ft)	45.3-45.5
Project No.	2015-616-02	Sample No.	UD
Lab ID	2015-616-02-02	Visual Description	YELLOW BROWN & GRAY SANDY LEAN CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED
Consolidometer No. R-409
1 Division = 0.0001 (in.)

Sample Properties	**Initial**	**Final**
Water Content		
Tare Number	812	805
Wt. Tare & WS (g)	335.16	257.86
Wt. Tare & DS (g)	289.50	226.84
Wt. Water (g)	45.66	31.02
Wt. Tare (g)	106.00	102.90
Wt. DS (g)	183.50	123.94
Water Content (%)	24.88	25.03
Sample Parameters		
Sample Diameter (in)	2.5	2.5
Sample Height (in)	1.0000	0.9348
Sample Volume (cc)	80.44	75.19
Wt. Wet Sample + Ring (g)	370.27	370.45
Wt. of Ring (g)	214.77	214.77
Wt. of Wet Sample (g)	155.50	155.68
Wet Density (pcf)	120.63	129.19
Wet Density (g/cc)	1.93	2.07
Water Content (%)	24.88	25.03
Wt. of Dry Sample (g)	124.52	124.52
Dry Density (pcf)	96.59	103.33
Dry Density (g/cc)	1.55	1.66
Void Ratio	0.7119	0.6003
Saturation (%)	92.62	110.48
Specific Gravity	2.65	*Measured*

Test Data Summary

Applied Pressure (tsf)	**Final Dial Reading** (div)	**Machine Deflection** (div)	**Corrected Reading** (div)	**Height of Sample** (mm)	**Volume (cc)**	**Dry Density** (g/cc)	**Void Ratio**
Seating	0	0	0	25.400	80.440	1.54795	**0.71194**
0.25	74.1	11.9	62.2	25.242	79.940	1.55763	**0.70130**
0.5	137.2	21.3	115.9	25.106	79.508	1.56610	**0.69210**
1	223.5	37.0	186.5	24.926	78.940	1.57736	**0.68002**
2	344.6	55.1	289.5	24.665	78.111	1.59410	**0.66238**
4	500.2	77.2	423.0	24.326	77.037	1.61632	**0.63952**
2	456.5	63.3	393.2	24.401	77.277	1.61131	**0.64463**
1	416.0	50.2	365.8	24.471	77.497	1.60673	**0.64931**
0.5	376.8	37.9	338.9	24.539	77.714	1.60225	**0.65393**
1	395.8	44.8	351.0	24.508	77.616	1.60426	**0.65185**
2	437.0	58.5	378.5	24.439	77.395	1.60884	**0.64715**
4	504.8	78.6	426.2	24.317	77.011	1.61686	**0.63898**
8	705.0	113.5	591.5	23.897	75.681	1.64527	**0.61068**
16	1026.1	169.2	856.9	23.224	73.547	1.69302	**0.56525**
8	966.5	127.2	839.3	23.268	73.688	1.68977	**0.56826**
4	895.3	101.9	793.4	23.385	74.057	1.68135	**0.57611**
2	825.4	80.9	744.4	23.509	74.452	1.67245	**0.58450**
1	759.8	64.6	695.2	23.634	74.848	1.66360	**0.59293**
0.5	704.3	52.2	652.1	23.744	75.194	1.65593	**0.60031**

Tested By *SFS* *Date* *4/30/2015* *Input Checked By* *GEM* *Date* 6/4/15 *R:*

DCN: CT-24E Date: 5/3/12 Revision: 6

\2015 PROJECTS\2015-616 AMEC - DAN RIVER\[2015-616-02-02 GEOJAC-16TSF TEMPLATE1.xlsm]STEP 1

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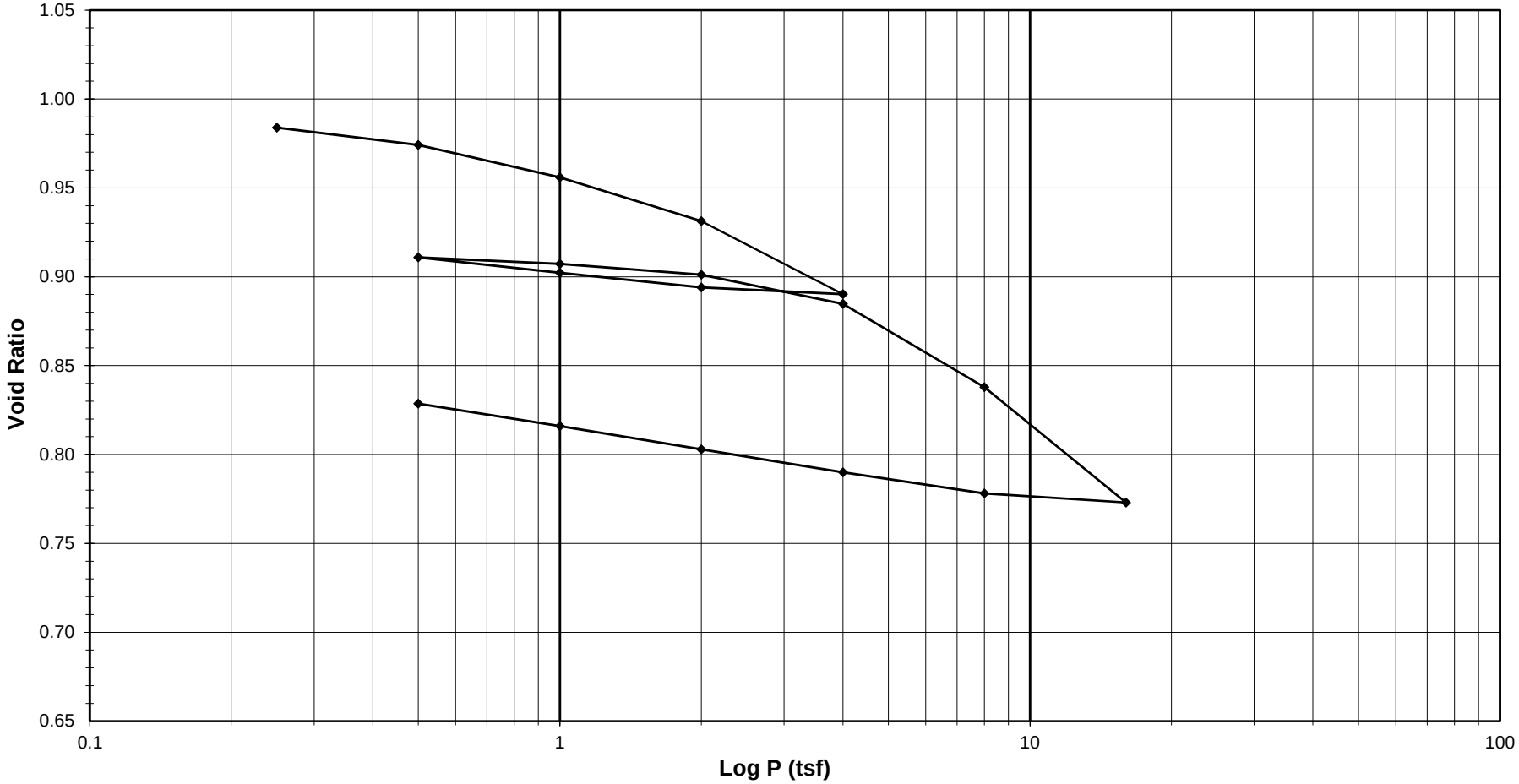
ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-11

Client	Amec Foster Wheeler	Boring No.	OW-417D
Client Reference	Dan River Steam Station Ash Removal	Depth (ft)	3.8-4.0
Project No.	2015-616-02	Sample No.	UD
Lab ID	2015-616-02-03	Visual Description	LIGHT BROWN ELASTIC SILT WITH SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Tested By SFS *Date* 5/7/15 *Approved By* MPS *Date* 6/415

DCN: CT-24E Date: 5/3/12 Revision: 6

Z:\2015 PROJECTS\2015-616 AMEC - DAN RIVER\[2015-616-02-03 GEOJAC-16TSF TEMPLATE1.xlsm]FINAL PLOT

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ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-11

Client	Amec Foster Wheeler	Boring No.	OW-417D
Client Reference	Dan River Steam Station Ash Removal	Depth (ft)	3.8-4.0
Project No.	2015-616-02	Sample No.	UD
Lab ID	2015-616-02-03	Visual Description	LIGHT BROWN ELASTIC SILT WITH SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED
Consolidometer No. R-409
1 Division = 0.0001 (in.)

Sample Properties	**Initial**	**Final**
Water Content		
Tare Number	810	809
Wt. Tare & WS (g)	374.94	257.11
Wt. Tare & DS (g)	320.11	224.67
Wt. Water (g)	54.83	32.44
Wt. Tare (g)	112.89	108.83
Wt. DS (g)	207.22	115.84
Water Content (%)	26.46	28.00
Sample Parameters		
Sample Diameter (in)	2.5	2.5
Sample Height (in)	1.0000	0.9186
Sample Volume (cc)	80.44	73.89
Wt. Wet Sample + Ring (g)	361.94	363.74
Wt. of Ring (g)	214.77	214.77
Wt. of Wet Sample (g)	147.17	148.97
Wet Density (pcf)	114.16	125.80
Wet Density (g/cc)	1.83	2.02
Water Content (%)	26.46	28.00
Wt. of Dry Sample (g)	116.38	116.38
Dry Density (pcf)	90.28	98.28
Dry Density (g/cc)	1.45	1.57
Void Ratio	0.9907	0.8286
Saturation (%)	76.92	97.33
Specific Gravity	2.88	*Measured*

Test Data Summary

Applied Pressure (tsf)	**Final Dial Reading** (div)	**Machine Deflection** (div)	**Corrected Reading** (div)	**Height of Sample** (mm)	**Volume (cc)**	**Dry Density** (g/cc)	**Void Ratio**
Seating	0	0	0	25.400	80.440	1.44676	**0.99066**
0.25	45.9	11.9	34.0	25.314	80.166	1.45170	**0.98389**
0.5	104.2	21.3	82.9	25.189	79.773	1.45886	**0.97415**
1	211.3	37.0	174.3	24.957	79.037	1.47243	**0.95595**
2	353.7	55.1	298.6	24.642	78.038	1.49129	**0.93121**
4	582.1	77.2	504.9	24.118	76.378	1.52369	**0.89015**
2	548.6	63.3	485.3	24.167	76.536	1.52055	**0.89405**
1	494.5	50.2	444.3	24.271	76.866	1.51403	**0.90221**
0.5	438.5	37.9	400.6	24.383	77.218	1.50713	**0.91092**
1	464.2	44.8	419.4	24.335	77.066	1.51009	**0.90717**
2	508.4	58.5	449.9	24.257	76.821	1.51491	**0.90110**
4	611.0	78.6	532.4	24.048	76.157	1.52811	**0.88468**
8	881.0	113.5	767.5	23.450	74.266	1.56704	**0.83787**
16	1262.7	169.2	1093.4	22.623	71.644	1.62437	**0.77299**
8	1194.5	127.2	1067.4	22.689	71.854	1.61963	**0.77818**
4	1110.3	101.9	1008.4	22.839	72.328	1.60901	**0.78992**
2	1024.2	80.9	943.2	23.004	72.852	1.59743	**0.80289**
1	942.2	64.6	877.6	23.171	73.380	1.58594	**0.81596**
0.5	866.1	52.2	813.9	23.333	73.893	1.57494	**0.82864**

Tested By SFS *Date* 5/7/15 *Input Checked By* GEM *Date* 6/4/15

DCN: CT-24E Date: 5/3/12 Revision: 6

Z:\2015 PROJECTS\2015-616 AMEC - DAN RIVER\[2015-616-02-03 GEOJAC-16TSF TEMPLATE1.xlsm]FINAL PLOT

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REFERENCE 2

Holtz, Robert D., and William D. Kovacs. “An introduction to geotechnical engineering”, 1981.

Required:

Calculate (a) the recompression index C_r and (b) the modified recompression index $C_{r\epsilon}$.

Solution:

a. The recompression index C_r is found in a similar manner to the C_c (Eq. 8-7). Using the points e and f over 1 log cycle, we find that

$$C_r = e_e - e_f = 0.790 - 0.760 = 0.030$$

b. The modified recompression index $C_{r\epsilon}$ is found from Eq. 8-15.

$$C_{r\epsilon} = \frac{C_r}{1 + e_o} = \frac{0.030}{1 + 0.865} = 0.016$$

Note that neither of these terms has units.

To calculate settlements of overconsolidated clays, Eqs. 8-11 and 8-13 become

$$s_c = C_r \frac{H_o}{1 + e_o} \log \frac{\sigma'_{vo} + \Delta\sigma_v}{\sigma'_{vo}} \tag{8-16}$$

$$s_c = C_{r\epsilon} H_o \log \frac{\sigma'_{vo} + \Delta\sigma_v}{\sigma'_{vo}} \tag{8-17}$$

when $\sigma'_{vo} + \Delta\sigma_v \le \sigma'_p$. Since C_r is usually much less than C_c, the settlements occurring when $\sigma'_{vo} + \Delta\sigma_v \le \sigma'_p$ are much less than if the soil were normally consolidated.

If the added stress caused by the structure exceeds the preconsolidation stress, then much larger settlements would be expected. This is because the compressibility of the soil is much greater on the virgin compression curve than on the recompression curve as was shown, for example, in Fig. 8.7. For the case, then, where $\sigma'_{vo} + \Delta\sigma_v > \sigma'_p$ the settlement equation consists of two parts: (1) the change in void ratio or strain on the recompression curve from the original in situ conditions of (e_o, σ'_{vo}) or $(\epsilon_{vo}, \sigma'_{vo})$ to σ'_p; and (2) the change in void ratio or strain on the virgin compression curve from σ'_p to the final conditions of (e_f, σ'_{vf}) or $(\epsilon_{vf}, \sigma'_{vf})$. Note that $\sigma'_{vf} = \sigma'_{vo} + \Delta\sigma_v$. These two parts are shown graphically in Fig. 8.10b. The complete settlement equation then becomes

$$s_c = C_r \frac{H_o}{1 + e_o} \log \frac{\sigma'_{vo} + (\sigma'_p - \sigma'_{vo})}{\sigma'_{vo}} + C_c \frac{H_o}{1 + e_o} \log \frac{\sigma'_p + (\sigma'_{vo} + \Delta\sigma_v - \sigma'_p)}{\sigma'_p} \tag{8-18a}$$

This equation reduces to

$$s_c = C_r \frac{H_o}{1 + e_o} \log \frac{\sigma'_p}{\sigma'_{vo}} + C_c \frac{H_o}{1 + e_o} \log \frac{\sigma'_{vo} + \Delta\sigma_v}{\sigma'_p} \tag{8-18b}$$

In terms of the modified indices, we have

$$s_c = C_{r\epsilon} H_o \log \frac{\sigma'_p}{\sigma'_{vo}} + C_{c\epsilon} H_o \log \frac{\sigma'_{vo} + \Delta\sigma_v}{\sigma'_p} \tag{8-19}$$

Both Eqs. 8-18 and 8-19 give the same results. One could argue that in the right-hand term of Eq. 8-18 the void ratio corresponding to the preconsolidation pressure on the true virgin compression curve should be used. Although this is technically correct, it doesn't make any significant difference in the answer.

Sometimes the degree of overconsolidation varies throughout the compressible layer. You could apply Eq. 8-16 or 8-17 to the part where $\sigma'_{vo} + \Delta\sigma_v < \sigma'_p$ and Eq. 8-18 or 8-19 to the part where $\sigma'_{vo} + \Delta\sigma_v > \sigma'_p$. In practice, however, it is usually easier to simply divide the entire stratum into several layers, apply the appropriate equation to calculate the average settlement for each layer, and then sum up the settlements by Eq. 8-14.

What is the best way to get C_r and $C_{r\epsilon}$ for use in Eqs. 8-16 through 8-19? Because of sample disturbance, the slope of the initial recompression portion of the laboratory consolidation curve (Fig. 8.7) is too steep and would yield values that are too large for these indices. Leonards (1976) offers the reasons why in situ values are generally smaller than those obtained from laboratory measurements: (1) disturbance during sampling, storage, and preparation of test specimens; (2) recompression of gas bubbles in the voids; and (3) errors in test procedures and methods of interpreting test results. This latter item includes the problem of reproducing the in situ state of stress in the specimen. Leonards recommends that the σ'_{vo} be applied to the specimen and that it be innundated and allowed to come to equilibrium for at least 24 hours before starting the incremental loading. Any tendency to swell should be controlled. Then the consolidation test is continued with relatively large load increments. To reproduce as closely as possible the in situ stress state, Leonards recommends that the sample be consolidated to slightly less than the σ'_p and then be allowed to rebound. This is the first cycle shown in Fig. 8.11. If you don't have a good idea of the σ'_p, then consolidate initially to $\sigma'_{vo} + \Delta\sigma_v$ only, which is presumably less than σ'_p. The determination of C_r or $C_{r\epsilon}$ is over the range of $\sigma'_{vo} + \Delta\sigma_v$, as shown in Fig. 8.11. It is common practice to take the average slope of the two curves. From the typical test results shown in Fig. 8.11, you can see that the actual values of the recompression index depend on the stress at which the rebound-reload cycle starts, especially whether it starts at a stress less than or greater than the σ'_p. See the difference in

APPENDIX IV

Calculations Addressing the Leachate Collection and Removal System

APPENDIX IV-1

Leachate Generation Calculation

Calculation Title:
Leachate Generation Calculation

Summary:
The liner system leachate collection geocomposite should be designed for a percolation rate of 1,155 gpad for a simulated time duration of 50 years.

Designs for flow volume, if any, may be developed based on the 25-year, 24-hour storm event.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal	Cedric H Ruhl	Jessica Ketchum	Thomas B Maier
		Cedric H. Ruhl	**Jessica Ketchum**	**Thomas B. Maier**

OBJECTIVE:

The objective of this calculation is to estimate leachate generation rates, both average annual and peak daily rates.

METHOD:

Leachate generation rates were estimated using the software package Hydrologic Evaluation of Landfill Performance (HELP, version 3.95D) for the following scenarios:

- Case 1: 10 feet of ash without cover;
- Case 2: 50 feet of ash without cover;
- Case 3: 100 feet of ash without cover; and
- Case 4: Closed landfill.

CALCULATIONS:

1.0 Define HELP model inputs

HELP software was used to calculate leachate generation rates based on the assumptions and material parameters described as follows.

1.1 Model Assumptions

Modeling was performed for a time duration of 50 years. Synthetically generated precipitation, temperature, solar radiation, and evaporation data for Greensboro, North Carolina were produced using HELP software. For the purposes of modelling, the landfill was assumed to be a one acre square with side lengths of approximately 209 feet. The slope length was assumed to be the diagonal of the square, or approximately 300 feet. Liner system slopes were assumed to be 2 percent, all other slopes were assumed to be 5 percent. Contact water runoff will be collected by a series of chimney drains as described in the “Leachate Collection Calculation”, therefore 100 percent of the area of the landfill was assumed to generate runoff.

Although the surface conditions for Cases 1 through 3 will consist of ash (soil texture # 30), surface conditions were conservatively assumed to consist of bare soil, coarse sand (soil texture #1, curve number = 73.63) because the sand will allow for relatively more infiltration than the ash. Surface conditions were assumed to consist of fair grass, sandy loam (curve number = 69.91) for Case 4. Initial moisture content of all the layers was initialized to steady state. The Leaf Area Index (LAI) was conservatively assumed to be two for all cases (resulting in more infiltration than LAI=0).

1.2 Material Parameters

Material parameters were selected in accordance with default HELP model settings, described as follows (from top to bottom, assuming closed landfill):

Vegetative Soil Cover – Soil Texture No. 6 (sandy loam)

- Thickness = 6 inches (0.5 feet)
- Porosity = 0.453

- Field Capacity = 0.19
- Wilting Point = 0.085
- Saturated Hydraulic Conductivity = 7.2×10^{-4} cm/sec

Final Soil Cover – Soil Texture No. 9 (silt loam)
- Thickness = 18 inches (1.5 feet)
- Porosity = 0.501
- Field Capacity = 0.284
- Wilting Point = 0.135
- Saturated Hydraulic Conductivity = 1.9×10^{-4} cm/sec

Cover System Geocomposite – Soil Texture No. 20 (drainage net)
- Thickness = 0.2 inches (200 mil)
- Porosity = 0.85
- Field Capacity = 0.01
- Wilting Point = 0.005
- Saturated Hydraulic Conductivity = 1.0×10^{1} cm/sec
- Drainage length = 300 ft.
- Slope = 5 percent

Cover System Geomembrane – Soil Texture No. 36 (LLDPE geomembrane)
- Thickness = 0.04 inches (40 mil)
- Saturated Hydraulic Conductivity = 4.0×10^{-13} cm/sec
- Pinhole density = 1/acre
- Installation defects = 2/acre
- Placement quality = good

Interim Soil Cover – Soil Texture No. 6 (sandy loam)
- Thickness = 12 inches (1 foot)
- Porosity = 0.453
- Field Capacity = 0.19
- Wilting Point = 0.085
- Saturated Hydraulic Conductivity = 7.2×10^{-4} cm/sec

Ash Waste – Soil Texture No. 30 (coal-burning electric plant fly ash)
- Thickness = varies (10 feet to 100 feet)
- Porosity = 0.541
- Field Capacity = 0.187
- Wilting Point = 0.047
- Saturated Hydraulic Conductivity = 5.0×10^{-5} cm/sec

Protective Cover – Soil Texture No. 6 (sandy loam)
- Thickness = 24 inches (2 feet)
- Porosity = 0.453
- Field Capacity = 0.19

- Wilting Point = 0.085
- Saturated Hydraulic Conductivity = 7.2×10^{-4} cm/sec

Leachate Collection Geocomposite – Soil Texture No. 20 (drainage net)

- Thickness = 0.2 inches (200 mil)
- Porosity = 0.85
- Field Capacity = 0.01
- Wilting Point = 0.005
- Saturated Hydraulic Conductivity = 1.0×10^{1} cm/sec
- Drainage length = 300 ft.
- Slope = 2 percent

Primary Geomembrane – Soil Texture No. 35 (HDPE geomembrane)

- Thickness = 0.06 inches (60 mil)
- Saturated Hydraulic Conductivity = 2.0×10^{-13} cm/sec
- Pinhole density = 1/acre
- Installation defects = 2/acre
- Placement quality = good

Witness Zone – Soil Texture No. 1 (coarse sand)

- Thickness = 12 inches (1 foot)
- Porosity = 0.417
- Field Capacity = 0.045
- Wilting Point = 0.018
- Saturated Hydraulic Conductivity = 1.0×10^{-2} cm/sec

The HELP model software requires that the lowest layer consist of a percolation layer. A bottom layer of sand (witness zone) was selected as a relatively free-draining material to meet this HELP model software requirement.

2.0 Estimate leachate generation rates

HELP modeling software was used to estimate leachate collected in the leachate collection geocomposite and leakage through the primary geomembrane for Cases 1 through 4 as summarized in the following table:

Table 1: Summary of Estimated Leachate Generation Rates							
Case No.	Description	Leachate Generation	Average Annual Percolation (in) [Ref. 1]	Average Daily Percolation (in) [Prev. Calc./365]	Average Daily Percolation (gpad)	Peak Daily Percolation (in) [Ref. 1]	Peak Daily Percolation (gpad)
1	open landfill 10-ft waste	Collected in Liner Geocomposite	1.55E+01	4.25E-02	1,155	4.45E-01	12,081
		Leakage through Primary Geomembrane	3.22E-02	8.82E-05	2.39	5.53E-04	15.02
2	open landfill 50-ft waste	Collected in Liner Geocomposite	1.43E+01	3.91E-02	1,063	1.31E-01	3,551
		Leakage through Primary Geomembrane	3.02E-02	8.28E-05	2.25	2.18E-04	5.92
3	open landfill 100-ft waste	Collected in Liner Geocomposite	1.27E+01	3.48E-02	945	1.28E-01	3,478
		Leakage through Primary Geomembrane	2.72E-02	7.45E-05	2.02	2.14E-04	5.81
4	closed landfill 100-ft waste	Collected in Liner Geocomposite	5.59E-03	1.53E-05	0.42	1.34E-03	36.39
		Leakage through Primary Geomembrane	7.00E-05	1.92E-07	0.01	7.00E-06	0.19

DISCUSSION:

Infiltration into the liner system (leachate collection) geocomposite and leakage through the primary liner is generally higher at lower waste heights. The liner system geocomposite should be designed for the highest average daily percolation rate of 1,155 gpad (Case 1).

REFERENCES:

1. Hydrologic Evaluation of Landfill Performance (HELP) Model, enhanced version 3.95.1.7 (based upon HELP 3.07), University of Hamburg, Institute of Soil Science.

REFERENCE 1

Hydrologic Evaluation of Landfill Performance (HELP) Model, enhanced version 3.95.1.7 (based upon HELP 3.07), University of Hamburg, Institute of Soil Science.

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:  19.59     DATE:   8.04.2015


 PRECIPITATION DATA FILE:      \\CLT1-FS1\projects\7810 Duke ABSAT
Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\DanRiver_LCS_Precip.d4
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Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\DanRiver_LCS_Temp.d7
 SOLAR RADIATION DATA FILE:    \\CLT1-FS1\projects\7810 Duke ABSAT
Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\DanRiver_LCS_SlrRdn.d13
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Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
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models\DanRiver_LCS_ET.d11
 SOIL AND DESIGN DATA FILE  1: \\CLT1-FS1\projects\7810 Duke ABSAT
Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\10ftAsh\10ftAsh.d10
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Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\10ftAsh\10ftAsh.out


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

     TITLE:  Dan River Landfill Leachate Generation Calculation

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


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


         NOTE:  PRECIPITATION DATA FOR     GREENSBORO          NORTH CAROLINA
```

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              WAS ENTERED BY THE USER.


      NOTE:  TEMPERATURE DATA FOR       GREENSBORO          NORTH CAROLINA
              WAS ENTERED BY THE USER.


      NOTE:  SOLAR RADIATION DATA FOR   GREENSBORO          NORTH CAROLINA
              WAS ENTERED BY THE USER.


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

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

                            VALID FOR  50 YEARS


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


                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  30
        THICKNESS                   =    120.00   INCHES
        POROSITY                    =      0.5410 VOL/VOL
        FIELD CAPACITY              =      0.1870 VOL/VOL
        WILTING POINT               =      0.0470 VOL/VOL
        INITIAL SOIL WATER CONTENT  =      0.2894 VOL/VOL
        EFFECTIVE SAT. HYD. CONDUCT.=      0.5000E-04 CM/SEC
      NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
              FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                LAYER  2
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   6
        THICKNESS                   =     24.00   INCHES
        POROSITY                    =      0.4530 VOL/VOL
        FIELD CAPACITY              =      0.1900 VOL/VOL
        WILTING POINT               =      0.0850 VOL/VOL
        INITIAL SOIL WATER CONTENT  =      0.1905 VOL/VOL
        EFFECTIVE SAT. HYD. CONDUCT.=      0.7200E-03 CM/SEC


                                LAYER  3
                                --------

                    TYPE 2 - LATERAL DRAINAGE LAYER
                      MATERIAL TEXTURE NUMBER  20
        THICKNESS                   =      0.20   INCHES
```

```
                                10ftAsh
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.=       10.00     CM/SEC
SLOPE                         =      2.00   PERCENT
DRAINAGE LENGTH               =    300.0    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      =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD


                            LAYER  5
                            --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   1
THICKNESS                     =     12.00   INCHES
POROSITY                      =      0.4170 VOL/VOL
FIELD CAPACITY                =      0.0450 VOL/VOL
WILTING POINT                 =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.0450 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-01 CM/SEC


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

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

                             VALID FOR  50 YEARS


          NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                   SOIL DATA BASE USING SOIL TEXTURE # 1 WITH BARE
                   GROUND CONDITIONS, A SURFACE SLOPE OF  5.% AND
                   A SLOPE LENGTH OF  300. FEET.

       SCS RUNOFF CURVE NUMBER              =     73.63
       FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
       AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
       EVAPORATIVE ZONE DEPTH               =      6.0    INCHES
       INITIAL WATER IN EVAPORATIVE ZONE    =      1.918  INCHES
       UPPER LIMIT OF EVAPORATIVE STORAGE   =      3.246  INCHES
       FIELD CAPACITY OF EVAPORATIVE ZONE   =      1.122  INCHES
       LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.282  INCHES
       SOIL EVAPORATION ZONE DEPTH          =      6.000  INCHES
       INITIAL SNOW WATER                   =      0.000  INCHES
       INITIAL INTERCEPTION WATER           =      0.000  INCHES
       INITIAL WATER IN LAYER MATERIALS     =     39.847  INCHES
       TOTAL INITIAL WATER                  =     39.847  INCHES
```

TOTAL SUBSURFACE INFLOW = 0.00 INCHES/YEAR

****

EVAPOTRANSPIRATION DATA 1

VALID FOR 50 YEARS

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
GREENSBORO NORTH CAROLINA

STATION LATITUDE	=	35.13	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	90	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.0	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.0	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	74.0	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	70.0	%

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FINAL WATER STORAGE AT END OF YEAR 50

LAYER	(INCHES)	(VOL/VOL)
1	36.4847	0.3040
2	6.2767	0.2615
3	0.0169	0.0847
4	0.0000	0.0000
5	0.6993	0.0583
TOTAL WATER IN LAYERS	43.478	
SNOW WATER	0.000	
INTERCEPTION WATER	0.000	
TOTAL FINAL WATER	43.478	

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 50

	(INCHES)	(CU. FT.)
PRECIPITATION	3.76	13648.800
RUNOFF	1.633	5928.4160
DRAINAGE COLLECTED FROM LAYER 3	0.44492	1615.07520
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000553	2.00800
AVERAGE HEAD ON TOP OF LAYER 4	0.118	
MAXIMUM HEAD ON TOP OF LAYER 4	0.232	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	4.7 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000211	0.76648
SNOW WATER	2.87	10419.2432

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5410

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 50

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.40	3.60	3.89	3.11	2.98	3.56
	4.20	4.47	3.75	3.22	2.72	3.43
STD. DEVIATIONS	1.69	1.90	1.56	1.43	1.35	2.05
	2.00	2.25	2.38	1.98	1.74	1.86
RUNOFF						
TOTALS	0.018	0.050	0.041	0.014	0.008	0.045
	0.023	0.045	0.132	0.106	0.059	0.066
STD. DEVIATIONS	0.039	0.150	0.203	0.067	0.033	0.217
	0.084	0.124	0.354	0.308	0.329	0.164

POTENTIAL EVAPOTRANSPIRATION

TOTALS	1.794	2.059	3.511	4.881	6.353	7.094
	7.029	6.265	4.763	3.388	2.185	1.639
STD. DEVIATIONS	0.185	0.263	0.307	0.323	0.275	0.311
	0.308	0.275	0.301	0.188	0.185	0.173

ACTUAL EVAPOTRANSPIRATION

TOTALS	1.213	1.450	2.326	2.518	2.859	3.089
	3.593	3.369	2.027	1.407	1.181	1.061
STD. DEVIATIONS	0.198	0.299	0.422	0.610	0.850	1.402
	1.248	1.058	0.890	0.493	0.303	0.207

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	1.1120	1.2178	1.7389	1.8218	1.7552	1.5381
	1.3386	1.1101	0.9681	0.8615	0.9837	1.0741
STD. DEVIATIONS	0.7050	0.8460	1.2943	1.0438	0.6699	0.4498
	0.3159	0.3045	0.3857	0.3738	0.7816	0.7541

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0024	0.0024	0.0033	0.0035	0.0035	0.0032
	0.0029	0.0025	0.0022	0.0020	0.0021	0.0023
STD. DEVIATIONS	0.0011	0.0014	0.0019	0.0016	0.0011	0.0007
	0.0005	0.0005	0.0006	0.0006	0.0012	0.0013

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0026	0.0021	0.0020	0.0017	0.0018	0.0020
	0.0024	0.0028	0.0029	0.0031	0.0029	0.0028
STD. DEVIATIONS	0.0012	0.0012	0.0013	0.0012	0.0010	0.0010
	0.0010	0.0011	0.0012	0.0012	0.0012	0.0013

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0095	0.0114	0.0148	0.0161	0.0150	0.0136
	0.0114	0.0095	0.0085	0.0074	0.0087	0.0092
STD. DEVIATIONS	0.0060	0.0079	0.0111	0.0092	0.0057	0.0040
	0.0027	0.0026	0.0034	0.0032	0.0069	0.0064

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 50

	10ftAsh INCHES		CU. FEET	PERCENT
PRECIPITATION	42.32	(6.463)	153634.7	100.00
RUNOFF	0.607	(0.6446)	2203.50	1.434
POTENTIAL EVAPOTRANSPIRATION	50.962	(0.8556)	184991.80	
ACTUAL EVAPOTRANSPIRATION	26.095	(2.8676)	94724.69	61.656
LATERAL DRAINAGE COLLECTED FROM LAYER 3	15.52003	(4.31543)	56337.703	36.66992
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.03218	(0.00677)	116.795	0.07602
AVERAGE HEAD ON TOP OF LAYER 4	0.011	(0.003)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.02899	(0.00974)	105.233	0.06850
CHANGE IN WATER STORAGE	0.073	(4.0783)	263.55	0.172

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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:  19.55     DATE:   8.04.2015


 PRECIPITATION DATA FILE:      \\CLT1-FS1\projects\7810 Duke ABSAT
Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
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models\DanRiver_LCS_Precip.d4
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Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\DanRiver_LCS_Temp.d7
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Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
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models\DanRiver_LCS_SlrRdn.d13
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Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
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Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\50ftAsh\50ftAsh.d10
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Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\50ftAsh\50ftAsh.out


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

     TITLE:  Dan River Landfill Leachate Generation Calculation

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                           WEATHER DATA SOURCES
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         NOTE:  PRECIPITATION DATA FOR     GREENSBORO          NORTH CAROLINA
```

50ftAsh
WAS ENTERED BY THE USER.

NOTE: TEMPERATURE DATA FOR GREENSBORO NORTH CAROLINA
WAS ENTERED BY THE USER.

NOTE: SOLAR RADIATION DATA FOR GREENSBORO NORTH CAROLINA
WAS ENTERED BY THE USER.

****

LAYER DATA 1

VALID FOR 50 YEARS

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

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 30

THICKNESS	=	600.00	INCHES
POROSITY	=	0.5410	VOL/VOL
FIELD CAPACITY	=	0.1870	VOL/VOL
WILTING POINT	=	0.0470	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2076	VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.5000E-04	CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4530	VOL/VOL
FIELD CAPACITY	=	0.1900	VOL/VOL
WILTING POINT	=	0.0850	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1900	VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.7200E-03	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES

50ftAsh

```
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.=         10.00     CM/SEC
SLOPE                         =      2.00   PERCENT
DRAINAGE LENGTH               =    300.0    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      =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD
```

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

```
THICKNESS                     =     12.00   INCHES
POROSITY                      =      0.4170 VOL/VOL
FIELD CAPACITY                =      0.0450 VOL/VOL
WILTING POINT                 =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.0450 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=        0.1000E-01 CM/SEC
```

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GENERAL DESIGN AND EVAPORATIVE ZONE DATA 1

VALID FOR 50 YEARS

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 1 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 300. FEET.

```
SCS RUNOFF CURVE NUMBER             =     73.63
FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =      6.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      1.918  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      3.246  INCHES
FIELD CAPACITY OF EVAPORATIVE ZONE  =      1.122  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.282  INCHES
SOIL EVAPORATION ZONE DEPTH         =      6.000  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL INTERCEPTION WATER          =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =    129.675  INCHES
TOTAL INITIAL WATER                 =    129.675  INCHES
```

50ftAsh
TOTAL SUBSURFACE INFLOW = 0.00 INCHES/YEAR

****

EVAPOTRANSPIRATION DATA 1

VALID FOR 50 YEARS

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
GREENSBORO NORTH CAROLINA

STATION LATITUDE	=	35.13	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	90	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.0	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.0	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	74.0	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	70.0	%

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FINAL WATER STORAGE AT END OF YEAR 50

LAYER	(INCHES)	(VOL/VOL)
1	188.3136	0.3139
2	6.2003	0.2583
3	0.0138	0.0690
4	0.0000	0.0000
5	0.7046	0.0587
TOTAL WATER IN LAYERS	195.232	
SNOW WATER	0.000	
INTERCEPTION WATER	0.000	
TOTAL FINAL WATER	195.232	

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 50

	(INCHES)	(CU. FT.)
PRECIPITATION	3.76	13648.800
RUNOFF	1.633	5928.4160
DRAINAGE COLLECTED FROM LAYER 3	0.13077	474.71078
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000218	0.79063
AVERAGE HEAD ON TOP OF LAYER 4	0.035	
MAXIMUM HEAD ON TOP OF LAYER 4	0.069	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	2.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000213	0.77372
SNOW WATER	2.87	10419.2432

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5410

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 50

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.40	3.60	3.89	3.11	2.98	3.56
	4.20	4.47	3.75	3.22	2.72	3.43
STD. DEVIATIONS	1.69	1.90	1.56	1.43	1.35	2.05
	2.00	2.25	2.38	1.98	1.74	1.86
RUNOFF						
TOTALS	0.018	0.050	0.041	0.014	0.008	0.045
	0.023	0.045	0.132	0.106	0.059	0.066
STD. DEVIATIONS	0.039	0.150	0.203	0.067	0.033	0.217
	0.084	0.124	0.354	0.308	0.329	0.164

POTENTIAL EVAPOTRANSPIRATION

TOTALS	1.794	2.059	3.511	4.881	6.353	7.094
	7.029	6.265	4.763	3.388	2.185	1.639
STD. DEVIATIONS	0.185	0.263	0.307	0.323	0.275	0.311
	0.308	0.275	0.301	0.188	0.185	0.173

ACTUAL EVAPOTRANSPIRATION

TOTALS	1.213	1.450	2.326	2.518	2.859	3.089
	3.593	3.369	2.027	1.407	1.181	1.061
STD. DEVIATIONS	0.198	0.299	0.422	0.610	0.850	1.402
	1.248	1.058	0.890	0.493	0.303	0.207

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.9454	0.7826	0.8928	0.8882	1.3211	1.5503
	1.6693	1.5840	1.3513	1.1915	1.0123	1.0950
STD. DEVIATIONS	0.5170	0.4044	0.4978	0.4885	0.7510	0.7021
	0.6634	0.5997	0.5171	0.5067	0.5292	0.5848

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0021	0.0018	0.0020	0.0020	0.0027	0.0031
	0.0033	0.0032	0.0028	0.0026	0.0022	0.0024
STD. DEVIATIONS	0.0010	0.0008	0.0009	0.0009	0.0013	0.0012
	0.0012	0.0011	0.0009	0.0009	0.0010	0.0011

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0027	0.0026	0.0027	0.0026	0.0019	0.0015
	0.0015	0.0018	0.0021	0.0025	0.0026	0.0026
STD. DEVIATIONS	0.0014	0.0013	0.0015	0.0013	0.0013	0.0011
	0.0009	0.0009	0.0011	0.0013	0.0014	0.0014

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0081	0.0073	0.0076	0.0078	0.0113	0.0137
	0.0143	0.0135	0.0119	0.0102	0.0089	0.0093
STD. DEVIATIONS	0.0044	0.0038	0.0043	0.0043	0.0064	0.0062
	0.0057	0.0051	0.0046	0.0043	0.0047	0.0050

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 50

	50ftAsh INCHES		CU. FEET	PERCENT
PRECIPITATION	42.32	(6.463)	153634.7	100.00
RUNOFF	0.607	(0.6446)	2203.50	1.434
POTENTIAL EVAPOTRANSPIRATION	50.962	(0.8556)	184991.80	
ACTUAL EVAPOTRANSPIRATION	26.095	(2.8676)	94724.69	61.656
LATERAL DRAINAGE COLLECTED FROM LAYER 3	14.28354	(4.68815)	51849.266	33.74842
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.03022	(0.00876)	109.711	0.07141
AVERAGE HEAD ON TOP OF LAYER 4	0.010	(0.003)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.02693	(0.01242)	97.760	0.06363
CHANGE IN WATER STORAGE	1.311	(6.5770)	4759.47	3.098

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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:  19.50     DATE:   8.04.2015


 PRECIPITATION DATA FILE:      \\CLT1-FS1\projects\7810 Duke ABSAT
Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
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Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
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Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\100ftAsh\100ftAsh.d10
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Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\100ftAsh\100ftAsh.out


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

     TITLE:  Dan River Landfill Leachate Generation Calculation

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                           WEATHER DATA SOURCES
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         NOTE:  PRECIPITATION DATA FOR     GREENSBORO          NORTH CAROLINA
```

100ftAsh
WAS ENTERED BY THE USER.

NOTE: TEMPERATURE DATA FOR GREENSBORO NORTH CAROLINA
WAS ENTERED BY THE USER.

NOTE: SOLAR RADIATION DATA FOR GREENSBORO NORTH CAROLINA
WAS ENTERED BY THE USER.

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LAYER DATA 1

VALID FOR 50 YEARS

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

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 30

THICKNESS	=	1200.00	INCHES
POROSITY	=	0.5410	VOL/VOL
FIELD CAPACITY	=	0.1870	VOL/VOL
WILTING POINT	=	0.0470	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1973	VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.5000E-04	CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4530	VOL/VOL
FIELD CAPACITY	=	0.1900	VOL/VOL
WILTING POINT	=	0.0850	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1900	VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.7200E-03	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES

```
                                100ftAsh
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.=         10.00     CM/SEC
SLOPE                         =      2.00   PERCENT
DRAINAGE LENGTH               =    300.0    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      =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD


                            LAYER  5
                            --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   1
THICKNESS                     =     12.00   INCHES
POROSITY                      =      0.4170 VOL/VOL
FIELD CAPACITY                =      0.0450 VOL/VOL
WILTING POINT                 =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.0450 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=        0.1000E-01 CM/SEC


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

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

                             VALID FOR  50 YEARS


          NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                   SOIL DATA BASE USING SOIL TEXTURE # 1 WITH BARE
                   GROUND CONDITIONS, A SURFACE SLOPE OF  5.% AND
                   A SLOPE LENGTH OF  300. FEET.

        SCS RUNOFF CURVE NUMBER             =     73.63
        FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
        EVAPORATIVE ZONE DEPTH              =      6.0    INCHES
        INITIAL WATER IN EVAPORATIVE ZONE   =      1.918  INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE  =      3.246  INCHES
        FIELD CAPACITY OF EVAPORATIVE ZONE  =      1.122  INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.282  INCHES
        SOIL EVAPORATION ZONE DEPTH         =      6.000  INCHES
        INITIAL SNOW WATER                  =      0.000  INCHES
        INITIAL INTERCEPTION WATER          =      0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS    =    241.882  INCHES
        TOTAL INITIAL WATER                 =    241.882  INCHES
```

100ftAsh
TOTAL SUBSURFACE INFLOW = 0.00 INCHES/YEAR

****

EVAPOTRANSPIRATION DATA 1

VALID FOR 50 YEARS

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
GREENSBORO NORTH CAROLINA

STATION LATITUDE	=	35.13	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	90	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.0	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.0	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	74.0	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	70.0	%

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FINAL WATER STORAGE AT END OF YEAR 50

LAYER	(INCHES)	(VOL/VOL)
1	379.4886	0.3162
2	6.2138	0.2589
3	0.0141	0.0705
4	0.0000	0.0000
5	0.7067	0.0589
TOTAL WATER IN LAYERS	386.423	
SNOW WATER	0.000	
INTERCEPTION WATER	0.000	
TOTAL FINAL WATER	386.423	

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 50

	(INCHES)	(CU. FT.)
PRECIPITATION	3.76	13648.800
RUNOFF	1.633	5928.4160
DRAINAGE COLLECTED FROM LAYER 3	0.12807	464.89871
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000214	0.77740
AVERAGE HEAD ON TOP OF LAYER 4	0.034	
MAXIMUM HEAD ON TOP OF LAYER 4	0.068	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000214	0.77501
SNOW WATER	2.87	10419.2432

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5410

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 50

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.40	3.60	3.89	3.11	2.98	3.56
	4.20	4.47	3.75	3.22	2.72	3.43
STD. DEVIATIONS	1.69	1.90	1.56	1.43	1.35	2.05
	2.00	2.25	2.38	1.98	1.74	1.86
RUNOFF						
TOTALS	0.018	0.050	0.041	0.014	0.008	0.045
	0.023	0.045	0.132	0.106	0.059	0.066
STD. DEVIATIONS	0.039	0.150	0.203	0.067	0.033	0.217
	0.084	0.124	0.354	0.308	0.329	0.164

POTENTIAL EVAPOTRANSPIRATION

TOTALS	1.794	2.059	3.511	4.881	6.353	7.094
	7.029	6.265	4.763	3.388	2.185	1.639
STD. DEVIATIONS	0.185	0.263	0.307	0.323	0.275	0.311
	0.308	0.275	0.301	0.188	0.185	0.173

ACTUAL EVAPOTRANSPIRATION

TOTALS	1.213	1.450	2.326	2.518	2.859	3.089
	3.593	3.369	2.027	1.407	1.181	1.061
STD. DEVIATIONS	0.198	0.299	0.422	0.610	0.850	1.402
	1.248	1.058	0.890	0.493	0.303	0.207

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.8835	0.6876	0.7278	0.6692	1.0727	1.2898
	1.5098	1.4947	1.2802	1.1163	0.9525	1.0228
STD. DEVIATIONS	0.5770	0.4462	0.4811	0.4389	0.6819	0.7481
	0.7611	0.7458	0.6716	0.6403	0.5886	0.6377

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0020	0.0016	0.0017	0.0015	0.0023	0.0026
	0.0030	0.0030	0.0027	0.0024	0.0021	0.0022
STD. DEVIATIONS	0.0011	0.0009	0.0009	0.0009	0.0013	0.0014
	0.0014	0.0014	0.0012	0.0012	0.0011	0.0012

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0024	0.0023	0.0025	0.0024	0.0018	0.0014
	0.0013	0.0014	0.0017	0.0021	0.0023	0.0023
STD. DEVIATIONS	0.0016	0.0014	0.0017	0.0015	0.0013	0.0011
	0.0009	0.0010	0.0012	0.0013	0.0015	0.0016

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0075	0.0064	0.0062	0.0059	0.0092	0.0114
	0.0129	0.0128	0.0113	0.0095	0.0084	0.0087
STD. DEVIATIONS	0.0049	0.0042	0.0041	0.0039	0.0058	0.0066
	0.0065	0.0064	0.0059	0.0055	0.0052	0.0054

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 50

	100ftAsh INCHES		CU. FEET	PERCENT
PRECIPITATION	42.32	(6.463)	153634.7	100.00
RUNOFF	0.607	(0.6446)	2203.50	1.434
POTENTIAL EVAPOTRANSPIRATION	50.962	(0.8556)	184991.80	
ACTUAL EVAPOTRANSPIRATION	26.095	(2.8676)	94724.69	61.656
LATERAL DRAINAGE COLLECTED FROM LAYER 3	12.70695	(5.76357)	46126.219	30.02332
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.02718	(0.01118)	98.648	0.06421
AVERAGE HEAD ON TOP OF LAYER 4	0.009	(0.004)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.02384	(0.01404)	86.547	0.05633
CHANGE IN WATER STORAGE	2.891	(7.2516)	10493.72	6.830

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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:  19.43     DATE:   8.04.2015


 PRECIPITATION DATA FILE:      \\CLT1-FS1\projects\7810 Duke ABSAT
Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\DanRiver_LCS_Precip.d4
 TEMPERATURE DATA FILE:        \\CLT1-FS1\projects\7810 Duke ABSAT
Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\DanRiver_LCS_Temp.d7
 SOLAR RADIATION DATA FILE:    \\CLT1-FS1\projects\7810 Duke ABSAT
Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\DanRiver_LCS_SlrRdn.d13
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Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\DanRiver_LCS_ET.d11
 SOIL AND DESIGN DATA FILE  1: \\CLT1-FS1\projects\7810 Duke ABSAT
Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\Closed\Closed.d10
 OUTPUT DATA FILE:             \\CLT1-FS1\projects\7810 Duke ABSAT
Alliance\Projects\2014\7810140065_ABSAT Dan River Off Site LF\P5.0 Landfill
Services\Task 5.6 30 Pct_OnSite\Calcs\16 Leachate Generation\HELP
models\Closed\Closed.out


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

     TITLE:  Dan River Landfill Leachate Generation Calculation

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


                           WEATHER DATA SOURCES
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         NOTE:  PRECIPITATION DATA FOR     GREENSBORO          NORTH CAROLINA
```

Closed
WAS ENTERED BY THE USER.

NOTE: TEMPERATURE DATA FOR GREENSBORO NORTH CAROLINA
WAS ENTERED BY THE USER.

NOTE: SOLAR RADIATION DATA FOR GREENSBORO NORTH CAROLINA
WAS ENTERED BY THE USER.

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LAYER DATA 1

VALID FOR 50 YEARS

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

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4530	VOL/VOL
FIELD CAPACITY	=	0.1900	VOL/VOL
WILTING POINT	=	0.0850	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2344	VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.7200E-03	CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9

THICKNESS	=	18.00	INCHES
POROSITY	=	0.5010	VOL/VOL
FIELD CAPACITY	=	0.2840	VOL/VOL
WILTING POINT	=	0.1350	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3563	VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1900E-03	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES

```
                              Closed
POROSITY                       =      0.8500 VOL/VOL
FIELD CAPACITY                 =      0.0100 VOL/VOL
WILTING POINT                  =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.0519 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=          10.00     CM/SEC
SLOPE                          =      5.00   PERCENT
DRAINAGE LENGTH                =    300.0    FEET


                         LAYER  4
                         --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  36
THICKNESS                      =      0.04   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=         0.4000E-12 CM/SEC
FML PINHOLE DENSITY            =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS       =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY          =  3 - GOOD


                         LAYER  5
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                      =     12.00   INCHES
POROSITY                       =      0.4530 VOL/VOL
FIELD CAPACITY                 =      0.1900 VOL/VOL
WILTING POINT                  =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.1900 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=         0.7200E-03 CM/SEC


                         LAYER  6
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  30
THICKNESS                      =   1200.00   INCHES
POROSITY                       =      0.5410 VOL/VOL
FIELD CAPACITY                 =      0.1870 VOL/VOL
WILTING POINT                  =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.1870 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=         0.5000E-04 CM/SEC


                         LAYER  7
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                      =     24.00   INCHES
POROSITY                       =      0.4530 VOL/VOL
FIELD CAPACITY                 =      0.1900 VOL/VOL
WILTING POINT                  =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.1900 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=         0.7200E-03 CM/SEC
```

Closed

LAYER 8

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

```
THICKNESS                    =      0.20   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.=       10.00     CM/SEC
SLOPE                        =      2.00   PERCENT
DRAINAGE LENGTH              =    300.0    FEET
```

LAYER 9

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     =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD
```

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

```
THICKNESS                    =     12.00   INCHES
POROSITY                     =      0.4170 VOL/VOL
FIELD CAPACITY               =      0.0450 VOL/VOL
WILTING POINT                =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0450 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-01 CM/SEC
```

****

GENERAL DESIGN AND EVAPORATIVE ZONE DATA 1

VALID FOR 50 YEARS

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 300. FEET.

```
SCS RUNOFF CURVE NUMBER             =     69.91
FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =      6.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      1.406  INCHES
```

```
                                   Closed
UPPER LIMIT OF EVAPORATIVE STORAGE  =      2.718  INCHES
FIELD CAPACITY OF EVAPORATIVE ZONE  =      1.140  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.510  INCHES
SOIL EVAPORATION ZONE DEPTH         =      6.000  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL INTERCEPTION WATER          =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =    239.612  INCHES
TOTAL INITIAL WATER                 =    239.612  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


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

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

                              VALID FOR  50 YEARS


         NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                  GREENSBORO          NORTH CAROLINA
             STATION LATITUDE                        =  35.13 DEGREES
             MAXIMUM LEAF AREA INDEX                 =   2.00
             START OF GROWING SEASON (JULIAN DATE)   =     90
             END OF GROWING SEASON (JULIAN DATE)     =    305
             EVAPORATIVE ZONE DEPTH                  =   6.0  INCHES
             AVERAGE ANNUAL WIND SPEED               =   7.60 MPH
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  66.0  %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  68.0  %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  74.0  %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  70.0  %
*******************************************************************************



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

                    FINAL WATER STORAGE AT END OF YEAR   50
-------------------------------------------------------------------------------

                     LAYER        (INCHES)       (VOL/VOL)
                     -----        --------       ---------
                       1            0.9424         0.1571

                       2            5.4469         0.3026

                       3            0.0041         0.0207

                       4            0.0000         0.0000

                       5            2.2800         0.1900

                       6          224.4000         0.1870

                       7            4.5600         0.1900

                       8            0.0020         0.0100

                       9            0.0000         0.0000
```

		Closed	
10	0.5400		0.0450

TOTAL WATER IN LAYERS	238.175
SNOW WATER	0.000
INTERCEPTION WATER	0.000
TOTAL FINAL WATER	238.175

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 50

	(INCHES)	(CU. FT.)
PRECIPITATION	3.76	13648.800
RUNOFF	0.586	2127.8301
DRAINAGE COLLECTED FROM LAYER 3	1.88775	6852.53076
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.006920	25.12060
AVERAGE HEAD ON TOP OF LAYER 4	15.396	
MAXIMUM HEAD ON TOP OF LAYER 4	24.027	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	65.3 FEET	
DRAINAGE COLLECTED FROM LAYER 8	0.00134	4.84607
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000007	0.02425
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.013	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000007	0.02425
SNOW WATER	2.87	10419.2432

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3284
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0850

*** 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.

Closed

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 50

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.40	3.60	3.89	3.11	2.98	3.56
	4.20	4.47	3.75	3.22	2.72	3.43
STD. DEVIATIONS	1.69	1.90	1.56	1.43	1.35	2.05
	2.00	2.25	2.38	1.98	1.74	1.86
RUNOFF						
TOTALS	0.001	0.005	0.012	0.001	0.001	0.011
	0.005	0.008	0.032	0.023	0.011	0.015
STD. DEVIATIONS	0.006	0.020	0.076	0.005	0.003	0.068
	0.028	0.031	0.112	0.083	0.069	0.051
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	1.794	2.059	3.511	4.881	6.353	7.094
	7.029	6.265	4.763	3.388	2.185	1.639
STD. DEVIATIONS	0.185	0.263	0.307	0.323	0.275	0.311
	0.308	0.275	0.301	0.188	0.185	0.173
ACTUAL EVAPOTRANSPIRATION						
TOTALS	1.211	1.431	2.235	2.234	2.366	2.735
	3.248	2.961	1.839	1.373	1.150	1.059
STD. DEVIATIONS	0.212	0.321	0.482	0.672	0.751	1.199
	1.023	0.915	0.867	0.542	0.346	0.216
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	2.1578	2.2100	2.0314	1.1928	0.8371	0.8055
	0.9302	1.2899	1.7538	1.8275	1.2929	2.0496
STD. DEVIATIONS	1.6072	1.8116	1.2589	0.7725	0.7044	0.9370
	1.0393	1.2253	1.3719	1.4192	1.2753	1.4659
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0005	0.0006	0.0007	0.0003	0.0002	0.0003
	0.0003	0.0004	0.0006	0.0007	0.0005	0.0006
STD. DEVIATIONS	0.0003	0.0008	0.0013	0.0001	0.0002	0.0007
	0.0005	0.0005	0.0009	0.0010	0.0013	0.0006
LATERAL DRAINAGE COLLECTED FROM LAYER 8						

```
                                    Closed
  TOTALS                  0.0005   0.0006   0.0007   0.0003   0.0002   0.0002
                          0.0003   0.0004   0.0005   0.0006   0.0005   0.0007

  STD. DEVIATIONS         0.0003   0.0008   0.0013   0.0001   0.0002   0.0003
                          0.0006   0.0005   0.0005   0.0008   0.0011   0.0013

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

PERCOLATION/LEAKAGE THROUGH LAYER 10
-------------------------------------
  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                0.0086   0.0204   0.0202   0.0042   0.0029   0.0088
                          0.0066   0.0092   0.0214   0.0246   0.0218   0.0151

  STD. DEVIATIONS         0.0101   0.0574   0.0872   0.0027   0.0024   0.0438
                          0.0262   0.0281   0.0620   0.0685   0.0974   0.0323

DAILY AVERAGE HEAD ON TOP OF LAYER  9
-------------------------------------
  AVERAGES                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
*******************************************************************************


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

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   50
-------------------------------------------------------------------------------

                                     INCHES            CU. FEET       PERCENT
                                 -------------------  -------------   ---------
 PRECIPITATION                    42.32    (   6.463)     153634.7     100.00

 RUNOFF                            0.125   (  0.1758)        454.34      0.296

 POTENTIAL EVAPOTRANSPIRATION     50.962   (  0.8556)     184991.80

 ACTUAL EVAPOTRANSPIRATION        23.843   (  2.6891)      86549.85     56.335
```

```
                                        Closed
 LATERAL DRAINAGE COLLECTED     18.37857 (  4.79956)     66714.227   43.42394
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH     0.00566 (  0.00254)        20.552     0.01338
   LAYER  4

 AVERAGE HEAD ON TOP             0.014   (    0.014)
   OF LAYER  4

 LATERAL DRAINAGE COLLECTED      0.00559 (  0.00252)        20.306    0.01322
   FROM LAYER  8

 PERCOLATION/LEAKAGE THROUGH     0.00007 (  0.00002)         0.246     0.00016
   LAYER  9

 AVERAGE HEAD ON TOP             0.000   (    0.000)
   OF LAYER  9

 PERCOLATION/LEAKAGE THROUGH     0.00007 (  0.00002)         0.246     0.00016
   LAYER 10

 CHANGE IN WATER STORAGE        -0.029   (  1.0823)       -104.29     -0.068
*******************************************************************************
*******************************************************************************
```

APPENDIX IV-2

Leachate Collection Calculation

Calculation Title:
Leachate Collection Calculation

Summary:
Chimney drain pipes should be perforated 12-inch diameter SDR-17 HDPE pipes with perforations as described in this calculation. Leachate collection pipes should be perforated SDR-17 HDPE pipes with a diameter based on the number of contributing chimney drains as shown in Table 9. Leakage detection pipes should be perforated SDR-17 HDPE pipes with a minimum diameter of 8 inches.

Leachate collection components were designed to provide hydraulic capacity for the 50-year, 24-hour storm event. Designs for flow volume, if any, may be developed based on the 25-year, 24-hour storm event.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal	Cedric H Ruhl		Thomas B Maier
		Cedric H. Ruhl	**Tryambak Kaushik**	**Thomas B. Maier**

OBJECTIVE:

The objective of this calculation is to provide design guidelines for chimney drains, leachate collection pipes, and leakage detection pipes for the proposed Dan River Landfill.

METHOD:

Chimney drain design guidelines were evaluated using HydroCAD modeling software and the Soil Conservation Service (SCS) method for calculating runoff. Leachate collection pipe design guidelines were evaluated assuming contributing flow from chimney drains and leachate generation. Leakage detection pipe design guidelines were developed based on an assumed Action Leakage Rate (ALR).

DEFINITION OF VARIABLES:

A = area;
CN = curve number;
D = diameter;
i = rainfall depth;
n = Manning's roughness coefficient;
Q = flow;
R = hydraulic radius;
S = longitudinal slope;
T_c = time of concentration;
V = velocity;

CALCULATIONS:

1.0 Design guidelines for chimney drains

A chimney drain consists of a vertical, perforated riser pipe surrounded by a filter media that receives flow from the active operations area and conveys flow to a horizontal pipe that is hydraulically connected by drainage aggregate to the leachate collection and removal system (LCRS) header and/or lateral pipes. The drainage path during a storm event is summarized as follows:

- Runoff across the ash discharges into the chimney drain;
- Flow from the chimney drain discharges into the horizontal pipe;
- Flow discharges into adjacent drainage aggregate via perforations in the horizontal pipe; and
- Flow discharges into LCRS pipes vis perforations in the LCRS pipes.

HydroCAD computer software [Ref. 1] was used to model the hydraulic performance of the chimney drains for the 50-year storm event.

1.1 Estimate flow to a typical chimney drain

The drainage area to a chimney drain will be limited to five acres. The tributary drainage area is fly ash, which was assumed to be consistent with a hydric soil class B based on engineering experience. The time of concentration was assumed to be six minutes which is the minimum time of concentration per TR-55 [Ref. 2]. The hydrologic conditions and peak flow to a typical chimney drain are summarized as shown in the following table:

Table 1: Flow to a Typical Chimney Drain

Description	Storm Recurrence Interval (years)	Rainfall for 24-Hour Storm {i} (in) [Ref. 3]	Curve Number {CN} [Ref. 5]	Drainage Area {A} (ac)	Time of Concentration {T_c} (min) [Ref. 2]	Peak Runoff {Q} (cfs) [Ref. 1]
Chimney Drain	50	7.17	86	5.00	6	46.10

1.2 Describe typical chimney drain outlets

The chimney drain will be a nominal 12-inch diameter solid-walled SDR-17 HDPE pipe with a minimum stick-up distance of five feet compared to the adjacent grades. See Reference 4 for pipe sizes. The elevation of the bottom of the chimney drain was set at a datum elevation of 0 feet, with the crest of the chimney drain pipe at elevation 5 feet.

The chimney drain pipe perforations were modeled as 0.2-inch diameter on 3-inch centers longitudinally and laterally. The number of rows of perforations was calculated as five feet stick-up x 4 perforations/foot – 1 ≈ 19. The number of columns of perforations was calculated as pi x 12-inch diameter / 3 inch spacing ≈ 12. The chimney drain outlets are summarized as shown in the following table:

Table 2: Chimney Drain Outlets

Description	Invert Elevation (feet)	Opening Orientation	Diameter (in)	No. of Columns	No. of Rows	Row Spacing (in)
Perforations	0.25	vertical plane	0.2	12	19	3
Crest of Pipe	5	horizontal plane	11.2	N/A	1	N/A

1.3 Estimate storage around a typical chimney drain

The ash will be graded to drain towards the chimney drain. For the purposes of this analysis it was assumed that the ash will be graded at a five percent slope towards the chimney drain from an elevation of 5 feet to an elevation of 0 feet; above elevation 5 feet the slope was assumed to be two percent. A 9-foot diameter flat area at elevation 0 feet was assumed to accommodate the filter material around the pipe. The stage-storage curve was estimated assuming an inverted cone shape as shown in the following table:

Table 3: Chimney Drain Stage-Storage Curve				
Elevation	Slope (percent)	Diameter (feet)	Suface Area (ft^2)	Description
0	0.0%	9	64	bottom elevation
1	5.0%	49	1,886	
2	5.0%	89	6,221	
3	5.0%	129	13,070	
4	5.0%	169	22,432	
5	5.0%	209	34,307	crest elevation
6	2.0%	309	74,991	
7	2.0%	409	131,382	
8	2.0%	509	203,482	

1.4 Evaluate hydraulic performance of a typical chimney drain

Chimney drain hydraulic performance was evaluated using HydroCAD software [Ref. 1] as summarized in the following table:

Table 4: Chimney Drain Hydraulic Performance				
Description	Storm Recurrence Interval (years)	Peak Elevation (ft) [Ref. 1]	Peak Inflow (cfs) [Ref. 1]	Peak Outflow (cfs) [Ref. 1]
Chimney Drain	50	5.21	46.10	1.32

Based on the stated assumptions, runoff from the 50-year storm event overtops the chimney drain by 0.21 feet. The peak flow from a typical chimney drain for the 50-year event was estimated to be 1.32 cfs.

1.5 Evaluate hydraulic performance of a horizontal pipe

The 12-inch diameter vertical chimney drain will discharge into a horizontal perforated nominal 12-inch diameter solid-walled SDR-17 HDPE pipe that will be placed on the floor of the landfill. The horizontal pipe will be hydraulically connected by drainage aggregate to the LCRS header and/or lateral pipes.

The horizontal pipe was assumed to be 40 feet long with 0.2-inch diameter perforations spaced on 3-inch centers. The number of rows of perforations was calculated as pi x 12-inch diameter / 3 inch spacing ≈ 12. The number of perforations per row was calculated as 40 feet length x 4 perforations/foot – 1 ≈ 159.

The bottom of the pipe was assumed to be at an elevation of -10 feet. For the purposes of modeling it was assumed that two rows of perforations are located horizontally along the bottom and top of the pipe, with the remaining 10 rows of perforations evenly spaced vertically on both sides of the pipe. The perforation spacing is summarized as shown in the following table:

Table 5: Horizontal Pipe Perforation Spacing						
Description	Invert Elevation (feet)	Opening Orientation	Diameter (in)	No. of Columns	No. of Rows	Row Spacing (in)
Perforations	-10.00	horizontal plane	0.2	159	1	3
Perforations	-9.83	vertical plane	0.2	318	1	3
Perforations	-9.67	vertical plane	0.2	318	1	3
Perforations	-9.50	vertical plane	0.2	318	1	3
Perforations	-9.33	vertical plane	0.2	318	1	3
Perforations	-9.17	vertical plane	0.2	318	1	3
Perforations	-9.00	horizontal plane	0.2	159	1	3

Chimney drain hydraulic performance was evaluated using HydroCAD software [Ref. 1] as summarized in the following table:

Table 6: Horizontal Pipe Hydraulic Performance			
Description	Storm Recurrence Interval (years)	Peak Elevation (ft) [Ref. 1]	Peak Flow (cfs) [Ref. 1]
Horizontal Pipe	50	-8.99	1.32

Runoff contribution from the chimney drain for the 50-year storm event generates a head of approximately 1.01 feet, indicating that the head is contained almost entirely within the horizontal pipe.

2.0 Hydraulic capacity of leachate pipes

Leachate collection and leakage detection pipes will consist of perforated solid-walled SDR-17 HDPE pipes with variable diameters. The leachate collection pipes will have a minimum slope of 2 percent. The pipe capacity was evaluated using Manning's equation presented as follows:

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$ [Ref. 5]

And

$$Q = AV$$ [Ref. 5]

The longitudinal slope of the pipe was assumed to be 1 percent, less than the minimum allowable landfill subgrade slope of 2 percent. The capacity of pipes with various diameters was calculated as shown in the following table:

Table 7: Leachate Pipe Capacity							
Nominal Diameter (in) [Ref. 4]	Pipe Inside Diameter {D} (in) [Ref. 4]	Manning's n of Pipe [assumed]	Hydraulic Radius {R} (ft)	Pipe Cross-Sectional Area {A} (ft^2)	Longitudinal Slope {S} (ft/ft) [assumed]	Flow Velocity {V} (ft/s)	Capacity {Q} (cfs)
8	7.549	0.012	0.1573	0.3108	0.0100	3.62	1.12
10	9.409	0.012	0.1960	0.4829	0.0100	4.19	2.02
12	11.160	0.012	0.2325	0.6793	0.0100	4.69	3.19
14	12.254	0.012	0.2553	0.8190	0.0100	5.00	4.09
16	14.005	0.012	0.2918	1.0698	0.0100	5.46	5.84
18	15.755	0.012	0.3282	1.3538	0.0100	5.91	8.00
24	21.007	0.012	0.4376	2.4069	0.0100	7.16	17.23
30	26.259	0.012	0.5471	3.7608	0.0100	8.31	31.24
36	31.511	0.012	0.6565	5.4157	0.0100	9.38	50.79

3.0 Design guidelines for leachate collection pipes

Leachate collection pipes will collect flow from chimney pipes during storm events and flow from the geocomposite drainage layer. The contribution of flow from the geocomposite drainage layer is 4.10E-8 ft/s as shown in the "Liner System Geocomposite Capacity Calculation". Based on hydraulic capacity, the contribution of flow from the geocomposite drainage layer is anticipated to be small relative to the contribution of flow from the chimney drains. The contribution of flow from the geocomposite drainage layer for the landfill footprint was calculated as shown in the following table:

Table 8: Contribution of Flow from Geocomposite Drainage Layer				
Geocomposite Location	Impingement Rate (gpad)	Impingement Rate (ft/s)	Limit of Waste Footprint (ac)	Contribution of Flow from Geocomposite {Q_{GCDL}} (cfs)
Leachate Collection Geocomposite	1,155	4.10E-08	23.3	0.042

The contribution of flow from the geocomposite drainage layer for the entire limit of waste is approximately 0.042 cfs, compared to 1.32 cfs for one chimney drain. The maximum number of chimney drains that can drain to an SDR-17 pipe of a given size is estimated as shown in the following table:

Table 9: Leachate Pipe Design Guidelines					
Nominal Diameter (in) [Ref. 4]	Pipe Inside Diameter {D} (in) [Ref. 4]	Pipe Capacity {Q} (cfs)	Contribution of Flow from Geocomposite {Q_{GCDL}} (cfs)	Contribution of Flow Per Chimney Drain {$Q_{chimney}$} (cfs) [Ref. 1]	Maximum No. of Chimney Drains
8	7.549	1.124	0.042	1.320	0
10	9.409	2.023	0.042	1.320	1
12	11.16	3.189	0.042	1.320	2
14	12.254	4.092	0.042	1.320	3
16	14.005	5.843	0.042	1.320	4
18	15.755	7.999	0.042	1.320	6
24	21.007	17.227	0.042	1.320	13
30	26.259	31.235	0.042	1.320	23
36	31.511	50.793	0.042	1.320	38

4.0 Design guidelines for leakage detection pipes

Leakage detection pipes will collect flow from the leakage detection geocomposite drainage layer. The contribution of flow from the geocomposite drainage layer is 3.55E-8 ft/s as shown in the "Liner System Geocomposite Capacity Calculation". The contribution of flow from the geocomposite drainage layer for the landfill footprint was calculated as shown in the following table:

Table 10: Contribution of Flow from Geocomposite Drainage Layer

Geocomposite Location	Impingement Rate (gpad)	Impingement Rate (ft/s)	Limit of Waste Footprint (ac)	Contribution of Flow from Geocomposite $\{Q_{GCDL}\}$ (cfs)
Leakage Detection Geocomposite	1,000	3.55E-08	26.4	0.041

A nominal 8-inch diameter HDPE pipe has a capacity of 1.12 cfs as shown in Table 7 which is greater than the contribution of flow from geocomposite; therefore, the minimum leakage detection pipe diameter is 8 inches.

DISCUSSION:

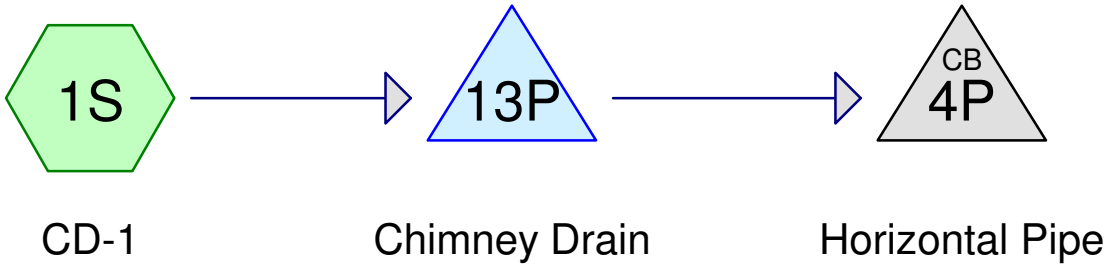
Chimney drain pipes should be perforated 12-inch diameter SDR-17 HDPE pipes with perforations as described in this calculation. Leachate collection pipes should be perforated SDR-17 HDPE pipes with a diameter based on the number of contributing chimney drains as shown in Table 9. Leakage detection pipes should be perforated SDR-17 HDPE pipes with a minimum diameter of 8 inches.

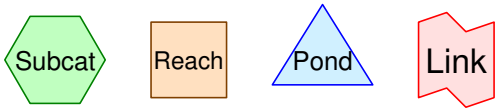
REFERENCES:

1. HydroCAD 10.00 (build 9), HydroCAD Software Solutions LLC, 2013.
2. United States Department of Agriculture, "Urban Hydrology for Small Watersheds", Technical Release 55, June 1986.
3. Bonnin, G.M. et. al., "NOAA Atlas 14, Volume 2, Version 3, Point Precipitation Frequency Estimates", NOAA National Weather Service, obtained September 15, 2014.
4. CAVCO Pipe Valves and Fittings product information.
5. North Carolina Department of Environment and Natural Resources, "Erosion and Sediment Control Planning and Design Manual", Revised May 2013.

REFERENCE 1

HydroCAD 10.00 (build 9), HydroCAD Software Solutions LLC, 2013.





Routing Diagram for Chimney_Drain
Prepared by AMEC, Printed 6/20/2015
HydroCAD® 10.00 s/n 08086 © 2013 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: CD-1

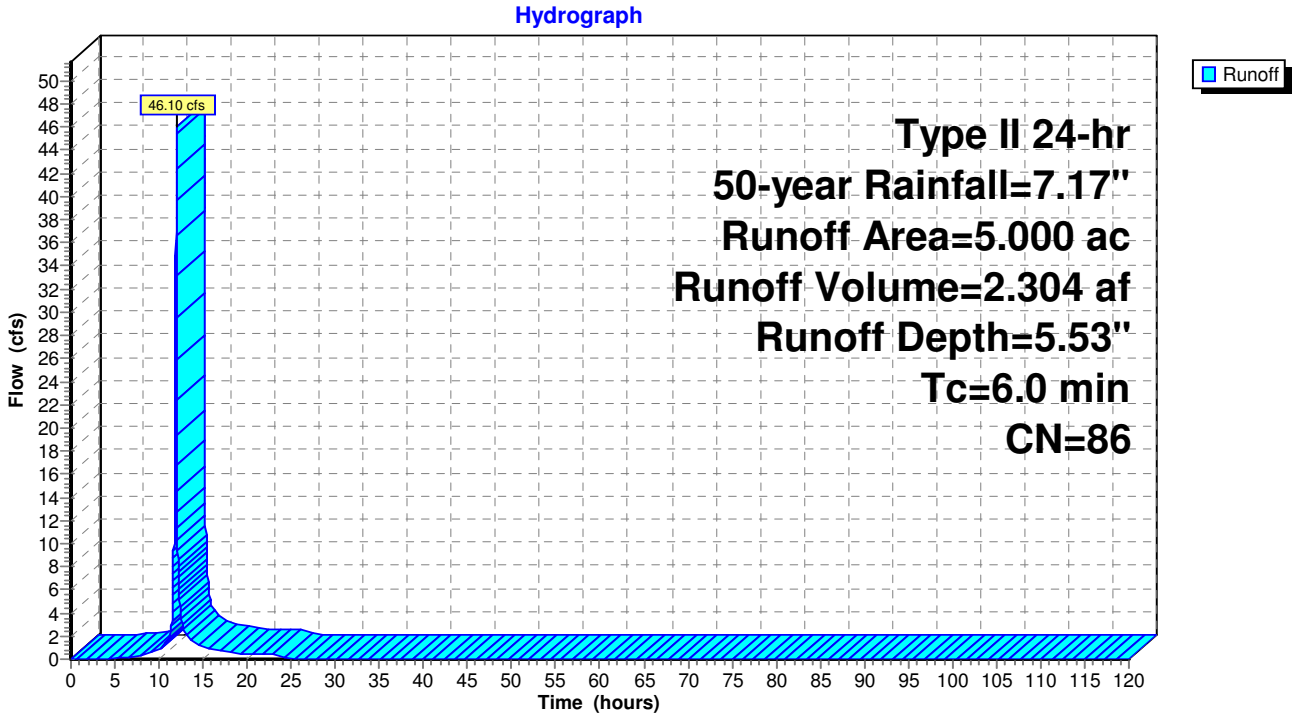
Runoff = 46.10 cfs @ 11.97 hrs, Volume= 2.304 af, Depth= 5.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (ac)	CN	Description
5.000	86	Newly graded area, HSG B
5.000		100.00% Pervious Area

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

Subcatchment 1S: CD-1



Hydrograph for Subcatchment 1S: CD-1

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	10.40	1.43	0.44	1.09
0.20	0.01	0.00	0.00	10.60	1.50	0.49	1.24
0.40	0.03	0.00	0.00	10.80	1.59	0.55	1.47
0.60	0.04	0.00	0.00	11.00	1.68	0.62	1.71
0.80	0.06	0.00	0.00	11.20	1.80	0.70	2.13
1.00	0.08	0.00	0.00	11.40	1.95	0.81	2.71
1.20	0.09	0.00	0.00	11.60	2.20	1.00	4.67
1.40	0.11	0.00	0.00	11.80	3.09	1.74	**18.46**
1.60	0.12	0.00	0.00	12.00	4.75	3.24	**42.34**
1.80	0.14	0.00	0.00	12.20	5.01	3.48	6.43
2.00	0.16	0.00	0.00	12.40	5.20	3.65	4.43
2.20	0.18	0.00	0.00	12.60	5.33	3.78	3.02
2.40	0.19	0.00	0.00	12.80	5.44	3.88	2.59
2.60	0.21	0.00	0.00	13.00	5.54	3.97	2.24
2.80	0.23	0.00	0.00	13.20	5.62	4.05	1.98
3.00	0.25	0.00	0.00	13.40	5.69	4.12	1.79
3.20	0.27	0.00	0.00	13.60	5.76	4.18	1.61
3.40	0.29	0.00	0.00	13.80	5.82	4.24	1.47
3.60	0.30	0.00	0.00	14.00	5.88	4.29	1.33
3.80	0.32	0.00	0.00	14.20	5.93	4.34	1.24
4.00	0.34	0.00	0.01	14.40	5.98	4.39	1.20
4.20	0.36	0.00	0.02	14.60	6.03	4.44	1.15
4.40	0.39	0.00	0.03	14.80	6.08	4.48	1.10
4.60	0.41	0.00	0.04	15.00	6.12	4.52	1.05
4.80	0.43	0.01	0.06	15.20	6.16	4.56	1.01
5.00	0.45	0.01	0.07	15.40	6.20	4.60	0.96
5.20	0.47	0.01	0.09	15.60	6.24	4.64	0.91
5.40	0.50	0.02	0.10	15.80	6.28	4.67	0.86
5.60	0.52	0.02	0.12	16.00	6.31	4.70	0.82
5.80	0.55	0.03	0.14	16.20	6.34	4.74	0.78
6.00	0.57	0.03	0.15	16.40	6.37	4.77	0.77
6.20	0.60	0.04	0.17	16.60	6.41	4.80	0.75
6.40	0.63	0.05	0.19	16.80	6.44	4.82	0.73
6.60	0.65	0.06	0.20	17.00	6.47	4.85	0.72
6.80	0.68	0.06	0.22	17.20	6.49	4.88	0.70
7.00	0.71	0.07	0.24	17.40	6.52	4.91	0.68
7.20	0.74	0.08	0.26	17.60	6.55	4.93	0.67
7.40	0.77	0.09	0.28	17.80	6.58	4.96	0.65
7.60	0.80	0.11	0.30	18.00	6.60	4.99	0.63
7.80	0.83	0.12	0.32	18.20	6.63	5.01	0.61
8.00	0.86	0.13	0.34	18.40	6.65	5.03	0.60
8.20	0.89	0.15	0.37	18.60	6.68	5.06	0.58
8.40	0.93	0.16	0.42	18.80	6.70	5.08	0.56
8.60	0.97	0.18	0.47	19.00	6.72	5.10	0.55
8.80	1.01	0.20	0.52	19.20	6.75	5.12	0.53
9.00	1.05	0.23	0.58	19.40	6.77	5.14	0.51
9.20	1.10	0.25	0.62	19.60	6.79	5.16	0.49
9.40	1.15	0.27	0.64	19.80	6.81	5.18	0.48
9.60	1.19	0.30	0.66	20.00	6.83	5.20	0.46
9.80	1.24	0.33	0.74	20.20	6.84	5.22	0.45
10.00	1.30	0.36	0.84	20.40	6.86	5.23	0.45
10.20	1.36	0.40	0.95	20.60	6.88	5.25	0.44

Hydrograph for Subcatchment 1S: CD-1 (continued)

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
20.80	6.90	5.27	0.44	31.20	7.17	5.53	0.00
21.00	6.92	5.29	0.44	31.40	7.17	5.53	0.00
21.20	6.94	5.30	0.43	31.60	7.17	5.53	0.00
21.40	6.95	5.32	0.43	31.80	7.17	5.53	0.00
21.60	6.97	5.34	0.43	32.00	7.17	5.53	0.00
21.80	6.99	5.35	0.42	32.20	7.17	5.53	0.00
22.00	7.01	5.37	0.42	32.40	7.17	5.53	0.00
22.20	7.02	5.39	0.42	32.60	7.17	5.53	0.00
22.40	7.04	5.40	0.41	32.80	7.17	5.53	0.00
22.60	7.06	5.42	0.41	33.00	7.17	5.53	0.00
22.80	7.07	5.44	0.40	33.20	7.17	5.53	0.00
23.00	7.09	5.45	0.40	33.40	7.17	5.53	0.00
23.20	7.11	5.47	0.40	33.60	7.17	5.53	0.00
23.40	7.12	5.48	0.39	33.80	7.17	5.53	0.00
23.60	7.14	5.50	0.39	34.00	7.17	5.53	0.00
23.80	7.15	5.51	0.39	34.20	7.17	5.53	0.00
24.00	**7.17**	**5.53**	0.38	34.40	7.17	5.53	0.00
24.20	7.17	5.53	0.01	34.60	7.17	5.53	0.00
24.40	7.17	5.53	0.00	34.80	7.17	5.53	0.00
24.60	7.17	5.53	0.00	35.00	7.17	5.53	0.00
24.80	7.17	5.53	0.00	35.20	7.17	5.53	0.00
25.00	7.17	5.53	0.00	35.40	7.17	5.53	0.00
25.20	7.17	5.53	0.00	35.60	7.17	5.53	0.00
25.40	7.17	5.53	0.00	35.80	7.17	5.53	0.00
25.60	7.17	5.53	0.00	36.00	7.17	5.53	0.00
25.80	7.17	5.53	0.00	36.20	7.17	5.53	0.00
26.00	7.17	5.53	0.00	36.40	7.17	5.53	0.00
26.20	7.17	5.53	0.00	36.60	7.17	5.53	0.00
26.40	7.17	5.53	0.00	36.80	7.17	5.53	0.00
26.60	7.17	5.53	0.00	37.00	7.17	5.53	0.00
26.80	7.17	5.53	0.00	37.20	7.17	5.53	0.00
27.00	7.17	5.53	0.00	37.40	7.17	5.53	0.00
27.20	7.17	5.53	0.00	37.60	7.17	5.53	0.00
27.40	7.17	5.53	0.00	37.80	7.17	5.53	0.00
27.60	7.17	5.53	0.00	38.00	7.17	5.53	0.00
27.80	7.17	5.53	0.00	38.20	7.17	5.53	0.00
28.00	7.17	5.53	0.00	38.40	7.17	5.53	0.00
28.20	7.17	5.53	0.00	38.60	7.17	5.53	0.00
28.40	7.17	5.53	0.00	38.80	7.17	5.53	0.00
28.60	7.17	5.53	0.00	39.00	7.17	5.53	0.00
28.80	7.17	5.53	0.00	39.20	7.17	5.53	0.00
29.00	7.17	5.53	0.00	39.40	7.17	5.53	0.00
29.20	7.17	5.53	0.00	39.60	7.17	5.53	0.00
29.40	7.17	5.53	0.00	39.80	7.17	5.53	0.00
29.60	7.17	5.53	0.00	40.00	7.17	5.53	0.00
29.80	7.17	5.53	0.00	40.20	7.17	5.53	0.00
30.00	7.17	5.53	0.00	40.40	7.17	5.53	0.00
30.20	7.17	5.53	0.00	40.60	7.17	5.53	0.00
30.40	7.17	5.53	0.00	40.80	7.17	5.53	0.00
30.60	7.17	5.53	0.00	41.00	7.17	5.53	0.00
30.80	7.17	5.53	0.00	41.20	7.17	5.53	0.00
31.00	7.17	5.53	0.00	41.40	7.17	5.53	0.00

Hydrograph for Subcatchment 1S: CD-1 (continued)

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
41.60	7.17	5.53	0.00	52.00	7.17	5.53	0.00
41.80	7.17	5.53	0.00	52.20	7.17	5.53	0.00
42.00	7.17	5.53	0.00	52.40	7.17	5.53	0.00
42.20	7.17	5.53	0.00	52.60	7.17	5.53	0.00
42.40	7.17	5.53	0.00	52.80	7.17	5.53	0.00
42.60	7.17	5.53	0.00	53.00	7.17	5.53	0.00
42.80	7.17	5.53	0.00	53.20	7.17	5.53	0.00
43.00	7.17	5.53	0.00	53.40	7.17	5.53	0.00
43.20	7.17	5.53	0.00	53.60	7.17	5.53	0.00
43.40	7.17	5.53	0.00	53.80	7.17	5.53	0.00
43.60	7.17	5.53	0.00	54.00	7.17	5.53	0.00
43.80	7.17	5.53	0.00	54.20	7.17	5.53	0.00
44.00	7.17	5.53	0.00	54.40	7.17	5.53	0.00
44.20	7.17	5.53	0.00	54.60	7.17	5.53	0.00
44.40	7.17	5.53	0.00	54.80	7.17	5.53	0.00
44.60	7.17	5.53	0.00	55.00	7.17	5.53	0.00
44.80	7.17	5.53	0.00	55.20	7.17	5.53	0.00
45.00	7.17	5.53	0.00	55.40	7.17	5.53	0.00
45.20	7.17	5.53	0.00	55.60	7.17	5.53	0.00
45.40	7.17	5.53	0.00	55.80	7.17	5.53	0.00
45.60	7.17	5.53	0.00	56.00	7.17	5.53	0.00
45.80	7.17	5.53	0.00	56.20	7.17	5.53	0.00
46.00	7.17	5.53	0.00	56.40	7.17	5.53	0.00
46.20	7.17	5.53	0.00	56.60	7.17	5.53	0.00
46.40	7.17	5.53	0.00	56.80	7.17	5.53	0.00
46.60	7.17	5.53	0.00	57.00	7.17	5.53	0.00
46.80	7.17	5.53	0.00	57.20	7.17	5.53	0.00
47.00	7.17	5.53	0.00	57.40	7.17	5.53	0.00
47.20	7.17	5.53	0.00	57.60	7.17	5.53	0.00
47.40	7.17	5.53	0.00	57.80	7.17	5.53	0.00
47.60	7.17	5.53	0.00	58.00	7.17	5.53	0.00
47.80	7.17	5.53	0.00	58.20	7.17	5.53	0.00
48.00	7.17	5.53	0.00	58.40	7.17	5.53	0.00
48.20	7.17	5.53	0.00	58.60	7.17	5.53	0.00
48.40	7.17	5.53	0.00	58.80	7.17	5.53	0.00
48.60	7.17	5.53	0.00	59.00	7.17	5.53	0.00
48.80	7.17	5.53	0.00	59.20	7.17	5.53	0.00
49.00	7.17	5.53	0.00	59.40	7.17	5.53	0.00
49.20	7.17	5.53	0.00	59.60	7.17	5.53	0.00
49.40	7.17	5.53	0.00	59.80	7.17	5.53	0.00
49.60	7.17	5.53	0.00	60.00	7.17	5.53	0.00
49.80	7.17	5.53	0.00	60.20	7.17	5.53	0.00
50.00	7.17	5.53	0.00	60.40	7.17	5.53	0.00
50.20	7.17	5.53	0.00	60.60	7.17	5.53	0.00
50.40	7.17	5.53	0.00	60.80	7.17	5.53	0.00
50.60	7.17	5.53	0.00	61.00	7.17	5.53	0.00
50.80	7.17	5.53	0.00	61.20	7.17	5.53	0.00
51.00	7.17	5.53	0.00	61.40	7.17	5.53	0.00
51.20	7.17	5.53	0.00	61.60	7.17	5.53	0.00
51.40	7.17	5.53	0.00	61.80	7.17	5.53	0.00
51.60	7.17	5.53	0.00	62.00	7.17	5.53	0.00
51.80	7.17	5.53	0.00	62.20	7.17	5.53	0.00

Hydrograph for Subcatchment 1S: CD-1 (continued)

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
62.40	7.17	5.53	0.00	72.80	7.17	5.53	0.00
62.60	7.17	5.53	0.00	73.00	7.17	5.53	0.00
62.80	7.17	5.53	0.00	73.20	7.17	5.53	0.00
63.00	7.17	5.53	0.00	73.40	7.17	5.53	0.00
63.20	7.17	5.53	0.00	73.60	7.17	5.53	0.00
63.40	7.17	5.53	0.00	73.80	7.17	5.53	0.00
63.60	7.17	5.53	0.00	74.00	7.17	5.53	0.00
63.80	7.17	5.53	0.00	74.20	7.17	5.53	0.00
64.00	7.17	5.53	0.00	74.40	7.17	5.53	0.00
64.20	7.17	5.53	0.00	74.60	7.17	5.53	0.00
64.40	7.17	5.53	0.00	74.80	7.17	5.53	0.00
64.60	7.17	5.53	0.00	75.00	7.17	5.53	0.00
64.80	7.17	5.53	0.00	75.20	7.17	5.53	0.00
65.00	7.17	5.53	0.00	75.40	7.17	5.53	0.00
65.20	7.17	5.53	0.00	75.60	7.17	5.53	0.00
65.40	7.17	5.53	0.00	75.80	7.17	5.53	0.00
65.60	7.17	5.53	0.00	76.00	7.17	5.53	0.00
65.80	7.17	5.53	0.00	76.20	7.17	5.53	0.00
66.00	7.17	5.53	0.00	76.40	7.17	5.53	0.00
66.20	7.17	5.53	0.00	76.60	7.17	5.53	0.00
66.40	7.17	5.53	0.00	76.80	7.17	5.53	0.00
66.60	7.17	5.53	0.00	77.00	7.17	5.53	0.00
66.80	7.17	5.53	0.00	77.20	7.17	5.53	0.00
67.00	7.17	5.53	0.00	77.40	7.17	5.53	0.00
67.20	7.17	5.53	0.00	77.60	7.17	5.53	0.00
67.40	7.17	5.53	0.00	77.80	7.17	5.53	0.00
67.60	7.17	5.53	0.00	78.00	7.17	5.53	0.00
67.80	7.17	5.53	0.00	78.20	7.17	5.53	0.00
68.00	7.17	5.53	0.00	78.40	7.17	5.53	0.00
68.20	7.17	5.53	0.00	78.60	7.17	5.53	0.00
68.40	7.17	5.53	0.00	78.80	7.17	5.53	0.00
68.60	7.17	5.53	0.00	79.00	7.17	5.53	0.00
68.80	7.17	5.53	0.00	79.20	7.17	5.53	0.00
69.00	7.17	5.53	0.00	79.40	7.17	5.53	0.00
69.20	7.17	5.53	0.00	79.60	7.17	5.53	0.00
69.40	7.17	5.53	0.00	79.80	7.17	5.53	0.00
69.60	7.17	5.53	0.00	80.00	7.17	5.53	0.00
69.80	7.17	5.53	0.00	80.20	7.17	5.53	0.00
70.00	7.17	5.53	0.00	80.40	7.17	5.53	0.00
70.20	7.17	5.53	0.00	80.60	7.17	5.53	0.00
70.40	7.17	5.53	0.00	80.80	7.17	5.53	0.00
70.60	7.17	5.53	0.00	81.00	7.17	5.53	0.00
70.80	7.17	5.53	0.00	81.20	7.17	5.53	0.00
71.00	7.17	5.53	0.00	81.40	7.17	5.53	0.00
71.20	7.17	5.53	0.00	81.60	7.17	5.53	0.00
71.40	7.17	5.53	0.00	81.80	7.17	5.53	0.00
71.60	7.17	5.53	0.00	82.00	7.17	5.53	0.00
71.80	7.17	5.53	0.00	82.20	7.17	5.53	0.00
72.00	7.17	5.53	0.00	82.40	7.17	5.53	0.00
72.20	7.17	5.53	0.00	82.60	7.17	5.53	0.00
72.40	7.17	5.53	0.00	82.80	7.17	5.53	0.00
72.60	7.17	5.53	0.00	83.00	7.17	5.53	0.00

Hydrograph for Subcatchment 1S: CD-1 (continued)

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
83.20	7.17	5.53	0.00	93.60	7.17	5.53	0.00
83.40	7.17	5.53	0.00	93.80	7.17	5.53	0.00
83.60	7.17	5.53	0.00	94.00	7.17	5.53	0.00
83.80	7.17	5.53	0.00	94.20	7.17	5.53	0.00
84.00	7.17	5.53	0.00	94.40	7.17	5.53	0.00
84.20	7.17	5.53	0.00	94.60	7.17	5.53	0.00
84.40	7.17	5.53	0.00	94.80	7.17	5.53	0.00
84.60	7.17	5.53	0.00	95.00	7.17	5.53	0.00
84.80	7.17	5.53	0.00	95.20	7.17	5.53	0.00
85.00	7.17	5.53	0.00	95.40	7.17	5.53	0.00
85.20	7.17	5.53	0.00	95.60	7.17	5.53	0.00
85.40	7.17	5.53	0.00	95.80	7.17	5.53	0.00
85.60	7.17	5.53	0.00	96.00	7.17	5.53	0.00
85.80	7.17	5.53	0.00	96.20	7.17	5.53	0.00
86.00	7.17	5.53	0.00	96.40	7.17	5.53	0.00
86.20	7.17	5.53	0.00	96.60	7.17	5.53	0.00
86.40	7.17	5.53	0.00	96.80	7.17	5.53	0.00
86.60	7.17	5.53	0.00	97.00	7.17	5.53	0.00
86.80	7.17	5.53	0.00	97.20	7.17	5.53	0.00
87.00	7.17	5.53	0.00	97.40	7.17	5.53	0.00
87.20	7.17	5.53	0.00	97.60	7.17	5.53	0.00
87.40	7.17	5.53	0.00	97.80	7.17	5.53	0.00
87.60	7.17	5.53	0.00	98.00	7.17	5.53	0.00
87.80	7.17	5.53	0.00	98.20	7.17	5.53	0.00
88.00	7.17	5.53	0.00	98.40	7.17	5.53	0.00
88.20	7.17	5.53	0.00	98.60	7.17	5.53	0.00
88.40	7.17	5.53	0.00	98.80	7.17	5.53	0.00
88.60	7.17	5.53	0.00	99.00	7.17	5.53	0.00
88.80	7.17	5.53	0.00	99.20	7.17	5.53	0.00
89.00	7.17	5.53	0.00	99.40	7.17	5.53	0.00
89.20	7.17	5.53	0.00	99.60	7.17	5.53	0.00
89.40	7.17	5.53	0.00	99.80	7.17	5.53	0.00
89.60	7.17	5.53	0.00	100.00	7.17	5.53	0.00
89.80	7.17	5.53	0.00	100.20	7.17	5.53	0.00
90.00	7.17	5.53	0.00	100.40	7.17	5.53	0.00
90.20	7.17	5.53	0.00	100.60	7.17	5.53	0.00
90.40	7.17	5.53	0.00	100.80	7.17	5.53	0.00
90.60	7.17	5.53	0.00	101.00	7.17	5.53	0.00
90.80	7.17	5.53	0.00	101.20	7.17	5.53	0.00
91.00	7.17	5.53	0.00	101.40	7.17	5.53	0.00
91.20	7.17	5.53	0.00	101.60	7.17	5.53	0.00
91.40	7.17	5.53	0.00	101.80	7.17	5.53	0.00
91.60	7.17	5.53	0.00	102.00	7.17	5.53	0.00
91.80	7.17	5.53	0.00	102.20	7.17	5.53	0.00
92.00	7.17	5.53	0.00	102.40	7.17	5.53	0.00
92.20	7.17	5.53	0.00	102.60	7.17	5.53	0.00
92.40	7.17	5.53	0.00	102.80	7.17	5.53	0.00
92.60	7.17	5.53	0.00	103.00	7.17	5.53	0.00
92.80	7.17	5.53	0.00	103.20	7.17	5.53	0.00
93.00	7.17	5.53	0.00	103.40	7.17	5.53	0.00
93.20	7.17	5.53	0.00	103.60	7.17	5.53	0.00
93.40	7.17	5.53	0.00	103.80	7.17	5.53	0.00

Hydrograph for Subcatchment 1S: CD-1 (continued)

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
104.00	7.17	5.53	0.00
104.20	7.17	5.53	0.00
104.40	7.17	5.53	0.00
104.60	7.17	5.53	0.00
104.80	7.17	5.53	0.00
105.00	7.17	5.53	0.00
105.20	7.17	5.53	0.00
105.40	7.17	5.53	0.00
105.60	7.17	5.53	0.00
105.80	7.17	5.53	0.00
106.00	7.17	5.53	0.00
106.20	7.17	5.53	0.00
106.40	7.17	5.53	0.00
106.60	7.17	5.53	0.00
106.80	7.17	5.53	0.00
107.00	7.17	5.53	0.00
107.20	7.17	5.53	0.00
107.40	7.17	5.53	0.00
107.60	7.17	5.53	0.00
107.80	7.17	5.53	0.00
108.00	7.17	5.53	0.00
108.20	7.17	5.53	0.00
108.40	7.17	5.53	0.00
108.60	7.17	5.53	0.00
108.80	7.17	5.53	0.00
109.00	7.17	5.53	0.00
109.20	7.17	5.53	0.00
109.40	7.17	5.53	0.00
109.60	7.17	5.53	0.00
109.80	7.17	5.53	0.00
110.00	7.17	5.53	0.00
110.20	7.17	5.53	0.00
110.40	7.17	5.53	0.00
110.60	7.17	5.53	0.00
110.80	7.17	5.53	0.00
111.00	7.17	5.53	0.00
111.20	7.17	5.53	0.00
111.40	7.17	5.53	0.00
111.60	7.17	5.53	0.00
111.80	7.17	5.53	0.00
112.00	7.17	5.53	0.00
112.20	7.17	5.53	0.00
112.40	7.17	5.53	0.00
112.60	7.17	5.53	0.00
112.80	7.17	5.53	0.00
113.00	7.17	5.53	0.00
113.20	7.17	5.53	0.00
113.40	7.17	5.53	0.00
113.60	7.17	5.53	0.00
113.80	7.17	5.53	0.00
114.00	7.17	5.53	0.00
114.20	7.17	5.53	0.00
114.40	7.17	5.53	0.00
114.60	7.17	5.53	0.00
114.80	7.17	5.53	0.00
115.00	7.17	5.53	0.00
115.20	7.17	5.53	0.00
115.40	7.17	5.53	0.00
115.60	7.17	5.53	0.00
115.80	7.17	5.53	0.00
116.00	7.17	5.53	0.00
116.20	7.17	5.53	0.00
116.40	7.17	5.53	0.00
116.60	7.17	5.53	0.00
116.80	7.17	5.53	0.00
117.00	7.17	5.53	0.00
117.20	7.17	5.53	0.00
117.40	7.17	5.53	0.00
117.60	7.17	5.53	0.00
117.80	7.17	5.53	0.00
118.00	7.17	5.53	0.00
118.20	7.17	5.53	0.00
118.40	7.17	5.53	0.00
118.60	7.17	5.53	0.00
118.80	7.17	5.53	0.00
119.00	7.17	5.53	0.00
119.20	7.17	5.53	0.00
119.40	7.17	5.53	0.00
119.60	7.17	5.53	0.00
119.80	7.17	5.53	0.00
120.00	7.17	5.53	0.00

Summary for Pond 4P: Horizontal Pipe

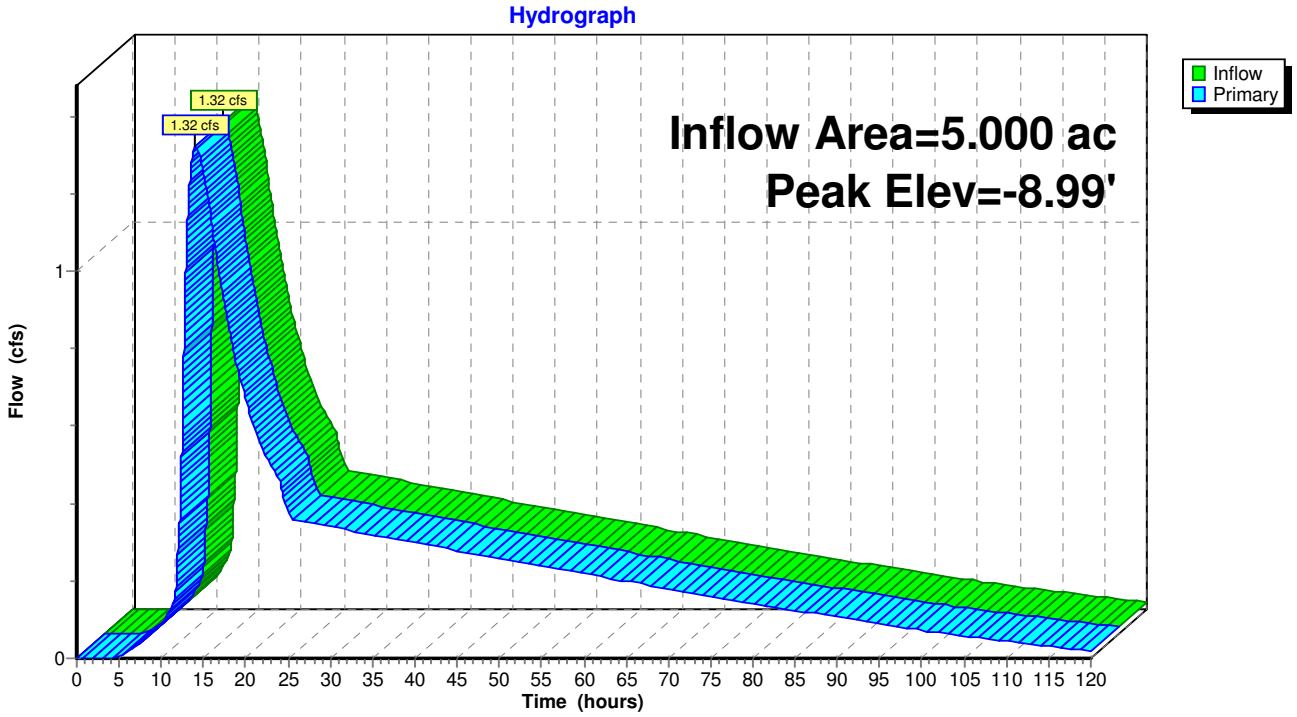
Inflow Area = 5.000 ac, 0.00% Impervious, Inflow Depth > 5.49" for 50-year event
Inflow = 1.32 cfs @ 14.01 hrs, Volume= 2.288 af
Outflow = 1.32 cfs @ 14.01 hrs, Volume= 2.288 af, Atten= 0%, Lag= 0.0 min
Primary = 1.32 cfs @ 14.01 hrs, Volume= 2.288 af

Routing by Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Peak Elev= -8.99' @ 14.01 hrs

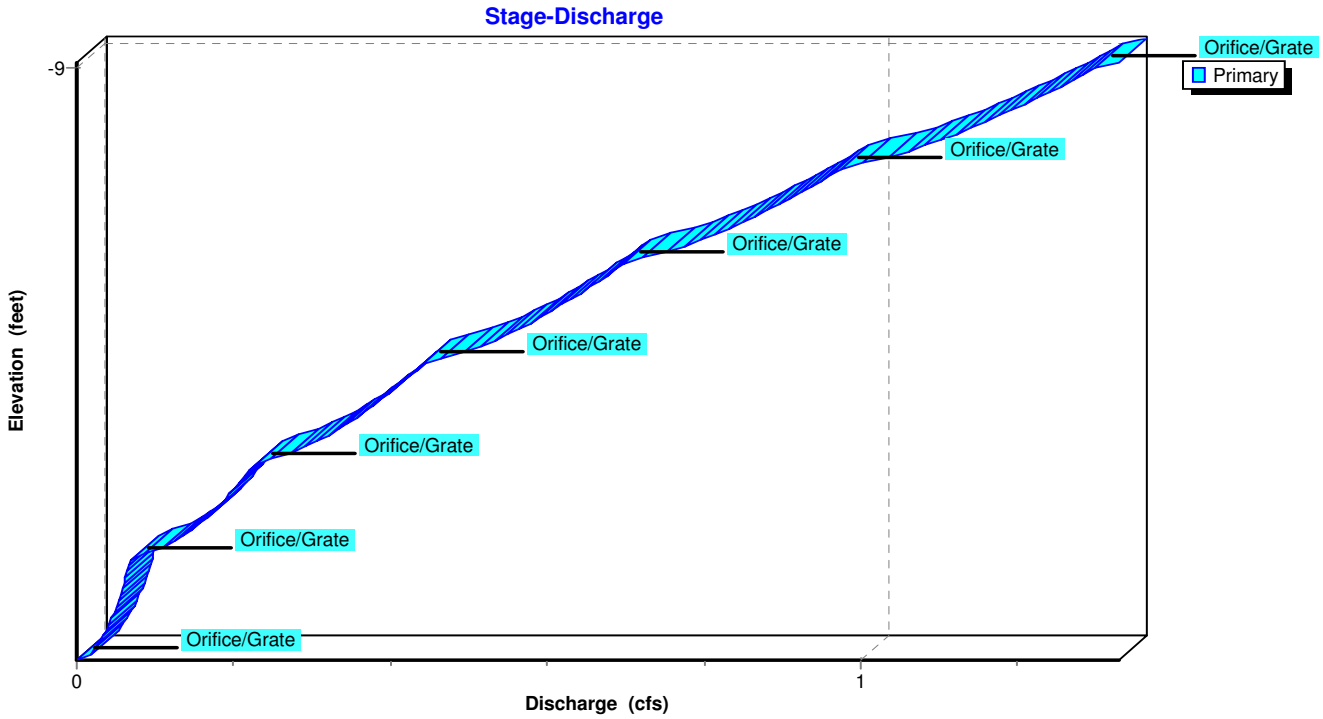
Device	Routing	Invert	Outlet Devices
#1	Primary	-10.00'	**0.2" Horiz. Orifice/Grate X 159.00** C= 0.600 Limited to weir flow at low heads
#2	Primary	-9.83'	**0.2" Vert. Orifice/Grate X 318.00** C= 0.600
#3	Primary	-9.67'	**0.2" Vert. Orifice/Grate X 318.00** C= 0.600
#4	Primary	-9.50'	**0.2" Vert. Orifice/Grate X 318.00** C= 0.600
#5	Primary	-9.33'	**0.2" Vert. Orifice/Grate X 318.00** C= 0.600
#6	Primary	-9.17'	**0.2" Vert. Orifice/Grate X 318.00** C= 0.600
#7	Primary	-9.00'	**0.2" Horiz. Orifice/Grate X 159.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.32 cfs @ 14.01 hrs HW=-8.99' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.17 cfs @ 4.83 fps)
- **2=Orifice/Grate** (Orifice Controls 0.30 cfs @ 4.38 fps)
- **3=Orifice/Grate** (Orifice Controls 0.27 cfs @ 3.94 fps)
- **4=Orifice/Grate** (Orifice Controls 0.24 cfs @ 3.40 fps)
- **5=Orifice/Grate** (Orifice Controls 0.19 cfs @ 2.76 fps)
- **6=Orifice/Grate** (Orifice Controls 0.14 cfs @ 1.98 fps)
- **7=Orifice/Grate** (Orifice Controls 0.01 cfs @ 0.42 fps)

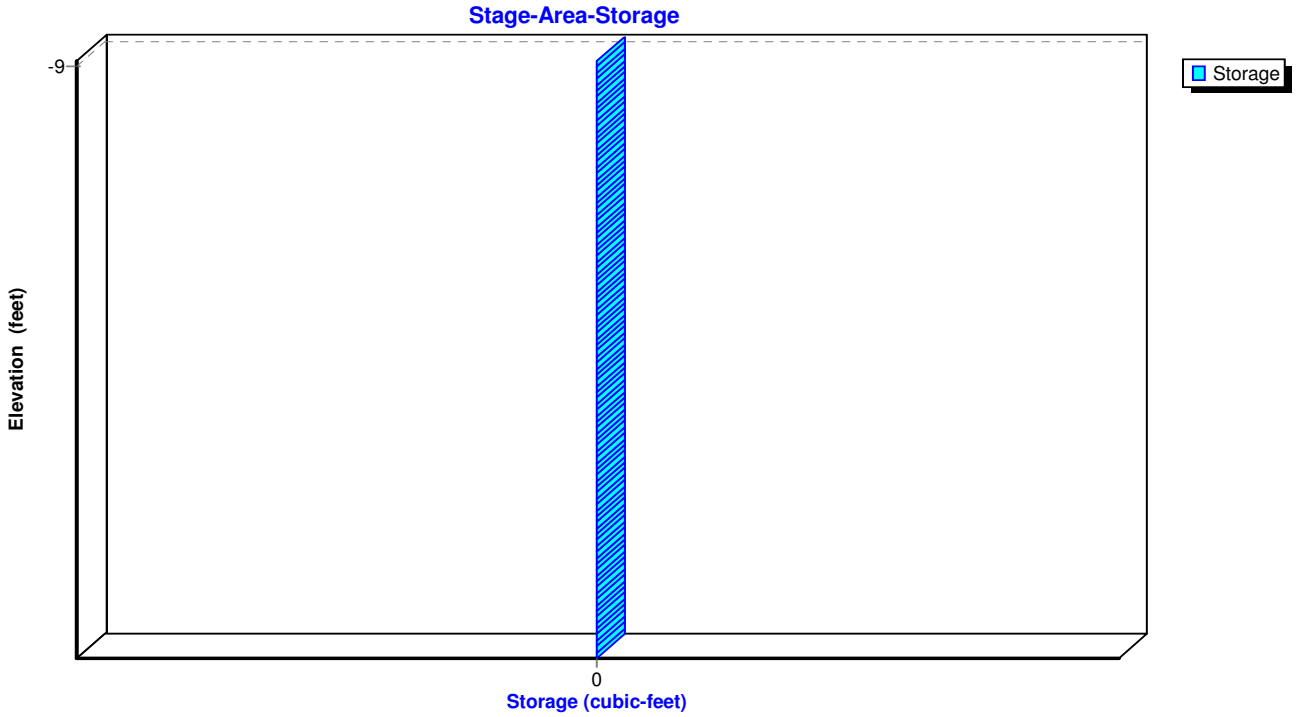
Pond 4P: Horizontal Pipe



Pond 4P: Horizontal Pipe



Pond 4P: Horizontal Pipe



Hydrograph for Pond 4P: Horizontal Pipe

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)	Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	-10.00	0.00	10.40	0.10	-9.81	0.10
0.20	0.00	-10.00	0.00	10.60	0.11	-9.81	0.11
0.40	0.00	-10.00	0.00	10.80	0.12	-9.80	0.12
0.60	0.00	-10.00	0.00	11.00	0.13	-9.80	0.13
0.80	0.00	-10.00	0.00	11.20	0.14	-9.79	0.14
1.00	0.00	-10.00	0.00	11.40	0.15	-9.78	0.15
1.20	0.00	-10.00	0.00	11.60	0.16	-9.76	0.16
1.40	0.00	-10.00	0.00	11.80	0.21	-9.70	0.21
1.60	0.00	-10.00	0.00	12.00	0.31	-9.63	0.31
1.80	0.00	-10.00	0.00	12.20	0.36	-9.59	0.36
2.00	0.00	-10.00	0.00	12.40	0.49	-9.48	0.49
2.20	0.00	-10.00	0.00	12.60	0.73	-9.32	0.73
2.40	0.00	-10.00	0.00	12.80	0.92	-9.21	0.92
2.60	0.00	-10.00	0.00	13.00	1.07	-9.14	1.07
2.80	0.00	-10.00	0.00	13.20	1.17	-9.09	1.17
3.00	0.00	-10.00	0.00	13.40	1.24	-9.04	1.24
3.20	0.00	-10.00	0.00	13.60	1.29	-9.01	1.29
3.40	0.00	-10.00	0.00	13.80	1.31	-9.00	1.31
3.60	0.00	-10.00	0.00	14.00	**1.32**	**-8.99**	**1.32**
3.80	0.00	-10.00	0.00	14.20	**1.32**	**-8.99**	**1.32**
4.00	0.00	-10.00	0.00	14.40	1.31	-9.00	1.31
4.20	0.00	-10.00	0.00	14.60	1.29	-9.01	1.29
4.40	0.00	-10.00	0.00	14.80	1.27	-9.02	1.27
4.60	0.00	-10.00	0.00	15.00	1.25	-9.03	1.25
4.80	0.00	-10.00	0.00	15.20	1.23	-9.05	1.23
5.00	0.00	-10.00	0.00	15.40	1.20	-9.06	1.20
5.20	0.01	-10.00	0.01	15.60	1.18	-9.08	1.18
5.40	0.01	-10.00	0.01	15.80	1.15	-9.10	1.15
5.60	0.01	-9.99	0.01	16.00	1.12	-9.11	1.12
5.80	0.01	-9.99	0.01	16.20	1.09	-9.13	1.09
6.00	0.01	-9.99	0.01	16.40	1.06	-9.14	1.06
6.20	0.02	-9.99	0.02	16.60	1.03	-9.15	1.03
6.40	0.02	-9.98	0.02	16.80	1.00	-9.16	1.00
6.60	0.02	-9.98	0.02	17.00	0.97	-9.17	0.97
6.80	0.03	-9.97	0.03	17.20	0.95	-9.19	0.95
7.00	0.03	-9.97	0.03	17.40	0.92	-9.21	0.92
7.20	0.03	-9.96	0.03	17.60	0.90	-9.23	0.90
7.40	0.04	-9.95	0.04	17.80	0.87	-9.24	0.87
7.60	0.04	-9.94	0.04	18.00	0.85	-9.26	0.85
7.80	0.04	-9.93	0.04	18.20	0.83	-9.27	0.83
8.00	0.05	-9.92	0.05	18.40	0.81	-9.28	0.81
8.20	0.05	-9.91	0.05	18.60	0.79	-9.30	0.79
8.40	0.05	-9.90	0.05	18.80	0.77	-9.30	0.77
8.60	0.06	-9.88	0.06	19.00	0.75	-9.31	0.75
8.80	0.06	-9.86	0.06	19.20	0.73	-9.32	0.73
9.00	0.07	-9.84	0.07	19.40	0.72	-9.32	0.72
9.20	0.07	-9.83	0.07	19.60	0.70	-9.33	0.70
9.40	0.08	-9.83	0.08	19.80	0.68	-9.34	0.68
9.60	0.08	-9.82	0.08	20.00	0.67	-9.36	0.67
9.80	0.09	-9.82	0.09	20.20	0.65	-9.37	0.65
10.00	0.09	-9.82	0.09	20.40	0.64	-9.39	0.64
10.20	0.10	-9.81	0.10	20.60	0.62	-9.40	0.62

Hydrograph for Pond 4P: Horizontal Pipe (continued)

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)	Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
20.80	0.61	-9.41	0.61	31.20	0.34	-9.61	0.34
21.00	0.60	-9.42	0.60	31.40	0.33	-9.61	0.33
21.20	0.58	-9.43	0.58	31.60	0.33	-9.61	0.33
21.40	0.57	-9.44	0.57	31.80	0.33	-9.61	0.33
21.60	0.56	-9.44	0.56	32.00	0.33	-9.61	0.33
21.80	0.55	-9.45	0.55	32.20	0.33	-9.61	0.33
22.00	0.54	-9.46	0.54	32.40	0.33	-9.61	0.33
22.20	0.53	-9.46	0.53	32.60	0.33	-9.61	0.33
22.40	0.52	-9.47	0.52	32.80	0.33	-9.61	0.33
22.60	0.51	-9.47	0.51	33.00	0.33	-9.61	0.33
22.80	0.51	-9.47	0.51	33.20	0.33	-9.62	0.33
23.00	0.50	-9.48	0.50	33.40	0.33	-9.62	0.33
23.20	0.49	-9.48	0.49	33.60	0.33	-9.62	0.33
23.40	0.48	-9.48	0.48	33.80	0.32	-9.62	0.32
23.60	0.48	-9.49	0.48	34.00	0.32	-9.62	0.32
23.80	0.47	-9.49	0.47	34.20	0.32	-9.62	0.32
24.00	0.46	-9.49	0.46	34.40	0.32	-9.62	0.32
24.20	0.44	-9.50	0.44	34.60	0.32	-9.62	0.32
24.40	0.42	-9.52	0.42	34.80	0.32	-9.62	0.32
24.60	0.41	-9.54	0.41	35.00	0.32	-9.62	0.32
24.80	0.39	-9.56	0.39	35.20	0.32	-9.62	0.32
25.00	0.37	-9.57	0.37	35.40	0.32	-9.62	0.32
25.20	0.36	-9.59	0.36	35.60	0.32	-9.62	0.32
25.40	0.36	-9.59	0.36	35.80	0.32	-9.62	0.32
25.60	0.36	-9.59	0.36	36.00	0.32	-9.62	0.32
25.80	0.36	-9.59	0.36	36.20	0.32	-9.62	0.32
26.00	0.36	-9.59	0.36	36.40	0.31	-9.62	0.31
26.20	0.36	-9.59	0.36	36.60	0.31	-9.63	0.31
26.40	0.36	-9.59	0.36	36.80	0.31	-9.63	0.31
26.60	0.35	-9.59	0.35	37.00	0.31	-9.63	0.31
26.80	0.35	-9.59	0.35	37.20	0.31	-9.63	0.31
27.00	0.35	-9.59	0.35	37.40	0.31	-9.63	0.31
27.20	0.35	-9.59	0.35	37.60	0.31	-9.63	0.31
27.40	0.35	-9.59	0.35	37.80	0.31	-9.63	0.31
27.60	0.35	-9.60	0.35	38.00	0.31	-9.63	0.31
27.80	0.35	-9.60	0.35	38.20	0.31	-9.63	0.31
28.00	0.35	-9.60	0.35	38.40	0.31	-9.63	0.31
28.20	0.35	-9.60	0.35	38.60	0.30	-9.63	0.30
28.40	0.35	-9.60	0.35	38.80	0.30	-9.63	0.30
28.60	0.35	-9.60	0.35	39.00	0.30	-9.63	0.30
28.80	0.35	-9.60	0.35	39.20	0.30	-9.63	0.30
29.00	0.35	-9.60	0.35	39.40	0.30	-9.63	0.30
29.20	0.34	-9.60	0.34	39.60	0.30	-9.63	0.30
29.40	0.34	-9.60	0.34	39.80	0.30	-9.63	0.30
29.60	0.34	-9.60	0.34	40.00	0.30	-9.64	0.30
29.80	0.34	-9.60	0.34	40.20	0.30	-9.64	0.30
30.00	0.34	-9.60	0.34	40.40	0.30	-9.64	0.30
30.20	0.34	-9.60	0.34	40.60	0.30	-9.64	0.30
30.40	0.34	-9.61	0.34	40.80	0.30	-9.64	0.30
30.60	0.34	-9.61	0.34	41.00	0.30	-9.64	0.30
30.80	0.34	-9.61	0.34	41.20	0.29	-9.64	0.29
31.00	0.34	-9.61	0.34	41.40	0.29	-9.64	0.29

Hydrograph for Pond 4P: Horizontal Pipe (continued)

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)	Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
41.60	0.29	-9.64	0.29	52.00	0.25	-9.66	0.25
41.80	0.29	-9.64	0.29	52.20	0.25	-9.66	0.25
42.00	0.29	-9.64	0.29	52.40	0.25	-9.66	0.25
42.20	0.29	-9.64	0.29	52.60	0.25	-9.66	0.25
42.40	0.29	-9.64	0.29	52.80	0.25	-9.66	0.25
42.60	0.29	-9.64	0.29	53.00	0.25	-9.66	0.25
42.80	0.29	-9.64	0.29	53.20	0.25	-9.66	0.25
43.00	0.29	-9.64	0.29	53.40	0.25	-9.66	0.25
43.20	0.29	-9.64	0.29	53.60	0.24	-9.66	0.24
43.40	0.29	-9.64	0.29	53.80	0.24	-9.66	0.24
43.60	0.28	-9.64	0.28	54.00	0.24	-9.66	0.24
43.80	0.28	-9.64	0.28	54.20	0.24	-9.66	0.24
44.00	0.28	-9.64	0.28	54.40	0.24	-9.66	0.24
44.20	0.28	-9.65	0.28	54.60	0.24	-9.66	0.24
44.40	0.28	-9.65	0.28	54.80	0.24	-9.66	0.24
44.60	0.28	-9.65	0.28	55.00	0.24	-9.66	0.24
44.80	0.28	-9.65	0.28	55.20	0.24	-9.66	0.24
45.00	0.28	-9.65	0.28	55.40	0.24	-9.66	0.24
45.20	0.28	-9.65	0.28	55.60	0.24	-9.67	0.24
45.40	0.28	-9.65	0.28	55.80	0.24	-9.67	0.24
45.60	0.28	-9.65	0.28	56.00	0.23	-9.67	0.23
45.80	0.28	-9.65	0.28	56.20	0.23	-9.67	0.23
46.00	0.27	-9.65	0.27	56.40	0.23	-9.67	0.23
46.20	0.27	-9.65	0.27	56.60	0.23	-9.67	0.23
46.40	0.27	-9.65	0.27	56.80	0.23	-9.67	0.23
46.60	0.27	-9.65	0.27	57.00	0.23	-9.67	0.23
46.80	0.27	-9.65	0.27	57.20	0.23	-9.67	0.23
47.00	0.27	-9.65	0.27	57.40	0.23	-9.67	0.23
47.20	0.27	-9.65	0.27	57.60	0.23	-9.67	0.23
47.40	0.27	-9.65	0.27	57.80	0.23	-9.67	0.23
47.60	0.27	-9.65	0.27	58.00	0.23	-9.67	0.23
47.80	0.27	-9.65	0.27	58.20	0.23	-9.67	0.23
48.00	0.27	-9.65	0.27	58.40	0.22	-9.67	0.22
48.20	0.27	-9.65	0.27	58.60	0.22	-9.67	0.22
48.40	0.27	-9.65	0.27	58.80	0.22	-9.67	0.22
48.60	0.26	-9.65	0.26	59.00	0.22	-9.68	0.22
48.80	0.26	-9.65	0.26	59.20	0.22	-9.68	0.22
49.00	0.26	-9.65	0.26	59.40	0.22	-9.68	0.22
49.20	0.26	-9.65	0.26	59.60	0.22	-9.68	0.22
49.40	0.26	-9.65	0.26	59.80	0.22	-9.68	0.22
49.60	0.26	-9.65	0.26	60.00	0.22	-9.68	0.22
49.80	0.26	-9.66	0.26	60.20	0.22	-9.68	0.22
50.00	0.26	-9.66	0.26	60.40	0.22	-9.68	0.22
50.20	0.26	-9.66	0.26	60.60	0.22	-9.69	0.22
50.40	0.26	-9.66	0.26	60.80	0.22	-9.69	0.22
50.60	0.26	-9.66	0.26	61.00	0.22	-9.69	0.22
50.80	0.25	-9.66	0.25	61.20	0.21	-9.69	0.21
51.00	0.25	-9.66	0.25	61.40	0.21	-9.69	0.21
51.20	0.25	-9.66	0.25	61.60	0.21	-9.69	0.21
51.40	0.25	-9.66	0.25	61.80	0.21	-9.69	0.21
51.60	0.25	-9.66	0.25	62.00	0.21	-9.70	0.21
51.80	0.25	-9.66	0.25	62.20	0.21	-9.70	0.21

Hydrograph for Pond 4P: Horizontal Pipe (continued)

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)	Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
62.40	0.21	-9.70	0.21	72.80	0.17	-9.75	0.17
62.60	0.21	-9.70	0.21	73.00	0.17	-9.76	0.17
62.80	0.21	-9.70	0.21	73.20	0.17	-9.76	0.17
63.00	0.21	-9.70	0.21	73.40	0.17	-9.76	0.17
63.20	0.21	-9.70	0.21	73.60	0.17	-9.76	0.17
63.40	0.21	-9.70	0.21	73.80	0.17	-9.76	0.17
63.60	0.20	-9.71	0.20	74.00	0.16	-9.76	0.16
63.80	0.20	-9.71	0.20	74.20	0.16	-9.76	0.16
64.00	0.20	-9.71	0.20	74.40	0.16	-9.76	0.16
64.20	0.20	-9.71	0.20	74.60	0.16	-9.76	0.16
64.40	0.20	-9.71	0.20	74.80	0.16	-9.76	0.16
64.60	0.20	-9.71	0.20	75.00	0.16	-9.77	0.16
64.80	0.20	-9.71	0.20	75.20	0.16	-9.77	0.16
65.00	0.20	-9.71	0.20	75.40	0.16	-9.77	0.16
65.20	0.20	-9.71	0.20	75.60	0.16	-9.77	0.16
65.40	0.20	-9.72	0.20	75.80	0.16	-9.77	0.16
65.60	0.20	-9.72	0.20	76.00	0.16	-9.77	0.16
65.80	0.20	-9.72	0.20	76.20	0.16	-9.77	0.16
66.00	0.20	-9.72	0.20	76.40	0.16	-9.77	0.16
66.20	0.20	-9.72	0.20	76.60	0.15	-9.77	0.15
66.40	0.19	-9.72	0.19	76.80	0.15	-9.77	0.15
66.60	0.19	-9.72	0.19	77.00	0.15	-9.77	0.15
66.80	0.19	-9.72	0.19	77.20	0.15	-9.77	0.15
67.00	0.19	-9.72	0.19	77.40	0.15	-9.77	0.15
67.20	0.19	-9.73	0.19	77.60	0.15	-9.77	0.15
67.40	0.19	-9.73	0.19	77.80	0.15	-9.78	0.15
67.60	0.19	-9.73	0.19	78.00	0.15	-9.78	0.15
67.80	0.19	-9.73	0.19	78.20	0.15	-9.78	0.15
68.00	0.19	-9.73	0.19	78.40	0.15	-9.78	0.15
68.20	0.19	-9.73	0.19	78.60	0.15	-9.78	0.15
68.40	0.19	-9.73	0.19	78.80	0.15	-9.78	0.15
68.60	0.19	-9.73	0.19	79.00	0.15	-9.78	0.15
68.80	0.18	-9.73	0.18	79.20	0.15	-9.78	0.15
69.00	0.18	-9.74	0.18	79.40	0.14	-9.78	0.14
69.20	0.18	-9.74	0.18	79.60	0.14	-9.78	0.14
69.40	0.18	-9.74	0.18	79.80	0.14	-9.78	0.14
69.60	0.18	-9.74	0.18	80.00	0.14	-9.78	0.14
69.80	0.18	-9.74	0.18	80.20	0.14	-9.79	0.14
70.00	0.18	-9.74	0.18	80.40	0.14	-9.79	0.14
70.20	0.18	-9.74	0.18	80.60	0.14	-9.79	0.14
70.40	0.18	-9.74	0.18	80.80	0.14	-9.79	0.14
70.60	0.18	-9.74	0.18	81.00	0.14	-9.79	0.14
70.80	0.18	-9.74	0.18	81.20	0.14	-9.79	0.14
71.00	0.18	-9.75	0.18	81.40	0.14	-9.79	0.14
71.20	0.18	-9.75	0.18	81.60	0.14	-9.79	0.14
71.40	0.17	-9.75	0.17	81.80	0.14	-9.79	0.14
71.60	0.17	-9.75	0.17	82.00	0.13	-9.79	0.13
71.80	0.17	-9.75	0.17	82.20	0.13	-9.79	0.13
72.00	0.17	-9.75	0.17	82.40	0.13	-9.79	0.13
72.20	0.17	-9.75	0.17	82.60	0.13	-9.79	0.13
72.40	0.17	-9.75	0.17	82.80	0.13	-9.79	0.13
72.60	0.17	-9.75	0.17	83.00	0.13	-9.79	0.13

Hydrograph for Pond 4P: Horizontal Pipe (continued)

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)	Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
83.20	0.13	-9.79	0.13	93.60	0.09	-9.82	0.09
83.40	0.13	-9.79	0.13	93.80	0.09	-9.82	0.09
83.60	0.13	-9.80	0.13	94.00	0.09	-9.82	0.09
83.80	0.13	-9.80	0.13	94.20	0.09	-9.82	0.09
84.00	0.13	-9.80	0.13	94.40	0.09	-9.82	0.09
84.20	0.13	-9.80	0.13	94.60	0.09	-9.82	0.09
84.40	0.13	-9.80	0.13	94.80	0.09	-9.82	0.09
84.60	0.13	-9.80	0.13	95.00	0.09	-9.82	0.09
84.80	0.12	-9.80	0.12	95.20	0.09	-9.82	0.09
85.00	0.12	-9.80	0.12	95.40	0.09	-9.82	0.09
85.20	0.12	-9.80	0.12	95.60	0.09	-9.82	0.09
85.40	0.12	-9.80	0.12	95.80	0.09	-9.82	0.09
85.60	0.12	-9.80	0.12	96.00	0.08	-9.82	0.08
85.80	0.12	-9.80	0.12	96.20	0.08	-9.82	0.08
86.00	0.12	-9.80	0.12	96.40	0.08	-9.82	0.08
86.20	0.12	-9.80	0.12	96.60	0.08	-9.82	0.08
86.40	0.12	-9.80	0.12	96.80	0.08	-9.82	0.08
86.60	0.12	-9.80	0.12	97.00	0.08	-9.82	0.08
86.80	0.12	-9.80	0.12	97.20	0.08	-9.82	0.08
87.00	0.12	-9.80	0.12	97.40	0.08	-9.82	0.08
87.20	0.12	-9.81	0.12	97.60	0.08	-9.82	0.08
87.40	0.12	-9.81	0.12	97.80	0.08	-9.82	0.08
87.60	0.12	-9.81	0.12	98.00	0.08	-9.82	0.08
87.80	0.11	-9.81	0.11	98.20	0.08	-9.82	0.08
88.00	0.11	-9.81	0.11	98.40	0.08	-9.82	0.08
88.20	0.11	-9.81	0.11	98.60	0.08	-9.82	0.08
88.40	0.11	-9.81	0.11	98.80	0.08	-9.83	0.08
88.60	0.11	-9.81	0.11	99.00	0.08	-9.83	0.08
88.80	0.11	-9.81	0.11	99.20	0.08	-9.83	0.08
89.00	0.11	-9.81	0.11	99.40	0.08	-9.83	0.08
89.20	0.11	-9.81	0.11	99.60	0.07	-9.83	0.07
89.40	0.11	-9.81	0.11	99.80	0.07	-9.83	0.07
89.60	0.11	-9.81	0.11	100.00	0.07	-9.83	0.07
89.80	0.11	-9.81	0.11	100.20	0.07	-9.83	0.07
90.00	0.11	-9.81	0.11	100.40	0.07	-9.83	0.07
90.20	0.11	-9.81	0.11	100.60	0.07	-9.83	0.07
90.40	0.10	-9.81	0.10	100.80	0.07	-9.83	0.07
90.60	0.10	-9.81	0.10	101.00	0.07	-9.83	0.07
90.80	0.10	-9.81	0.10	101.20	0.07	-9.83	0.07
91.00	0.10	-9.81	0.10	101.40	0.07	-9.84	0.07
91.20	0.10	-9.81	0.10	101.60	0.07	-9.84	0.07
91.40	0.10	-9.81	0.10	101.80	0.07	-9.84	0.07
91.60	0.10	-9.81	0.10	102.00	0.07	-9.84	0.07
91.80	0.10	-9.81	0.10	102.20	0.07	-9.85	0.07
92.00	0.10	-9.81	0.10	102.40	0.07	-9.85	0.07
92.20	0.10	-9.81	0.10	102.60	0.06	-9.85	0.06
92.40	0.10	-9.81	0.10	102.80	0.06	-9.85	0.06
92.60	0.10	-9.81	0.10	103.00	0.06	-9.85	0.06
92.80	0.10	-9.82	0.10	103.20	0.06	-9.86	0.06
93.00	0.10	-9.82	0.10	103.40	0.06	-9.86	0.06
93.20	0.10	-9.82	0.10	103.60	0.06	-9.86	0.06
93.40	0.10	-9.82	0.10	103.80	0.06	-9.86	0.06

Hydrograph for Pond 4P: Horizontal Pipe (continued)

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
104.00	0.06	-9.87	0.06
104.20	0.06	-9.87	0.06
104.40	0.06	-9.87	0.06
104.60	0.06	-9.87	0.06
104.80	0.06	-9.88	0.06
105.00	0.06	-9.88	0.06
105.20	0.06	-9.88	0.06
105.40	0.06	-9.89	0.06
105.60	0.06	-9.89	0.06
105.80	0.06	-9.89	0.06
106.00	0.05	-9.89	0.05
106.20	0.05	-9.90	0.05
106.40	0.05	-9.90	0.05
106.60	0.05	-9.90	0.05
106.80	0.05	-9.90	0.05
107.00	0.05	-9.90	0.05
107.20	0.05	-9.91	0.05
107.40	0.05	-9.91	0.05
107.60	0.05	-9.91	0.05
107.80	0.05	-9.91	0.05
108.00	0.05	-9.91	0.05
108.20	0.05	-9.91	0.05
108.40	0.05	-9.92	0.05
108.60	0.05	-9.92	0.05
108.80	0.05	-9.92	0.05
109.00	0.05	-9.92	0.05
109.20	0.05	-9.92	0.05
109.40	0.05	-9.92	0.05
109.60	0.05	-9.93	0.05
109.80	0.04	-9.93	0.04
110.00	0.04	-9.93	0.04
110.20	0.04	-9.93	0.04
110.40	0.04	-9.93	0.04
110.60	0.04	-9.94	0.04
110.80	0.04	-9.94	0.04
111.00	0.04	-9.94	0.04
111.20	0.04	-9.94	0.04
111.40	0.04	-9.94	0.04
111.60	0.04	-9.94	0.04
111.80	0.04	-9.95	0.04
112.00	0.04	-9.95	0.04
112.20	0.04	-9.95	0.04
112.40	0.04	-9.95	0.04
112.60	0.04	-9.95	0.04
112.80	0.04	-9.95	0.04
113.00	0.04	-9.95	0.04
113.20	0.04	-9.95	0.04
113.40	0.04	-9.96	0.04
113.60	0.03	-9.96	0.03
113.80	0.03	-9.96	0.03
114.00	0.03	-9.96	0.03
114.20	0.03	-9.96	0.03
114.40	0.03	-9.96	0.03
114.60	0.03	-9.96	0.03
114.80	0.03	-9.96	0.03
115.00	0.03	-9.96	0.03
115.20	0.03	-9.97	0.03
115.40	0.03	-9.97	0.03
115.60	0.03	-9.97	0.03
115.80	0.03	-9.97	0.03
116.00	0.03	-9.97	0.03
116.20	0.03	-9.97	0.03
116.40	0.03	-9.97	0.03
116.60	0.03	-9.97	0.03
116.80	0.03	-9.98	0.03
117.00	0.03	-9.98	0.03
117.20	0.03	-9.98	0.03
117.40	0.02	-9.98	0.02
117.60	0.02	-9.98	0.02
117.80	0.02	-9.98	0.02
118.00	0.02	-9.98	0.02
118.20	0.02	-9.98	0.02
118.40	0.02	-9.98	0.02
118.60	0.02	-9.98	0.02
118.80	0.02	-9.98	0.02
119.00	0.02	-9.98	0.02
119.20	0.02	-9.98	0.02
119.40	0.02	-9.98	0.02
119.60	0.02	-9.98	0.02
119.80	0.02	-9.98	0.02
120.00	0.02	-9.98	0.02

Summary for Pond 13P: Chimney Drain

Inflow Area = 5.000 ac, 0.00% Impervious, Inflow Depth = 5.53" for 50-year event
Inflow = 46.10 cfs @ 11.97 hrs, Volume= 2.304 af
Outflow = 1.32 cfs @ 14.01 hrs, Volume= 2.288 af, Atten= 97%, Lag= 122.7 min
Primary = 1.32 cfs @ 14.01 hrs, Volume= 2.288 af

Routing by Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Peak Elev= 5.21' @ 14.01 hrs Surf.Area= 42,945 sf Storage= 68,995 cf

Plug-Flow detention time= 1,684.2 min calculated for 2.288 af (99% of inflow)
Center-of-Mass det. time= 1,679.7 min (2,467.9 - 788.2)

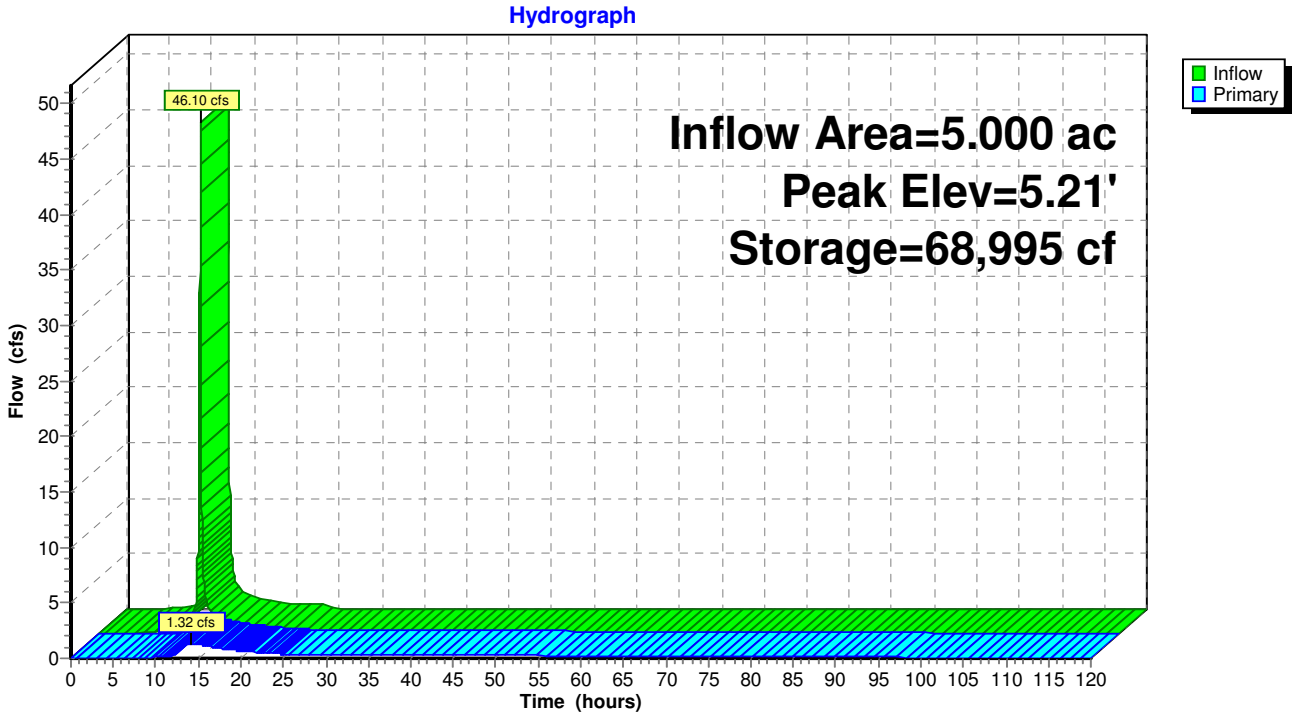
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	386,062 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	64	0	0
1.00	1,886	975	975
2.00	6,221	4,054	5,029
3.00	13,070	9,646	14,674
4.00	22,432	17,751	32,425
5.00	34,307	28,370	60,795
6.00	74,991	54,649	115,444
7.00	131,382	103,187	218,630
8.00	203,482	167,432	386,062

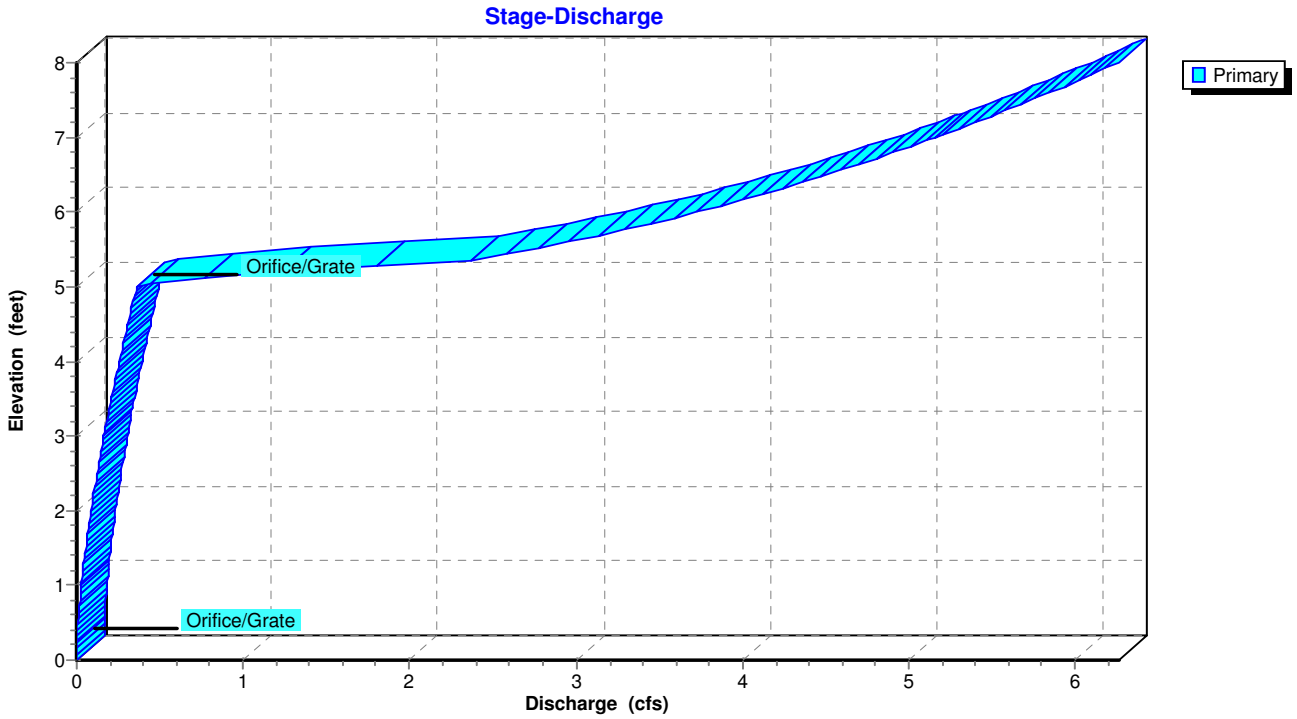
Device	Routing	Invert	Outlet Devices
#1	Primary	0.25'	**0.2" Vert. Orifice/Grate X 12.00 columns** X 19 rows with 3.0" cc spacing C= 0.600
#2	Primary	5.00'	**11.2" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.32 cfs @ 14.01 hrs HW=5.21' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.38 cfs @ 7.61 fps)
└─**2=Orifice/Grate** (Weir Controls 0.94 cfs @ 1.51 fps)

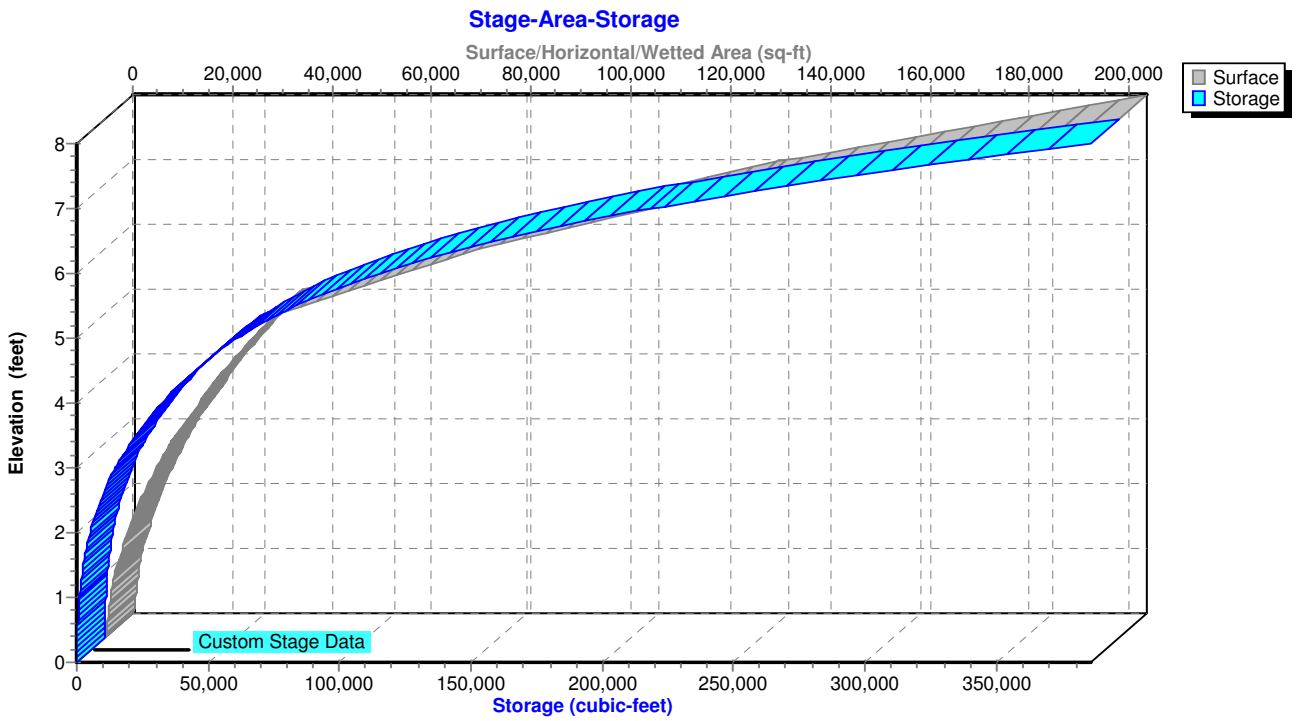
Pond 13P: Chimney Drain



Pond 13P: Chimney Drain



Pond 13P: Chimney Drain



Hydrograph for Pond 13P: Chimney Drain

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	0	0.00	0.00
0.50	0.00	0	0.00	0.00
1.00	0.00	0	0.00	0.00
1.50	0.00	0	0.00	0.00
2.00	0.00	0	0.00	0.00
2.50	0.00	0	0.00	0.00
3.00	0.00	0	0.00	0.00
3.50	0.00	0	0.00	0.00
4.00	0.01	1	0.01	0.00
4.50	0.04	40	0.17	0.00
5.00	0.07	137	0.35	0.00
5.50	0.11	293	0.53	0.01
6.00	0.15	510	0.71	0.01
6.50	0.20	790	0.90	0.02
7.00	0.24	1,136	1.08	0.03
7.50	0.29	1,549	1.24	0.04
8.00	0.34	2,032	1.39	0.05
8.50	0.44	2,629	1.54	0.06
9.00	0.58	3,433	1.71	0.07
9.50	0.65	4,416	1.90	0.08
10.00	0.84	5,572	2.08	0.09
10.50	1.16	7,172	2.30	0.11
11.00	1.71	9,513	2.55	0.13
11.50	**3.01**	13,389	2.90	0.15
12.00	**42.34**	46,735	4.56	0.31
12.50	3.66	63,900	5.09	0.63
13.00	2.24	67,279	5.17	1.07
13.50	1.70	68,650	5.20	1.26
14.00	1.33	**69,012**	**5.21**	**1.32**
14.50	1.17	**68,872**	**5.21**	**1.30**
15.00	1.05	68,576	5.20	1.25
15.50	0.94	68,166	5.19	1.19
16.00	0.82	67,660	5.18	1.12
16.50	0.76	67,122	5.17	1.04
17.00	0.72	66,636	5.16	0.97
17.50	0.67	66,193	5.14	0.91
18.00	0.63	65,782	5.13	0.85
18.50	0.59	65,397	5.12	0.80
19.00	0.55	65,028	5.12	0.75
19.50	0.50	64,657	5.11	0.71
20.00	0.46	64,283	5.10	0.67
20.50	0.44	63,925	5.09	0.63
21.00	0.44	63,615	5.08	0.60
21.50	0.43	63,348	5.07	0.57
22.00	0.42	63,114	5.06	0.54
22.50	0.41	62,908	5.06	0.52
23.00	0.40	62,725	5.05	0.50
23.50	0.39	62,561	5.05	0.48
24.00	0.38	62,413	5.05	0.46
24.50	0.00	61,751	5.03	0.41
25.00	0.00	61,042	5.01	0.37
25.50	0.00	60,391	4.99	0.36

Hydrograph for Pond 13P: Chimney Drain (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
26.00	0.00	59,747	4.97	0.36
26.50	0.00	59,106	4.95	0.35
27.00	0.00	58,469	4.93	0.35
27.50	0.00	57,835	4.91	0.35
28.00	0.00	57,205	4.89	0.35
28.50	0.00	56,578	4.87	0.35
29.00	0.00	55,954	4.86	0.35
29.50	0.00	55,335	4.84	0.34
30.00	0.00	54,719	4.82	0.34
30.50	0.00	54,107	4.80	0.34
31.00	0.00	53,498	4.78	0.34
31.50	0.00	52,894	4.76	0.33
32.00	0.00	52,295	4.74	0.33
32.50	0.00	51,699	4.72	0.33
33.00	0.00	51,108	4.70	0.33
33.50	0.00	50,519	4.68	0.33
34.00	0.00	49,934	4.66	0.32
34.50	0.00	49,352	4.64	0.32
35.00	0.00	48,774	4.63	0.32
35.50	0.00	48,199	4.61	0.32
36.00	0.00	47,628	4.59	0.32
36.50	0.00	47,060	4.57	0.31
37.00	0.00	46,496	4.55	0.31
37.50	0.00	45,937	4.53	0.31
38.00	0.00	45,382	4.51	0.31
38.50	0.00	44,831	4.49	0.30
39.00	0.00	44,284	4.47	0.30
39.50	0.00	43,740	4.45	0.30
40.00	0.00	43,200	4.43	0.30
40.50	0.00	42,663	4.41	0.30
41.00	0.00	42,129	4.39	0.30
41.50	0.00	41,598	4.37	0.29
42.00	0.00	41,072	4.35	0.29
42.50	0.00	40,548	4.33	0.29
43.00	0.00	40,029	4.31	0.29
43.50	0.00	39,513	4.29	0.29
44.00	0.00	39,002	4.27	0.28
44.50	0.00	38,495	4.25	0.28
45.00	0.00	37,993	4.23	0.28
45.50	0.00	37,493	4.21	0.28
46.00	0.00	36,997	4.19	0.27
46.50	0.00	36,505	4.17	0.27
47.00	0.00	36,015	4.15	0.27
47.50	0.00	35,529	4.13	0.27
48.00	0.00	35,046	4.11	0.27
48.50	0.00	34,567	4.09	0.27
49.00	0.00	34,091	4.07	0.26
49.50	0.00	33,619	4.05	0.26
50.00	0.00	33,152	4.03	0.26
50.50	0.00	32,689	4.01	0.26
51.00	0.00	32,231	3.99	0.25
51.50	0.00	31,776	3.97	0.25

Hydrograph for Pond 13P: Chimney Drain (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
52.00	0.00	31,324	3.95	0.25
52.50	0.00	30,875	3.93	0.25
53.00	0.00	30,430	3.91	0.25
53.50	0.00	29,987	3.89	0.24
54.00	0.00	29,548	3.87	0.24
54.50	0.00	29,113	3.85	0.24
55.00	0.00	28,680	3.83	0.24
55.50	0.00	28,253	3.81	0.24
56.00	0.00	27,829	3.79	0.23
56.50	0.00	27,409	3.76	0.23
57.00	0.00	26,994	3.74	0.23
57.50	0.00	26,581	3.72	0.23
58.00	0.00	26,172	3.70	0.23
58.50	0.00	25,767	3.68	0.22
59.00	0.00	25,364	3.66	0.22
59.50	0.00	24,965	3.64	0.22
60.00	0.00	24,569	3.62	0.22
60.50	0.00	24,176	3.60	0.22
61.00	0.00	23,786	3.58	0.22
61.50	0.00	23,401	3.56	0.21
62.00	0.00	23,019	3.54	0.21
62.50	0.00	22,642	3.51	0.21
63.00	0.00	22,268	3.49	0.21
63.50	0.00	21,897	3.47	0.20
64.00	0.00	21,530	3.45	0.20
64.50	0.00	21,167	3.43	0.20
65.00	0.00	20,806	3.41	0.20
65.50	0.00	20,449	3.39	0.20
66.00	0.00	20,095	3.37	0.20
66.50	0.00	19,744	3.34	0.19
67.00	0.00	19,397	3.32	0.19
67.50	0.00	19,054	3.30	0.19
68.00	0.00	18,714	3.28	0.19
68.50	0.00	18,378	3.26	0.19
69.00	0.00	18,045	3.24	0.18
69.50	0.00	17,716	3.22	0.18
70.00	0.00	17,391	3.19	0.18
70.50	0.00	17,069	3.17	0.18
71.00	0.00	16,750	3.15	0.18
71.50	0.00	16,435	3.13	0.17
72.00	0.00	16,122	3.11	0.17
72.50	0.00	15,813	3.08	0.17
73.00	0.00	15,507	3.06	0.17
73.50	0.00	15,205	3.04	0.17
74.00	0.00	14,907	3.02	0.16
74.50	0.00	14,614	3.00	0.16
75.00	0.00	14,325	2.97	0.16
75.50	0.00	14,038	2.95	0.16
76.00	0.00	13,754	2.93	0.16
76.50	0.00	13,473	2.91	0.16
77.00	0.00	13,195	2.88	0.15
77.50	0.00	12,920	2.86	0.15

Hydrograph for Pond 13P: Chimney Drain (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
78.00	0.00	12,649	2.84	0.15
78.50	0.00	12,381	2.82	0.15
79.00	0.00	12,116	2.79	0.15
79.50	0.00	11,855	2.77	0.14
80.00	0.00	11,598	2.75	0.14
80.50	0.00	11,344	2.73	0.14
81.00	0.00	11,095	2.70	0.14
81.50	0.00	10,848	2.68	0.14
82.00	0.00	10,604	2.66	0.13
82.50	0.00	10,362	2.64	0.13
83.00	0.00	10,124	2.61	0.13
83.50	0.00	9,889	2.59	0.13
84.00	0.00	9,656	2.57	0.13
84.50	0.00	9,428	2.54	0.13
85.00	0.00	9,203	2.52	0.12
85.50	0.00	8,982	2.50	0.12
86.00	0.00	8,765	2.48	0.12
86.50	0.00	8,550	2.45	0.12
87.00	0.00	8,339	2.43	0.12
87.50	0.00	8,130	2.41	0.12
88.00	0.00	7,924	2.38	0.11
88.50	0.00	7,721	2.36	0.11
89.00	0.00	7,520	2.34	0.11
89.50	0.00	7,323	2.31	0.11
90.00	0.00	7,129	2.29	0.11
90.50	0.00	6,940	2.27	0.10
91.00	0.00	6,754	2.24	0.10
91.50	0.00	6,571	2.22	0.10
92.00	0.00	6,392	2.20	0.10
92.50	0.00	6,214	2.17	0.10
93.00	0.00	6,039	2.15	0.10
93.50	0.00	5,867	2.13	0.09
94.00	0.00	5,698	2.10	0.09
94.50	0.00	5,532	2.08	0.09
95.00	0.00	5,369	2.05	0.09
95.50	0.00	5,210	2.03	0.09
96.00	0.00	5,055	2.00	0.08
96.50	0.00	4,904	1.98	0.08
97.00	0.00	4,755	1.95	0.08
97.50	0.00	4,608	1.93	0.08
98.00	0.00	4,464	1.91	0.08
98.50	0.00	4,322	1.88	0.08
99.00	0.00	4,183	1.86	0.08
99.50	0.00	4,047	1.83	0.07
100.00	0.00	3,914	1.81	0.07
100.50	0.00	3,785	1.78	0.07
101.00	0.00	3,659	1.76	0.07
101.50	0.00	3,536	1.74	0.07
102.00	0.00	3,416	1.71	0.07
102.50	0.00	3,298	1.69	0.06
103.00	0.00	3,182	1.66	0.06
103.50	0.00	3,069	1.64	0.06

Hydrograph for Pond 13P: Chimney Drain (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
104.00	0.00	2,958	1.62	0.06
104.50	0.00	2,849	1.59	0.06
105.00	0.00	2,743	1.57	0.06
105.50	0.00	2,641	1.54	0.06
106.00	0.00	2,541	1.52	0.05
106.50	0.00	2,444	1.50	0.05
107.00	0.00	2,349	1.47	0.05
107.50	0.00	2,257	1.45	0.05
108.00	0.00	2,168	1.42	0.05
108.50	0.00	2,080	1.40	0.05
109.00	0.00	1,995	1.38	0.05
109.50	0.00	1,911	1.35	0.05
110.00	0.00	1,830	1.33	0.04
110.50	0.00	1,752	1.30	0.04
111.00	0.00	1,676	1.28	0.04
111.50	0.00	1,603	1.26	0.04
112.00	0.00	1,533	1.23	0.04
112.50	0.00	1,464	1.21	0.04
113.00	0.00	1,399	1.18	0.04
113.50	0.00	1,335	1.16	0.03
114.00	0.00	1,273	1.14	0.03
114.50	0.00	1,213	1.11	0.03
115.00	0.00	1,155	1.09	0.03
115.50	0.00	1,099	1.06	0.03
116.00	0.00	1,045	1.04	0.03
116.50	0.00	995	1.01	0.03
117.00	0.00	949	0.99	0.03
117.50	0.00	904	0.96	0.02
118.00	0.00	860	0.94	0.02
118.50	0.00	817	0.91	0.02
119.00	0.00	777	0.89	0.02
119.50	0.00	737	0.86	0.02
120.00	0.00	700	0.84	0.02

REFERENCE 2

United States Department of Agriculture, “Urban Hydrology for Small Watersheds”, Technical Release 55, June 1986.

Manning's equation is:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad \text{[eq. 3-4]}$$

where:

V = average velocity (ft/s)
r = hydraulic radius (ft) and is equal to a/p_w
a = cross sectional flow area (ft^2)
p_w = wetted perimeter (ft)
s = slope of the hydraulic grade line (channel slope, ft/ft)
n = Manning's roughness coefficient for open channel flow.

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1959) or Linsley et al. (1982). After average velocity is computed using equation 3-4, T_t for the channel segment can be estimated using equation 3-1.

Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

Limitations

- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 3-3 was developed for use with the four standard rainfall intensity-duration relationships.

- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T_c. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.

- The minimum T_c used in TR-55 is 0.1 hour.

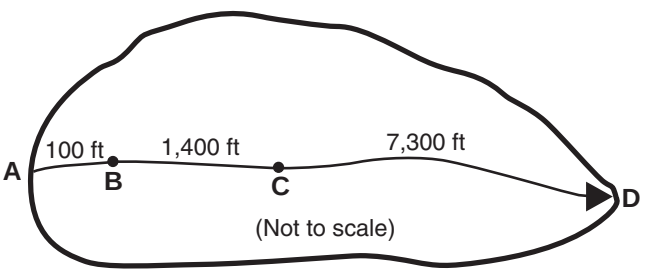
- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

Example 3-1

The sketch below shows a watershed in Dyer County, northwestern Tennessee. The problem is to compute T_c at the outlet of the watershed (point D). The 2-year 24-hour rainfall depth is 3.6 inches. All three types of flow occur from the hydraulically most distant point (A) to the point of interest (D). To compute T_c, first determine T_t for each segment from the following information:

Segment AB: Sheet flow; dense grass; slope (s) = 0.01 ft/ft; and length (L) = 100 ft. Segment BC: Shallow concentrated flow; unpaved; s = 0.01 ft/ft; and L = 1,400 ft. Segment CD: Channel flow; Manning's n = .05; flow area (a) = 27 ft^2; wetted perimeter (p_w) = 28.2 ft; s = 0.005 ft/ft; and L = 7,300 ft.

See figure 3-2 for the computations made on worksheet 3.



REFERENCE 3

Bonnin, G.M. et. al., “NOAA Atlas 14, Volume 2, Version 3, Point Precipitation Frequency Estimates”, NOAA National Weather Service, obtained September 15, 2014.

NOAA Atlas 14, Volume 2, Version 3
Location name: Eden, North Carolina, US*
Latitude: 36.4999°, Longitude: -79.7013°
Elevation: 582 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.363 (0.331-0.397)	0.433 (0.396-0.473)	0.512 (0.467-0.560)	0.567 (0.518-0.619)	0.633 (0.575-0.688)	0.676 (0.612-0.735)	0.717 (0.646-0.781)	0.754 (0.676-0.822)	0.796 (0.708-0.869)	0.826 (0.729-0.902)
10-min	0.579 (0.529-0.634)	0.692 (0.633-0.757)	0.820 (0.749-0.898)	0.908 (0.829-0.991)	1.01 (0.917-1.10)	1.08 (0.974-1.17)	1.14 (1.03-1.24)	1.20 (1.07-1.30)	1.26 (1.12-1.38)	1.30 (1.15-1.42)
15-min	0.724 (0.661-0.792)	0.870 (0.796-0.951)	1.04 (0.947-1.14)	1.15 (1.05-1.25)	1.28 (1.16-1.39)	1.36 (1.23-1.48)	1.44 (1.30-1.57)	1.51 (1.35-1.64)	1.59 (1.41-1.73)	1.63 (1.44-1.78)
30-min	0.993 (0.906-1.09)	1.20 (1.10-1.31)	1.47 (1.35-1.61)	1.66 (1.52-1.82)	1.89 (1.72-2.06)	2.05 (1.86-2.23)	2.21 (1.99-2.40)	2.35 (2.11-2.56)	2.52 (2.24-2.75)	2.64 (2.33-2.89)
60-min	1.24 (1.13-1.35)	1.51 (1.38-1.65)	1.89 (1.73-2.07)	2.17 (1.98-2.36)	2.52 (2.29-2.74)	2.78 (2.52-3.03)	3.04 (2.74-3.31)	3.29 (2.95-3.59)	3.62 (3.22-3.95)	3.86 (3.41-4.22)
2-hr	1.47 (1.35-1.61)	1.79 (1.63-1.96)	2.25 (2.06-2.46)	2.61 (2.38-2.85)	3.08 (2.80-3.36)	3.45 (3.12-3.75)	3.83 (3.44-4.16)	4.20 (3.75-4.57)	4.71 (4.15-5.12)	5.10 (4.45-5.56)
3-hr	1.59 (1.46-1.73)	1.93 (1.78-2.11)	2.44 (2.24-2.66)	2.82 (2.58-3.07)	3.33 (3.03-3.62)	3.73 (3.38-4.04)	4.13 (3.72-4.48)	4.54 (4.06-4.92)	5.08 (4.49-5.52)	5.50 (4.81-5.98)
6-hr	1.96 (1.80-2.15)	2.37 (2.18-2.61)	2.99 (2.74-3.27)	3.48 (3.17-3.80)	4.15 (3.76-4.53)	4.70 (4.22-5.12)	5.28 (4.70-5.73)	5.87 (5.18-6.37)	6.71 (5.82-7.29)	7.38 (6.31-8.02)
12-hr	2.36 (2.17-2.59)	2.87 (2.63-3.14)	3.63 (3.32-3.96)	4.26 (3.88-4.62)	5.15 (4.65-5.57)	5.89 (5.28-6.37)	6.70 (5.94-7.21)	7.56 (6.62-8.12)	8.81 (7.57-9.48)	9.84 (8.31-10.6)
24-hr	2.81 (2.61-3.04)	3.40 (3.16-3.68)	4.33 (4.02-4.67)	5.10 (4.72-5.48)	6.22 (5.72-6.68)	7.17 (6.55-7.69)	8.20 (7.44-8.79)	9.32 (8.39-10.0)	11.0 (9.74-11.8)	12.4 (10.9-13.3)
2-day	3.30 (3.08-3.55)	3.99 (3.72-4.30)	5.04 (4.70-5.42)	5.90 (5.48-6.33)	7.12 (6.59-7.63)	8.13 (7.48-8.71)	9.21 (8.42-9.88)	10.4 (9.40-11.1)	12.0 (10.8-13.0)	13.4 (11.9-14.5)
3-day	3.49 (3.26-3.76)	4.22 (3.93-4.55)	5.33 (4.96-5.73)	6.23 (5.79-6.69)	7.52 (6.95-8.07)	8.59 (7.89-9.21)	9.72 (8.88-10.4)	10.9 (9.92-11.8)	12.7 (11.4-13.7)	14.2 (12.6-15.3)
4-day	3.68 (3.43-3.97)	4.45 (4.15-4.80)	5.61 (5.23-6.05)	6.56 (6.10-7.06)	7.92 (7.32-8.51)	9.04 (8.31-9.71)	10.2 (9.35-11.0)	11.5 (10.4-12.4)	13.4 (12.0-14.4)	14.9 (13.2-16.1)
7-day	4.22 (3.96-4.51)	5.07 (4.75-5.42)	6.29 (5.89-6.72)	7.29 (6.81-7.78)	8.71 (8.11-9.28)	9.88 (9.14-10.5)	11.1 (10.2-11.9)	12.4 (11.4-13.3)	14.3 (12.9-15.3)	15.9 (14.2-17.0)
10-day	4.77 (4.48-5.10)	5.71 (5.37-6.10)	7.01 (6.58-7.48)	8.06 (7.55-8.60)	9.53 (8.89-10.2)	10.7 (9.96-11.4)	12.0 (11.1-12.8)	13.3 (12.2-14.2)	15.1 (13.8-16.2)	16.6 (15.0-17.8)
20-day	6.43 (6.05-6.85)	7.65 (7.21-8.16)	9.20 (8.66-9.81)	10.4 (9.79-11.1)	12.1 (11.3-12.9)	13.4 (12.5-14.3)	14.7 (13.7-15.7)	16.1 (14.9-17.2)	17.9 (16.4-19.2)	19.3 (17.6-20.8)
30-day	7.95 (7.53-8.41)	9.40 (8.91-9.94)	11.1 (10.5-11.7)	12.3 (11.7-13.0)	14.0 (13.2-14.8)	15.3 (14.4-16.2)	16.5 (15.5-17.5)	17.7 (16.6-18.8)	19.3 (18.0-20.5)	20.5 (19.0-21.9)
45-day	10.0 (9.48-10.6)	11.8 (11.2-12.5)	13.7 (13.0-14.5)	15.2 (14.4-16.0)	17.1 (16.1-18.0)	18.5 (17.4-19.5)	19.8 (18.6-21.0)	21.1 (19.8-22.4)	22.8 (21.3-24.2)	24.0 (22.3-25.6)
60-day	12.0 (11.4-12.6)	14.0 (13.4-14.8)	16.1 (15.3-17.0)	17.7 (16.8-18.6)	19.7 (18.7-20.7)	21.2 (20.0-22.3)	22.6 (21.3-23.8)	23.9 (22.5-25.2)	25.6 (24.0-27.1)	26.8 (25.1-28.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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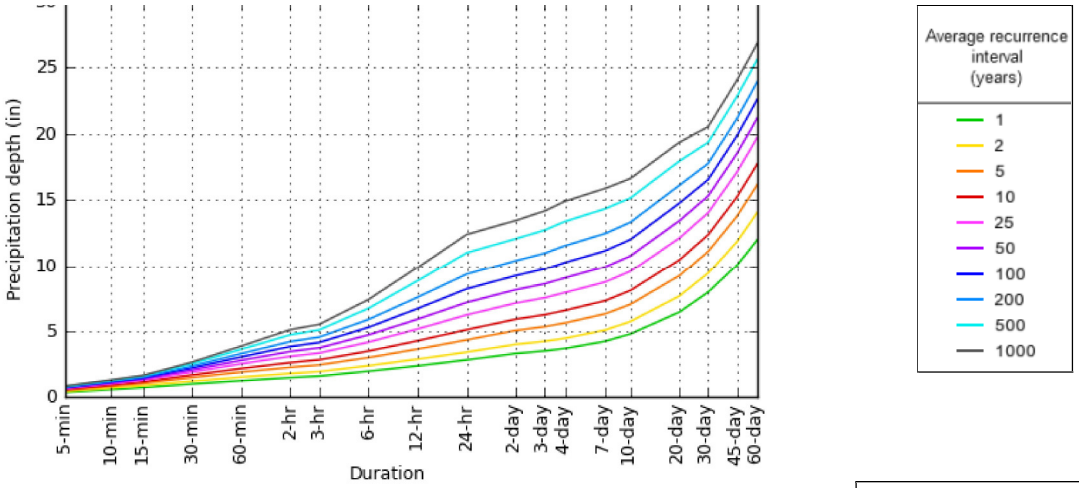
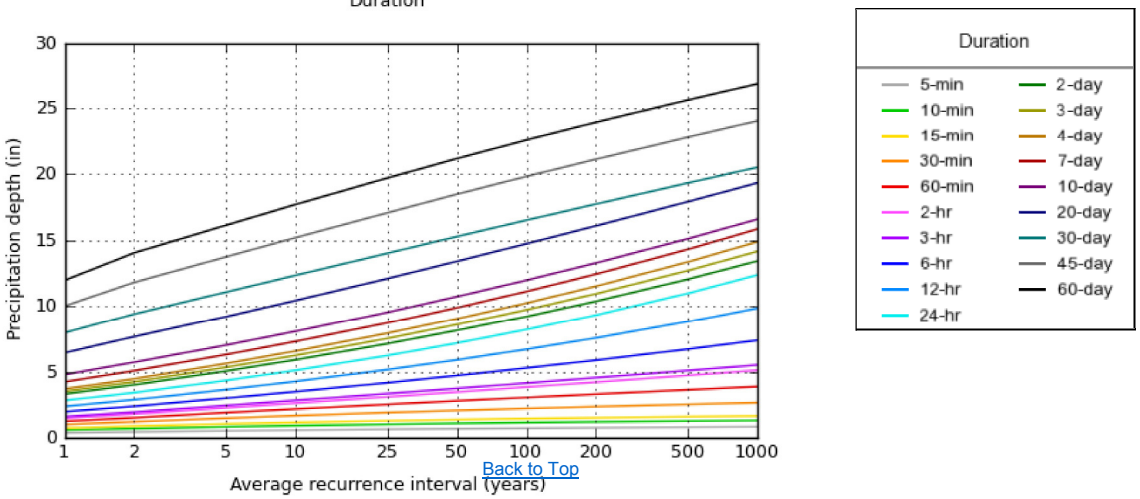
PF graphical





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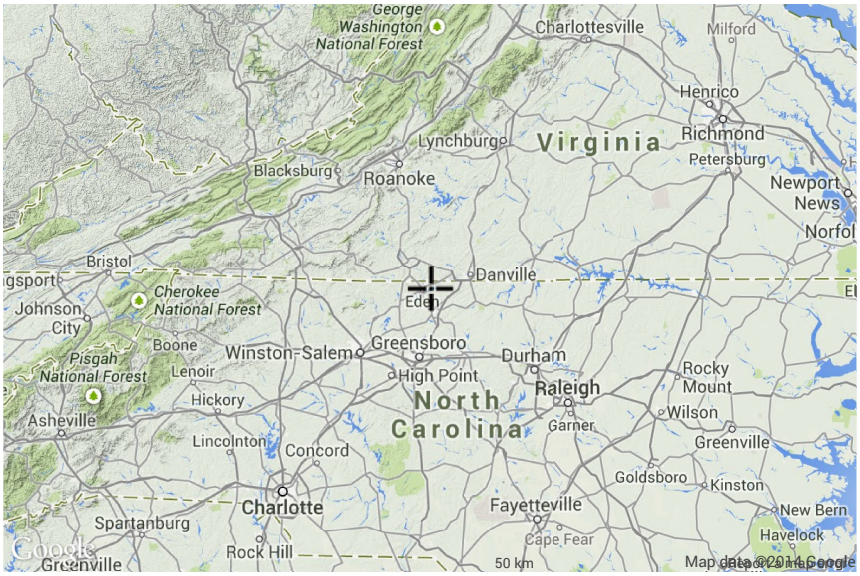
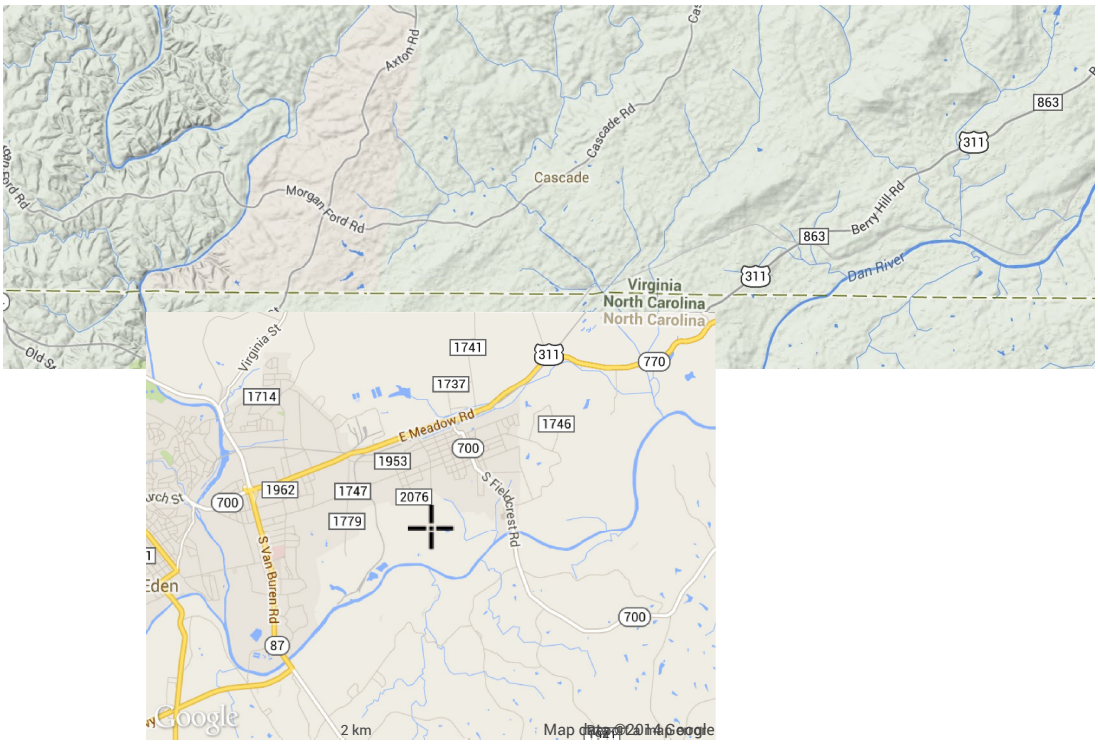
Maps & aerials

NOAA Atlas 14, Volume 2, Version 3 Created (GMT): Mon Sep 15 14:27:08 2014

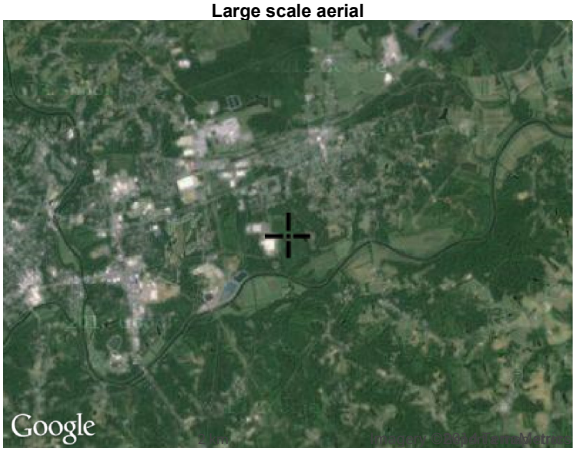
Small scale terrain



Large scale terrain



Large scale aerial



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Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

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REFERENCE 4

CAVCO Pipe Valves and Fittings product information.

PE 3608/3408 IPS HDPE PIPE SIZES

Pressure Rating		DR 7 (267psi)			DR 7.3 (254psi)			DR 9 (200psi)			DR 11 (160psi)			DR 13.5 (128psi)			DR 15.5 (110psi)		
Nominal Size	Actual O.D.	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf
3/4"	1.05"	0.150"	0.732"	0.184	0.144"	0.745"	0.178	0.117"	0.803"	0.150	0.095"	0.848"	0.125	---	---	---	---	---	---
1"	1.315"	0.188"	0.917"	0.289	0.180"	0.933"	0.279	0.146"	1.005"	0.234	0.120"	1.062"	0.197	---	---	---	---	---	---
1 1/4"	1.66"	0.237"	1.157"	0.460	0.227"	1.178"	0.444	0.184"	1.269"	0.372	0.151"	1.340"	0.312	---	---	---	---	---	---
1 1/2"	1.90"	0.271"	1.325"	0.603	0.260"	1.348"	0.582	0.211"	1.452"	0.488	0.173"	1.534"	0.409	---	---	---	---	---	---
2"	2.375"	0.339"	1.656"	0.943	0.325"	1.685"	0.762	0.264"	1.816"	0.762	0.216"	1.917"	0.639	0.176"	2.002"	0.531	0.153"	2.050"	0.467
3"	3.500"	0.500"	2.440"	2.047	0.479"	2.484"	1.656	0.389"	2.676"	1.656	0.318"	2.825"	1.387	0.259"	2.950"	1.153	0.226"	3.021"	1.015
4"	4.500"	0.643"	3.137"	3.384	0.616"	3.193"	2.737	0.500"	3.440"	2.737	0.409"	3.633"	2.294	0.333"	3.793"	1.906	0.290"	3.885"	1.678
5"	5.375"	0.768"	3.747"	4.830	0.736"	3.814"	4.663	0.597"	4.109"	3.903	0.489"	4.339"	3.272	0.398"	4.531"	2.718	0.347"	4.640"	2.396
5"	5.563"	0.795"	3.878"	5.172	0.762"	3.947"	4.182	0.618"	4.253"	4.182	0.506"	4.491"	3.505	0.412"	4.689"	2.912	0.359"	4.802"	2.564
6"	6.625"	0.946"	4.619"	7.336	0.908"	4.701"	5.932	0.736"	5.064"	5.932	0.602"	5.348"	4.971	0.491"	5.585"	4.130	0.427"	5.719"	3.637
7"	7.125"	1.018"	4.967"	8.195	0.976"	5.056"	8.200	0.792"	5.447"	6.863	0.648"	5.752"	5.750	0.528"	6.006"	4.779	0.460"	6.150"	3.985
8"	8.625"	1.232"	6.013"	12.433	1.182"	6.120"	10.054	0.958"	6.593"	10.054	0.784"	6.963"	8.425	0.639"	7.271"	7.001	0.556"	7.445"	6.164
10"	10.750"	1.536"	7.494"	19.314	1.473"	7.628"	15.618	1.194"	8.218"	15.618	0.977"	8.678"	13.089	0.796"	9.062"	10.875	0.694"	9.280"	9.576
12"	12.750"	1.821"	8.889"	27.170	1.747"	9.047"	21.970	1.417"	9.747"	21.970	1.159"	10.293"	18.412	0.944"	10.748"	15.298	0.823"	11.006"	13.471
14"	14.000"	2.000"	9.760"	32.758	1.918"	9.934"	26.489	1.556"	10.702"	26.489	1.273"	11.302"	22.199	1.037"	11.801"	18.445	0.903"	12.085"	16.242
16"	16.00"	2.286"	11.154"	42.786	2.192"	11.353"	34.598	1.778"	12.231"	34.598	1.455"	12.916"	28.994	1.185"	13.487"	24.092	1.032"	13.812"	21.214
18"	18.00"	2.571"	12.549"	54.151	2.466"	12.773"	43.788	2.000"	13.760"	43.788	1.636"	14.531"	36.696	1.333"	15.173"	30.491	1.161"	15.538"	26.849
20"	20.00"	2.857"	13.943"	66.853	2.740"	14.192"	54.059	2.222"	15.289"	54.059	1.818"	16.145"	45.304	1.481"	16.859"	37.643	1.290"	17.265"	33.146
22"	22.00"	3.143"	15.337"	80.170	3.014"	15.611"	65.412	2.444"	16.818"	65.412	2.000"	17.760"	54.818	1.630"	18.545"	45.548	1.419"	18.991"	40.107
24"	24.00"	3.429"	16.731"	96.267	3.288"	17.030"	92.988	2.667"	18.347"	77.845	2.182"	19.375"	65.237	1.778"	20.231"	54.206	1.548"	20.717"	47.731
26"	26.00"	---	---	---	3.562"	18.449"	110.192	2.889"	19.876"	92.050	2.364"	20.989"	76.563	1.926"	21.917"	63.617	1.677"	22.444"	56.018
28"	28.00"	---	---	---	---	---	---	3.111"	21.404"	106.750	2.545"	22.604"	88.795	2.074"	23.603"	73.781	1.806"	24.170"	64.967
30"	30.00"	---	---	---	---	---	---	3.333"	22.933"	121.633	2.727"	24.218"	101.934	2.222"	25.289"	84.697	1.935"	25.897"	74.580
32"	32.00"	---	---	---	---	---	---	3.556"	24.462"	139.452	2.909"	25.833"	116.670	2.370"	26.975"	96.367	2.065"	27.623"	84.855
34"	34.00"	---	---	---	---	---	---	---	---	---	3.091"	27.447"	130.930	2.519"	28.661"	109.332	2.194"	29.350"	96.209
36"	36.00"	---	---	---	---	---	---	---	---	---	3.273"	29.062"	146.780	2.667"	30.347"	121.960	2.323"	31.076"	107.395
42"	42.00"	---	---	---	---	---	---	---	---	---	---	---	---	3.111"	35.404"	166.800	2.710"	36.255"	146.176
48"	48.00"	---	---	---	---	---	---	---	---	---	---	---	---	3.556"	40.462"	217.895	3.097"	41.435"	175.891
54"	54.00"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3.484"	46.614"	242.649
63"	62.99"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

NOTE:

- Items highlighted in Blue indicates standard stocking items that are more readily available.
- Pressures are based on using water at 23°C (73°F).
- Average inside diameter calculated using nominal OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.
- Service factors should be utilized to compensate for the effect of liquids other than water, and for other temperatures.
- Other piping sizes or DR's may be available upon request.
- Standard Lengths: 40' for 2"-24" / 50' for 26" and larger / Coils available for 3/4"-6"(8" by special order)

PE 3608/3408 IPS HDPE PIPE SIZES

Pressure Rating		DR 17 (100psi)			DR 19 (89psi)			DR 21 (80psi)			DR 26 (65psi)			DR 32.5 (50psi)		
Nominal Size	Actual O.D.	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf
3/4"	1.050"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1"	1.315"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1 1/4"	1.660"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1 1/2"	1.900"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2"	2.375"	0.140"	2.079"	0.429	---	---	---	---	---	---	---	---	---	---	---	---
3"	3.500"	0.206"	3.064"	0.932	---	---	---	---	---	---	---	---	---	---	---	---
4"	4.500"	0.265"	3.939"	1.540	0.237"	3.998"	1.387	0.214"	4.046"	1.262	0.173"	4.133"	1.030	0.138"	4.206"	0.831
5"	5.375"	0.316"	4.705"	2.197	0.283"	4.775"	1.980	0.256"	4.832"	1.801	0.207"	4.937"	1.470	0.165"	5.024"	1.186
5"	5.563"	0.327"	4.869"	2.353	0.293"	4.942"	2.120	0.265"	5.001"	1.929	0.214"	5.109"	1.574	0.171"	5.200"	1.270
6"	6.625"	0.390"	5.799"	3.338	0.349"	5.886"	3.007	0.315"	5.956"	2.736	0.255"	6.085"	2.233	0.204"	6.193"	1.801
7"	7.125"	0.419"	6.236"	3.860	0.375"	6.330"	3.478	0.339"	6.406"	3.165	0.274"	6.544"	2.582	0.219"	6.660"	2.083
8"	8.625"	0.507"	7.549"	5.657	0.454"	7.663"	5.097	0.411"	7.754"	4.637	0.332"	7.922"	3.784	0.265"	8.062"	3.053
10"	10.750"	0.632"	9.409"	8.788	0.566"	9.551"	7.918	0.512"	9.665"	7.204	0.413"	9.873"	5.878	0.331"	10.049"	4.742
12"	12.750"	0.750"	11.160"	12.362	0.671"	11.327"	11.138	0.607"	11.463"	10.134	0.490"	11.710"	8.269	0.392"	11.918"	6.671
14"	14.000"	0.824"	12.254"	14.905	0.737"	12.438"	13.429	0.667"	12.587"	12.218	0.538"	12.858"	9.970	0.431"	13.087"	8.044
16"	16.00"	0.941"	14.005"	19.467	0.842"	14.215"	17.540	0.762"	14.385"	15.959	0.615"	14.695"	13.022	0.492"	14.956"	10.506
18"	18.00"	1.059"	15.755"	24.638	0.947"	15.992"	22.199	0.857"	16.183"	20.198	0.692"	16.532"	16.480	0.554"	16.826"	13.296
20"	20.00"	1.176"	17.506"	30.418	1.053"	17.768"	27.406	0.952"	17.981"	24.936	0.769"	18.369"	20.346	0.615"	18.695"	16.415
22"	22.00"	1.294"	19.256"	36.805	1.158"	19.545"	33.162	1.048"	19.779"	30.172	0.846"	20.206"	24.619	0.677"	20.565"	19.863
24"	24.00"	1.412"	21.007"	43.801	1.263"	21.322"	39.465	1.143"	21.577"	35.907	0.923"	22.043"	29.299	0.738"	22.434"	23.638
26"	26.00"	1.529"	22.758"	51.406	1.368"	23.099"	46.316	1.238"	23.375"	42.141	1.000"	23.880"	34.385	0.800"	24.304"	27.742
28"	28.00"	1.647"	24.508"	59.618	1.474"	24.876"	53.716	1.333"	25.173"	48.874	1.077"	25.717"	39.879	0.862"	26.174"	32.174
30"	30.00"	1.765"	26.259"	68.439	1.579"	26.653"	61.664	1.429"	26.971"	56.105	1.154"	27.554"	45.779	0.923"	28.043"	36.934
32"	32.00"	1.882"	28.009"	77.869	1.684"	28.429"	70.160	1.524"	28.770"	63.835	1.231"	29.391"	52.086	0.985"	29.913"	42.023
34"	34.00"	2.000"	29.760"	87.907	1.789"	30.206"	79.204	1.619"	30.568"	72.064	1.308"	31.228"	58.814	1.046"	31.782"	47.440
36"	36.00"	2.118"	31.511"	98.553	1.895"	31.983"	88.796	1.714"	32.366"	80.791	1.385"	33.065"	65.922	1.108"	33.652"	53.186
42"	42.00"	2.471"	36.762"	134.141	2.211"	37.314"	120.861	2.000"	37.760"	109.966	1.615"	38.575"	89.727	1.292"	39.260"	72.392
48"	48.00"	2.824"	42.014"	175.205	2.526"	42.644"	157.857	2.286"	43.154"	143.629	1.846"	44.086"	117.194	1.477"	44.869"	94.552
54"	54.00"	3.176"	47.266"	222.547	2.842"	47.975"	199.791	2.571"	48.549"	182.298	2.077"	49.597"	148.324	1.662"	50.478"	119.668
63"	62.99"	---	---	---	---	---	---	3.000"	56.631"	247.800	2.423"	57.854"	202.010	1.938"	58.881"	162.980

NOTE:

- Items highlighted in Blue indicates standard stocking items that are more readily available.
- Pressures are based on using water at 23°C (73°F).
- Average inside diameter calculated using nominal OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.
- Service factors should be utilized to compensate for the effect of liquids other than water, and for other temperatures.
- Other piping sizes or DR's may be available upon request.
- Standard Lengths: 40' for 2"-24" / 50' for 26" and larger / Coils available for 3/4"-6"(8" by special order)

REFERENCE 5

North Carolina Department of Environment and Natural Resources, “Erosion and Sediment Control Planning and Design Manual”, Revised May 2013.

Table 8.03e Runoff curve numbers of urban areas[1]

Cover Description: Cover type and hydrologic condition	Average percent impervious area[2]	Curve number for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [4]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1. Average runoff condition, and Ia = 0.2S.
2. The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using Figure 8.03c or 8.03d.
3. CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4. Composite CN's to use for the design of temporary measures during grading and construction should be computed using Figure 8.03c or 8.03d based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

The permissible velocity procedure is recommended for the design of vegetative channels because of common usage and the availability of reliable design tables. The tractive force approach is recommended for design of channels with temporary synthetic liners or riprap liners. The tractive force procedure is described in full in the U.S. Department of Transportation, Federal Highway Administration Bulletin, *Design of Roadside Channels with Flexible Linings*.

Permissible Velocity Procedure

The permissible velocity procedure uses two equations to calculate flow:

Manning's equation,

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

where:

V	=	average velocity in the channel in ft/sec.
n	=	Manning's roughness coefficient, based upon the lining of the channel
R	=	hydraulic radius, wetted cross-sectional area/wetted perimeter in ft
S	=	slope of the channel in ft/ft

and the continuity equation,

$$Q = AV$$

where:

Q	=	flow in the channel in cfs
A	=	cross-sectional area of flow within the channel in ft^2
V	=	average velocity in the channel in ft/sec.

Manning's equation and the continuity equation are used together to determine channel capacity and flow velocity. A nomograph for solving Manning's equation is given in Figure 8.05a.

Selecting Permanent Channel Lining

Channel lining materials include such flexible materials as grass, riprap and gabions, as well as rigid materials such as paving blocks, flag stone, gunite, asphalt, and concrete. The design of concrete and similar rigid linings is generally not restricted by flow velocities. However, flexible channel linings do have maximum permissible flow velocities beyond which they are susceptible to erosion. The designer should select the type of liner that best fits site conditions.

Table 8.05a lists maximum permissible velocities for established grass linings and soil conditions. Before grass is established, permissible velocity is determined by the choice of temporary liner. Permissible velocities for riprap linings are higher than for grass and depend on the stone size selected.

APPENDIX IV-3

Leachate Force Main Calculation

Calculation Title:
Leachate Force Main Calculation

Summary:
The leachate sump pumps were designed to reduce the head on the leachate collection liner system generated by a 50-year, 24-hour storm event to less than one foot within 72 hours after the storm event.

Designs for flow volume, if any, may be developed based on the 25-year, 24-hour storm event.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal	Jessica Ketchum		Cedric H Ruhl
		Jessica Ketchum	**Tryambak Kaushik**	**Cedric H. Ruhl**

OBJECTIVE:

The objective of this calculation is to evaluate the performance of the leachate force main system to ensure that pumps are adequately sized to satisfy the North Carolina Department of Environment and Natural Resources (NCDENR) Solid Waste Division requirement to reduce the head on the leachate collection liner system generated by a 25-year, 24-hour storm event to less than one foot within 72 hours. To be conservative, this calculation was based on the drawdown of leachate head during a 50-year, 24-hr storm.

METHOD:

The Dan River Landfill will be constructed as three cells. Each cell will have a dedicated sump with leachate collection and leak detection components. The LCS sump will be located in the leachate collection layer and the LDS sump will be located in the leak detection layer. The LDS sump will include one low-flow pump. The LCS sump will include a combination of one low-flow pump and one high-flow pump. Force main performance was evaluated for average and peak generation rates.

CALCULATIONS:

1.0 Describe leachate force main configuration

The leachate force main system is comprised of three separate force mains, one for each of the three cells of the landfill. Cell 1 is the northwest area of the landfill, Cell 2 comprises the northeast area, and Cell 3 encompasses the southern portion. All three force mains will route leachate from their respective cells to the Leachate Storage Tank Facility, located along the northwestern side of the landfill perimeter road. The Leachate Storage Tank Facility will consist of a system of tanks with secondary containment.

It is anticipated that leachate generated at the Dan River Landfill will ultimately discharge to a publically owned treatment works (POTW) for treatment. Modifications to this calculation may be required pending discussions with the POTW which are currently in progress.

2.0 Estimate leakage and leachate generation rates

Leakage and leachate generation rates were estimated for average and peak generation conditions. Average generation conditions were assumed to consist of typical landfill operating conditions for leachate infiltration. Peak generation conditions were assumed to consist of a 50-year, 24-hour design storm event and included peak leachate infiltration conditions coupled with contact water flow from chimney drains.

Leakage and leachate generation rates for average conditions were assumed to be the average daily percolation rates for 10-feet of waste as calculated in the “Leachate Generation Calculation”.

The peak infiltration generation rate to the leak detection layer was assumed to be 1,000 gpad, which is two times the action leak rate defined in the “Liner System Geocomposite Capacity

Calculation". The peak infiltration generation rate to the leachate collection layer was assumed to be the peak daily percolation rate for 10-feet of waste as calculated in the "Leachate Generation Calculation".

Stormwater generation rates were assumed to be zero for average conditions for the LCS and LDS sumps. Stormwater generation rates were also assumed to be zero for peak conditions for the leakage detection layer. The peak stormwater generation rate to the leachate collection layer was assumed to be the hydrograph data modeled with the HydroCAD 10.00 (build 9) software as calculated in the "Leachate Collection Calculation". The Stormwater Runoff Hydrograph is provided in Attachment 1. The leakage and leachate generation rates are summarized as shown in the following table:

Table 1: Leak and Leachate Generation Rates

Cell	Area (acre)	Condition	Leakage Detection				Leachate Collection			
			Infiltration (gpad)	Infiltration (gpam)	Infiltration (gpm)	Stormwater (gpm)	Infiltration (gpad)	Infiltration (gpam)	Infiltration (gpm)	Stormwater (gpm)
1	5.1	Average Generation	2.39	0.002	0.008	0	1,155	0.80	4.09	0
		Peak Generation	1,000	0.69	3.54	0	12,081	8.39	42.79	See Attachment 1
2	7.4	Average Generation	2.39	0.002	0.012	0	1,155	0.80	5.94	0
		Peak Generation	1,000	0.69	5.14	0	12,081	8.39	62.08	See Attachment 1
3	10.8	Average Generation	2.39	0.002	0.018	0	1,155	0.80	8.66	0
		Peak Generation	1,000	0.69	7.50	0	12,081	8.39	90.61	See Attachment 1

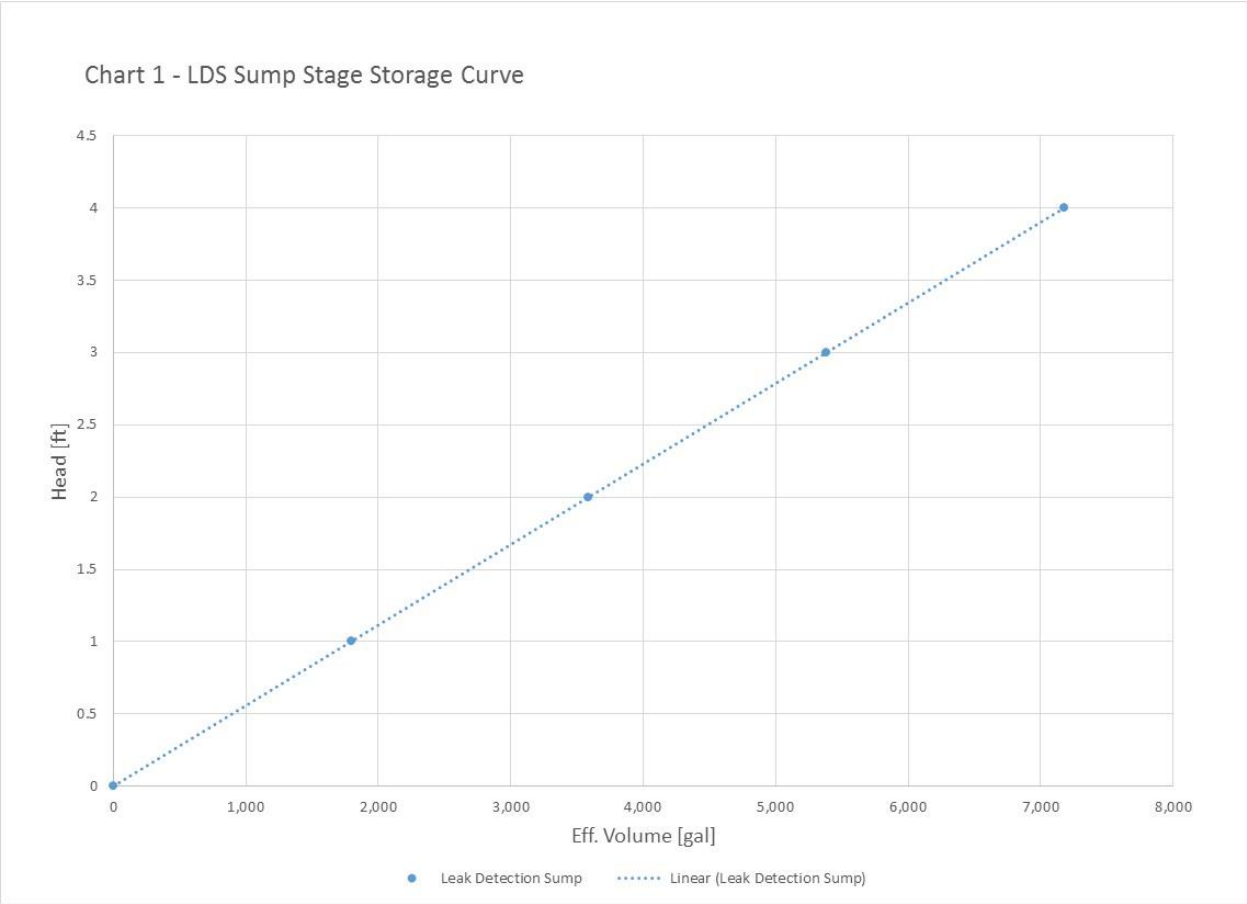
3.0 Estimate leakage and leachate sump stage storage relationships

The proposed sump configuration includes a localized aggregate zone that will extend from approximately two feet below the adjacent cell floor to two feet above the adjacent cell floor. Stage storage relationships for the leachate collection system sump for Cells 1 through 3 were estimated using the stage storage method by approximating the localized sump area with respect to geosynthetic liner system subgrade grades. An average porosity of 0.3 was assumed for fill in the sump, cover soil, and waste fill. The total storage volume was multiplied by 0.3 to calculate the effective storage volume. Stage storage relationships for the leakage detection system sump was assumed to be a constant area with a depth of four feet.

The stage storage relationship for the leak detection sump is presented in the following table and chart:

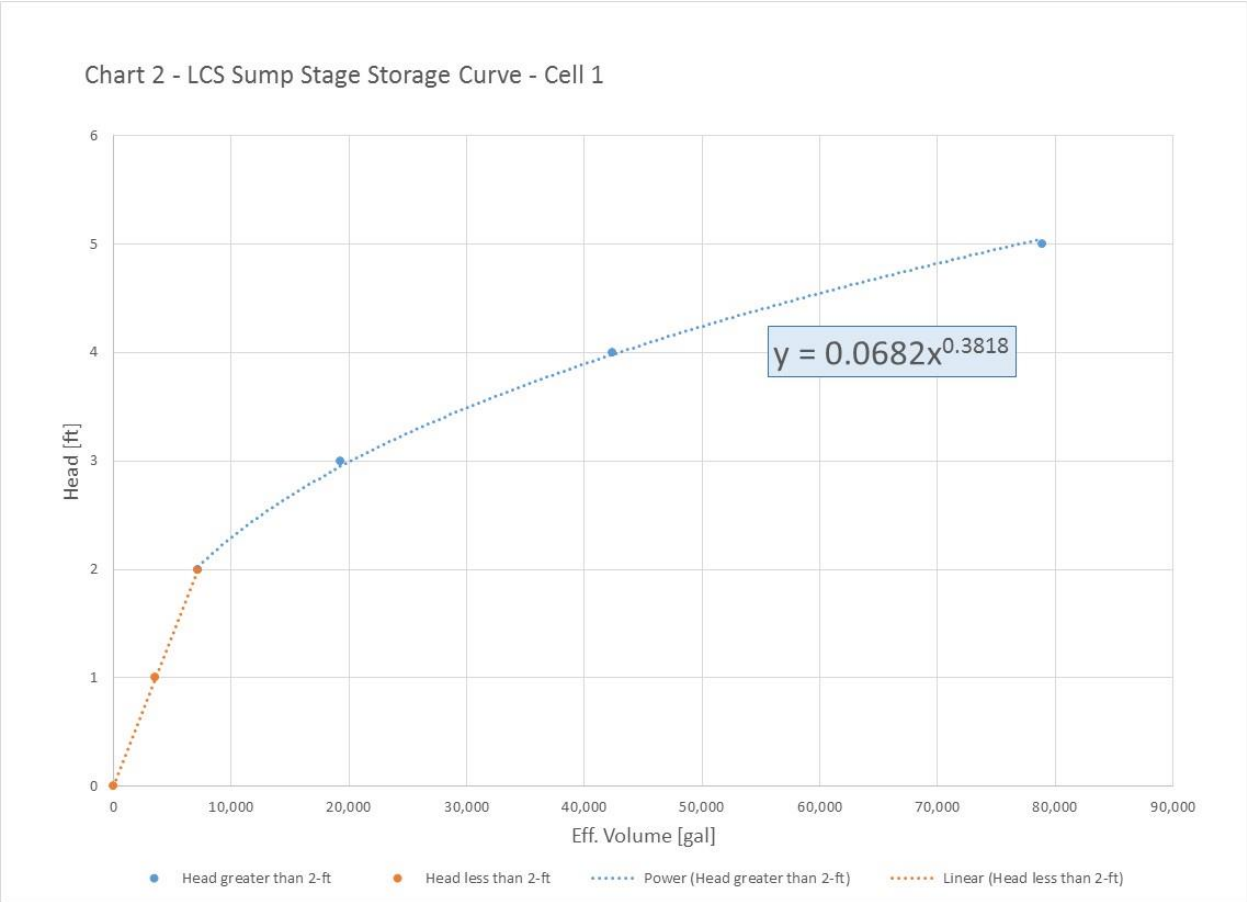
Table 2: Leak Detection System Stage Storage Relationship

Height (ft)	Leak Detection System					
	Area (ft^2)	Incremental Storage Volume (ft^3)	Cumulative Storage Volume (ft^3)	Porosity	Effective Cumulative Volume (ft^3)	Effective Cumulative Volume (gal.)
0	800	0	0	0.3	0	0
1	800	800	800	0.3	240	1,795
2	800	800	1,600	0.3	480	3,590
3	800	800	2,400	0.3	720	5,386
4	800	800	3,200	0.3	960	7,181



The stage storage relationship for Cell 1 is presented in the following table and chart:

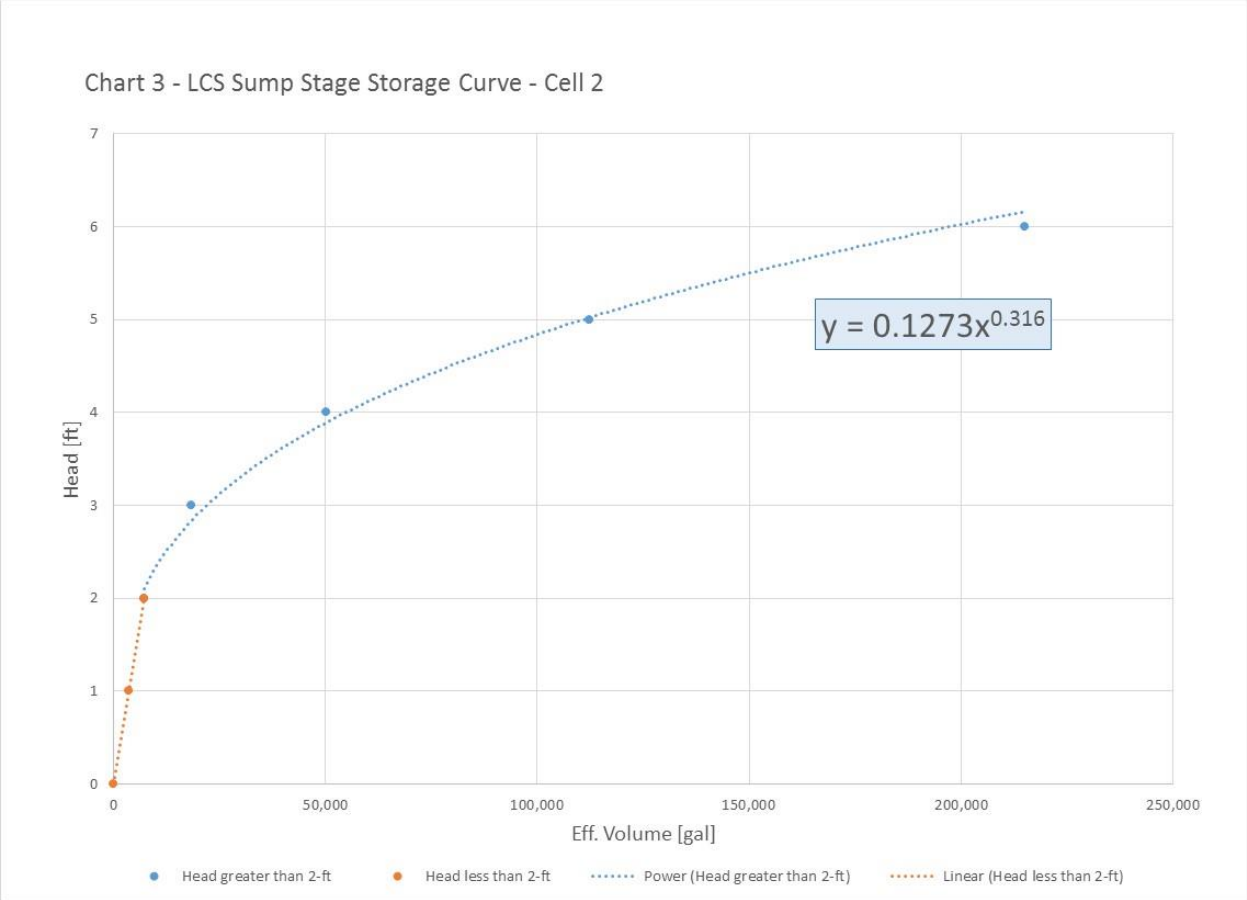
Table 3: Leachate Collection System Stage Storage Relationships - Cell 1						
Height (ft)	**Area (ft^2)**	**Incremental Storage Volume (ft^3)**	**Cumulative Storage Volume (ft^3)**	**Porosity**	**Effective Cumulative Volume (ft^3)**	**Effective Cumulative Volume (gal.)**
0	1,600	0	0	0.3	0	0
1	1,600	1,600	1,600	0.3	480	3,590
2	1,600	1,600	3,200	0.3	960	7,181
3	5,403	5,403	8,603	0.3	2,581	19,305
4	10,308	10,308	18,911	0.3	5,673	42,437
5	16,263	16,263	35,174	0.3	10,552	78,931



The stage storage relationship for Cell 2 is presented in the following table and chart:

Table 4: Leachate Collection System Stage Storage Relationships - Cell 2

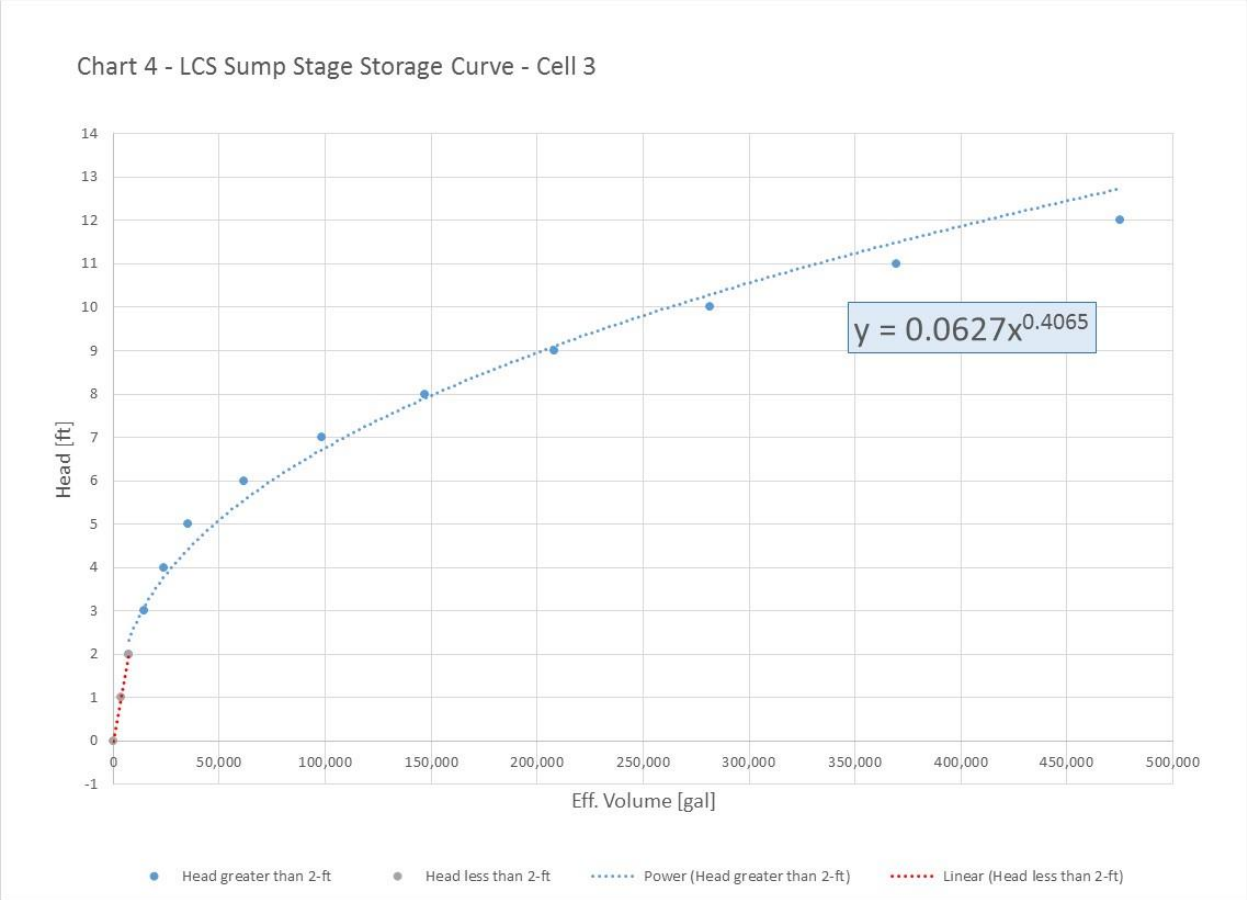
Height (ft)	Area (ft^2)	Incremental Storage Volume (ft^3)	Total Storage Volume (ft^3)	Porosity	Effective Volume (ft^3)	Effective Volume (gal.)
0	1,600	0	0	0.3	0	0
1	1,600	1,600	1,600	0.3	480	3,590
2	1,600	1,600	3,200	0.3	960	7,181
3	4,992	4,992	8,192	0.3	2,458	18,383
4	14,251	14,251	22,443	0.3	6,733	50,363
5	27,633	27,633	50,076	0.3	15,023	112,370
6	45,741	45,741	95,816	0.3	28,745	215,012



The stage storage relationship for Cell 3 is presented in the following table and chart:

Table 5: Leachate Collection System Stage Storage Relationships - Cell 3

Height (ft)	Area (ft^2)	Incremental Storage Volume (ft^3)	Cumulative Storage Volume (ft^3)	Porosity	Effective Cumulative Volume (ft^3)	Effective Cumulative Volume (gal.)
0	1,600	0	0	0.3	0	0
1	1,600	1,600	1,600	0.3	480	3,590
2	1,600	1,600	3,200	0.3	960	7,181
3	3260	3,260	6,460	0.3	1,938	14,496
4	4113	4,113	10,573	0.3	3,172	23,726
5	5065	5,065	15,638	0.3	4,691	35,092
6	11764	11,764	27,402	0.3	8,221	61,490
7	16367	16,367	43,769	0.3	13,131	98,218
8	21750	21,750	65,519	0.3	19,656	147,025
9	27132	27,132	92,651	0.3	27,795	207,909
10	32808	32,808	125,459	0.3	37,638	281,530
11	39125	39,125	164,584	0.3	49,375	369,326
12	47109	47,109	211,693	0.3	63,508	475,039



4.0 Pump rates and controls

The leak detection layer sump will include one low-flow pump and the leachate collection layer sump will include a combination of one low-flow pump and one high-flow pump. Leachate disposal options are being discussed with the City of Eden. The final pump design may change pending the outcome of these discussions. The pump rates and controls are listed in the following table:

Table 6: Pump Rates & Controls

Pump Type	Pump Rate (gpm)	Pump Height On (ft)	Pump Height Off (ft)
LDS Pump	100	1	0.5
LCS - Low Flow	100	1	0.5
LCS - High Flow	550	4	2

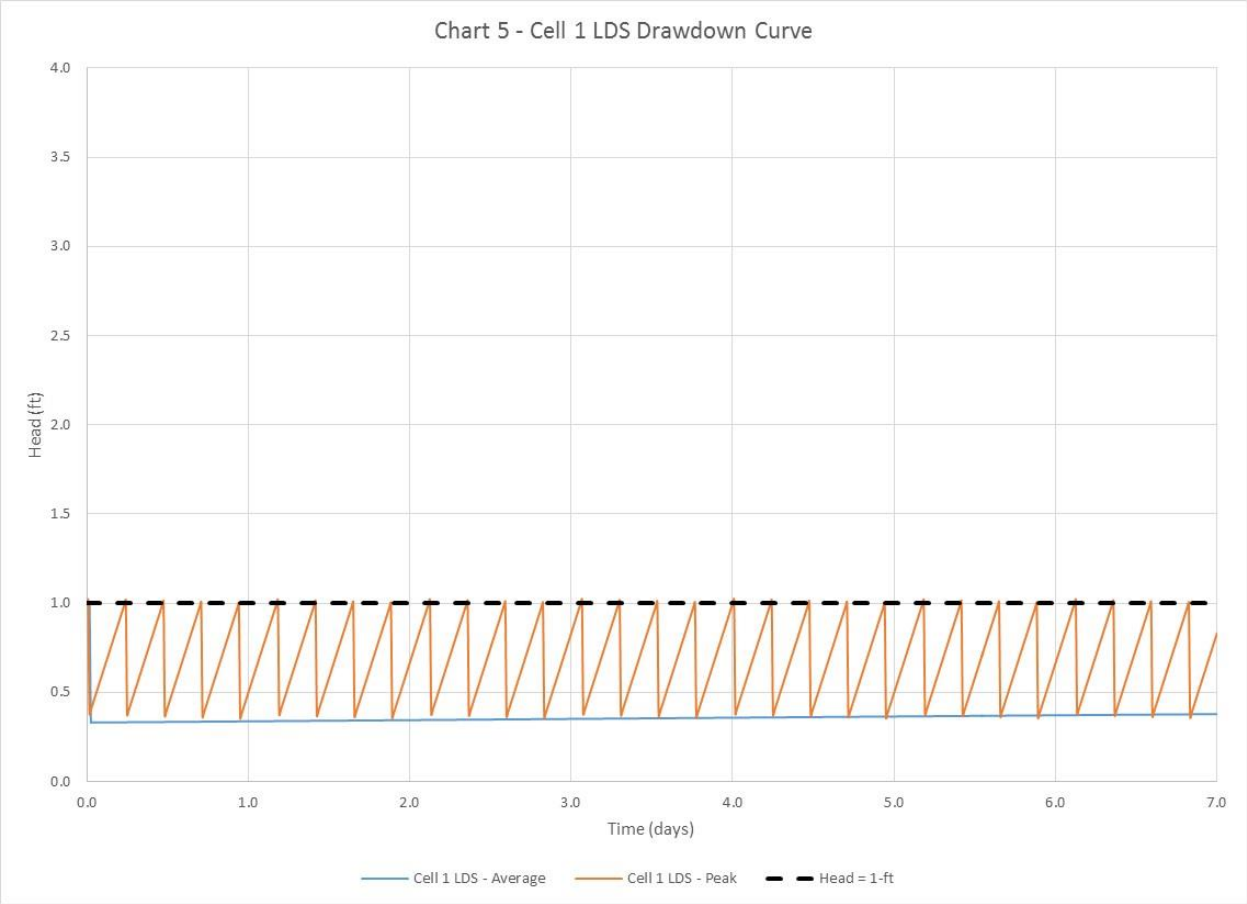
5.0 Model the force main to check sump drawdown

Leachate force main performance was evaluated for the following scenarios assuming a seven-day simulation duration:

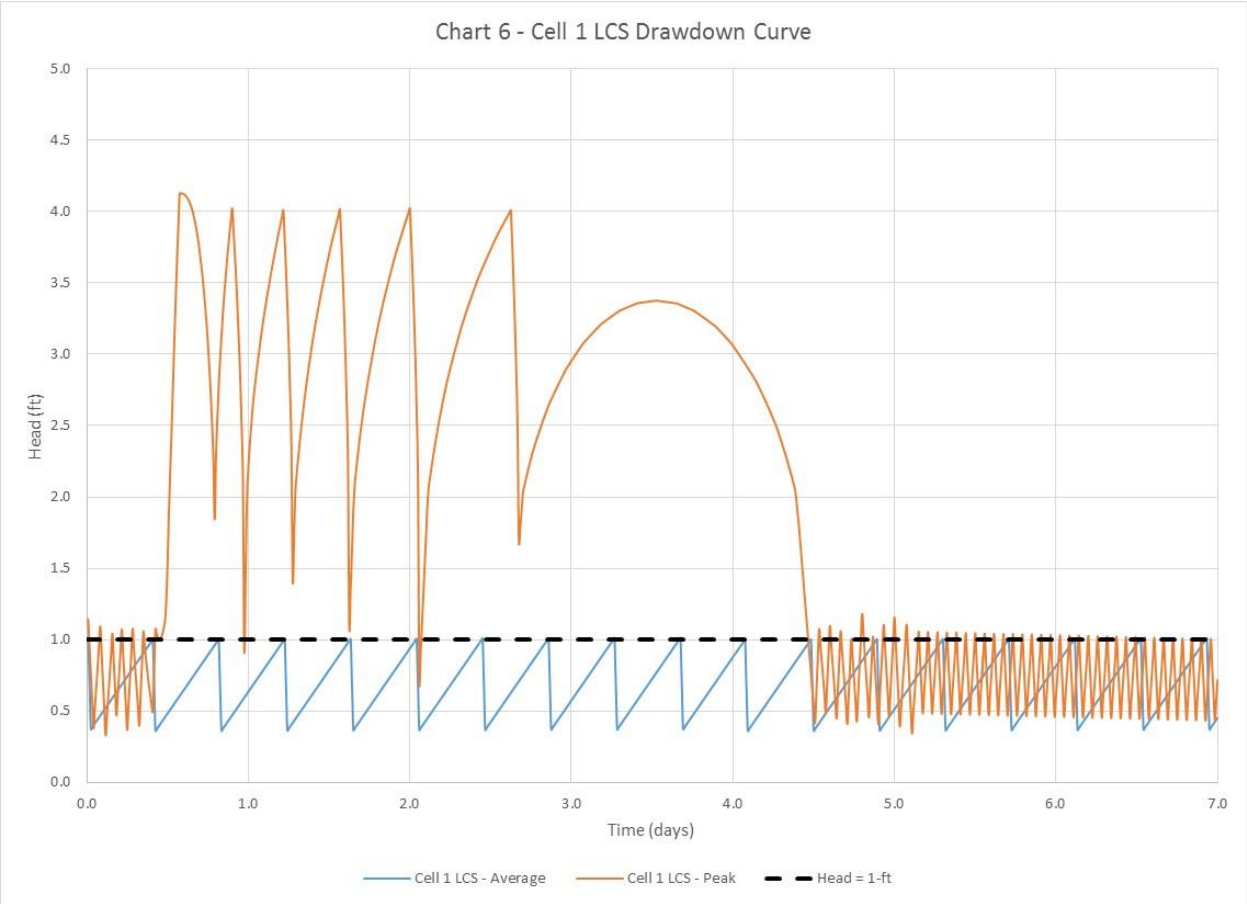
- Cells 1, 2, and 3

- LDS sump average conditions;
- LDS sump peak conditions
- LCS sump average conditions
- LCS sump peak conditions

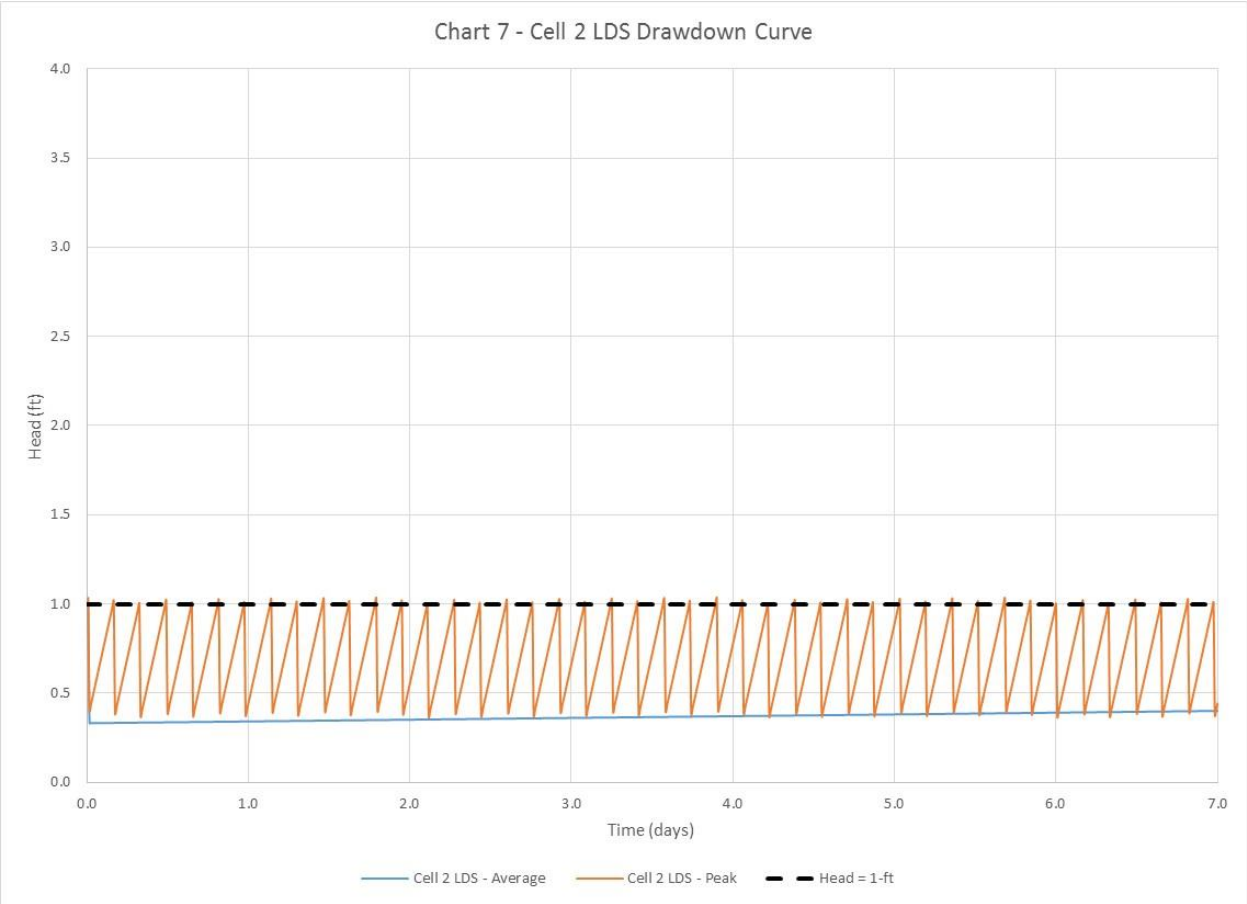
The Cell 1 LDS sump average and peak performance is presented in Attachments 2 and 3 and summarized in the following chart:



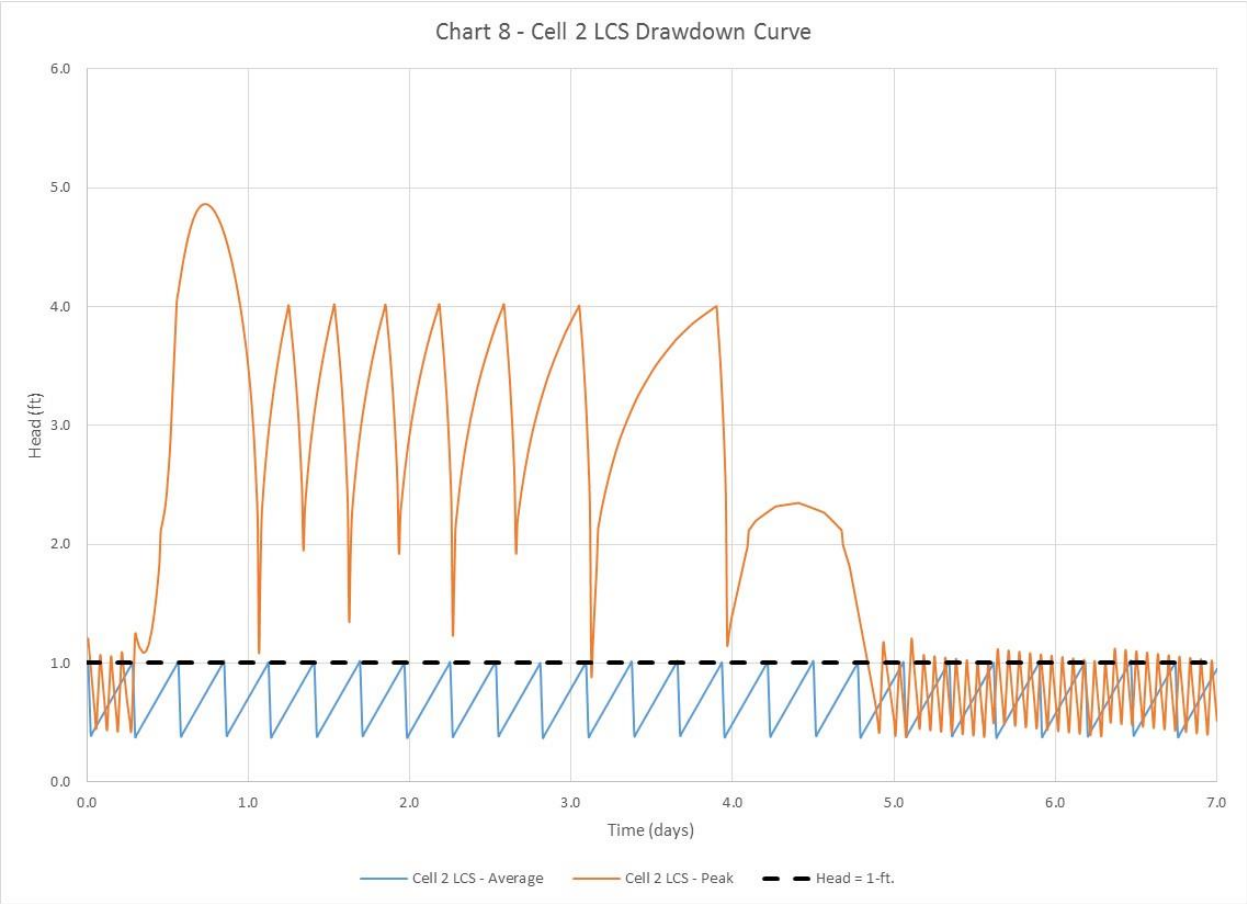
The Cell 1 LCS sump average and peak performance is presented in Attachments 4 and 5 and summarized in the following chart:



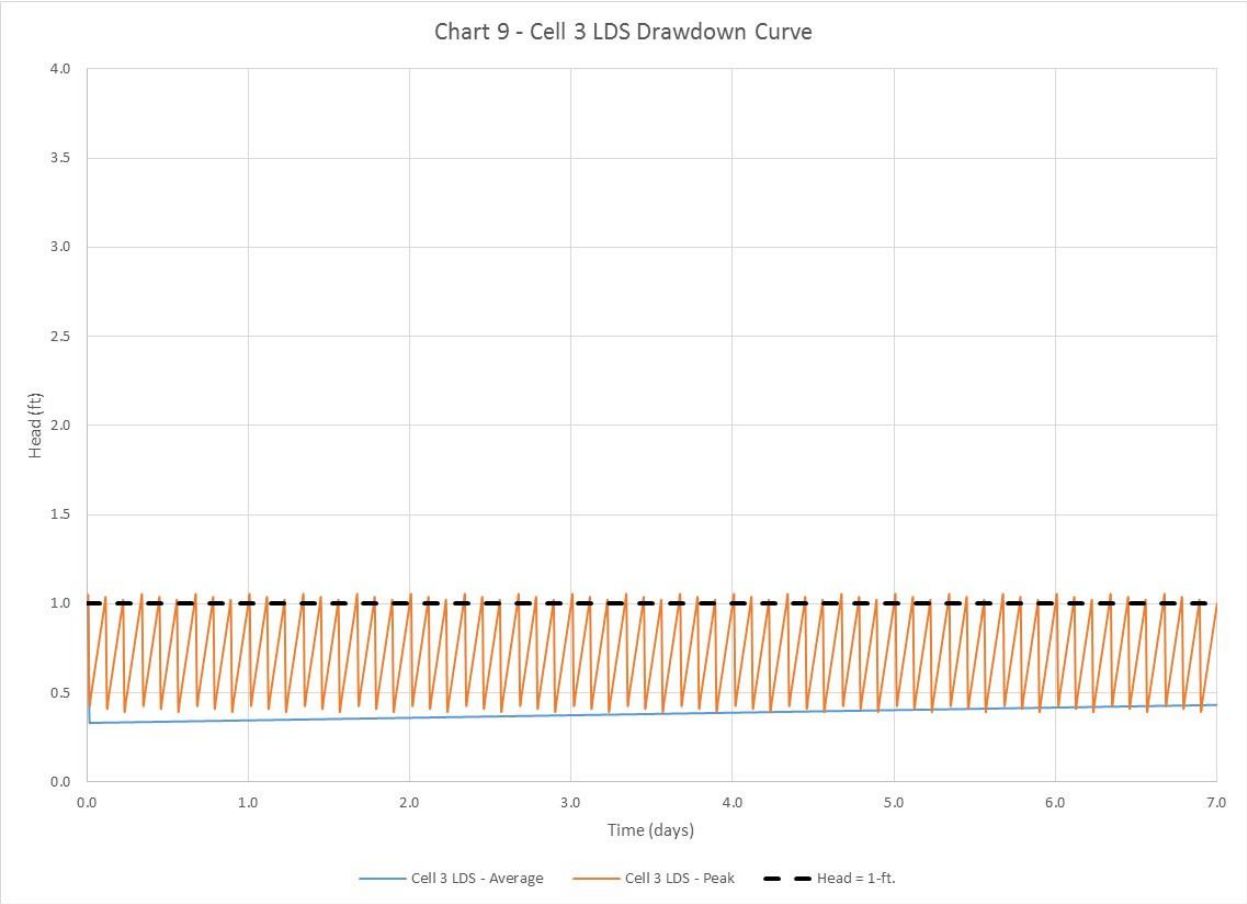
The Cell 2 LDS sump average and peak performance is presented in Attachments 6 and 7 and summarized in the following chart:



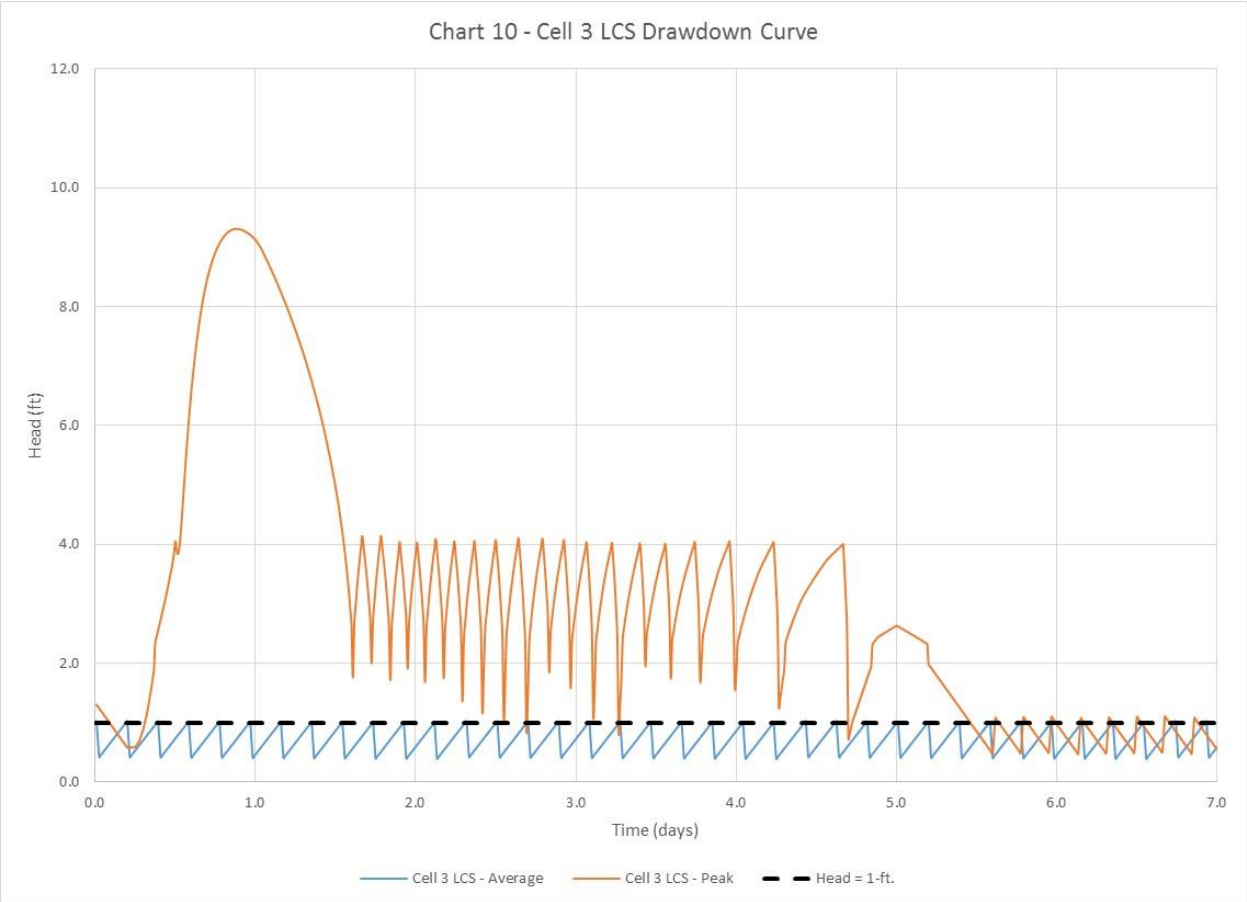
The Cell 2 LCS sump average and peak performance is presented in Attachments 8 and 9 and summarized in the following chart:



The Cell 3 LDS sump average and peak performance is presented in Attachments 10 and 11 and summarized in the following chart:



The Cell 3 LCS sump average and peak performance is presented in Attachments 12 and 13 and summarized in the following chart:



The drawdown to less than one foot of head was visually interpreted from the preceding charts and summarized in the following table:

Table 7: Drawdown Summary

Cell	Sump	Condition	Time One Foot of Head is Exceeded (hours)	Time Leachate Level is Less Than One Foot of Head (hours)	Duration of Head Level in Excess of One Foot (hours)	Maximum Allowable Duration of Head Level in Excess of One Foot (hours)
Cell 1	LDS	average	N/A	N/A	< 1	72
	LDS	peak	N/A	N/A	< 1	72
	LCS	average	N/A	N/A	< 1	72
	LCS	peak	49	108	59	72
Cell 2	LDS	average	N/A	N/A	< 1	72
	LDS	peak	N/A	N/A	< 1	72
	LCS	average	N/A	N/A	< 1	72
	LCS	peak	6	75	70	72
Cell 3	LDS	average	N/A	N/A	< 1	72
	LDS	peak	N/A	N/A	< 1	72
	LCS	average	N/A	N/A	< 1	72
	LCS	peak	7	65	58	72

Additionally, the analyses indicate freeboard as summarized in the following table:

Table 8: Freeboard Summary			
Cell	**Peak Sump Elevation (ft)**	**Peak Leachate Elevation (ft)**	**Freeboard (in)**
Cell 1	5	4.13	10.5
Cell 2	6	4.86	13.6
Cell 3	12	9.31	32.3

DISCUSSION:

All four scenarios for Cells 1, 2, and 3 satisfy the North Carolina Department of Environment and Natural Resources (NCDENR) Solid Waste Division requirement to reduce the head on the leachate collection liner system generated by a 24-hr, 25-year storm event to less than one foot within 72 hours after the storm event.

ATTACHMENTS:

1. Peak Stormwater Generation Rates
2. Cell 1 Leakage Detection Sump – Average Conditions
3. Cell 1 Leakage Detection Sump – Peak Conditions
4. Cell 1 Leachate Collection Sump – Average Conditions
5. Cell 1 Leachate Collection Sump – Peak Conditions
6. Cell 2 Leakage Detection Sump – Average Conditions
7. Cell 2 Leakage Detection Sump – Peak Conditions
8. Cell 2 Leachate Collection Sump – Average Conditions
9. Cell 2 Leachate Collection Sump – Peak Conditions
10. Cell 3 Leakage Detection Sump – Average Conditions
11. Cell 3 Leakage Detection Sump – Peak Conditions
12. Cell 3 Leachate Collection Sump – Average Conditions
13. Cell 3 Leachate Collection Sump – Peak Conditions

ATTACHMENT 1

Peak Stormwater Generation Rates

Attachment 1 - Peak Stormwater Generation Rates						
Time (hr)	Stormwater Flow/5 Acres (cfs)	Stormwater Flow/Acre (cfs)	Stormwater Flow/Acre (gpm)	Stormwater Flow Cell 1 (gpm)	Stormwater Flow Cell 2 (gpm)	Stormwater Flow Cell 3 (gpm)
0	0.00	0.00	0.00	0.00	0.00	0.00
0.2	0.00	0.00	0.00	0.00	0.00	0.00
0.4	0.00	0.00	0.00	0.00	0.00	0.00
0.6	0.00	0.00	0.00	0.00	0.00	0.00
0.8	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00
1.2	0.00	0.00	0.00	0.00	0.00	0.00
1.4	0.00	0.00	0.00	0.00	0.00	0.00
1.6	0.00	0.00	0.00	0.00	0.00	0.00
1.8	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00
2.2	0.00	0.00	0.00	0.00	0.00	0.00
2.4	0.00	0.00	0.00	0.00	0.00	0.00
2.6	0.00	0.00	0.00	0.00	0.00	0.00
2.8	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00
3.2	0.00	0.00	0.00	0.00	0.00	0.00
3.4	0.00	0.00	0.00	0.00	0.00	0.00
3.6	0.00	0.00	0.00	0.00	0.00	0.00
3.8	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00
4.2	0.00	0.00	0.00	0.00	0.00	0.00
4.4	0.00	0.00	0.00	0.00	0.00	0.00
4.6	0.00	0.00	0.00	0.00	0.00	0.00
4.8	0.00	0.00	0.00	0.00	0.00	0.00
5	0.01	0.00	0.90	4.58	6.64	9.69
5.2	0.01	0.00	0.90	4.58	6.64	9.69
5.4	0.01	0.00	0.90	4.58	6.64	9.69
5.6	0.01	0.00	0.90	4.58	6.64	9.69
5.8	0.01	0.00	0.90	4.58	6.64	9.69
6	0.01	0.00	0.90	4.58	6.64	9.69
6.2	0.02	0.00	1.80	9.16	13.28	19.39
6.4	0.02	0.00	1.80	9.16	13.28	19.39
6.6	0.02	0.00	1.80	9.16	13.28	19.39
6.8	0.03	0.01	2.69	13.73	19.93	29.08
7	0.03	0.01	2.69	13.73	19.93	29.08
7.2	0.03	0.01	2.69	13.73	19.93	29.08
7.4	0.04	0.01	3.59	18.31	26.57	38.78
7.6	0.04	0.01	3.59	18.31	26.57	38.78
7.8	0.04	0.01	3.59	18.31	26.57	38.78
8	0.05	0.01	4.49	22.89	33.21	48.47
8.2	0.05	0.01	4.49	22.89	33.21	48.47
8.4	0.05	0.01	4.49	22.89	33.21	48.47
8.6	0.06	0.01	5.39	27.47	39.85	58.16
8.8	0.06	0.01	5.39	27.47	39.85	58.16
9	0.07	0.01	6.28	32.04	46.50	67.86
9.2	0.07	0.01	6.28	32.04	46.50	67.86
9.4	0.08	0.02	7.18	36.62	53.14	77.55
9.6	0.08	0.02	7.18	36.62	53.14	77.55
9.8	0.09	0.02	8.08	41.20	59.78	87.25
10	0.09	0.02	8.08	41.20	59.78	87.25
10.2	0.10	0.02	8.98	45.78	66.42	96.94
10.4	0.10	0.02	8.98	45.78	66.42	96.94
10.6	0.11	0.02	9.87	50.36	73.06	106.63
10.8	0.12	0.02	10.77	54.93	79.71	116.33
11	0.13	0.03	11.67	59.51	86.35	126.02
11.2	0.14	0.03	12.57	64.09	92.99	135.72
11.4	0.15	0.03	13.46	68.67	99.63	145.41
11.6	0.16	0.03	14.36	73.24	106.28	155.11
11.8	0.21	0.04	18.85	96.13	139.49	203.58
12	0.31	0.06	27.83	141.91	205.91	300.52
12.2	0.36	0.07	32.31	164.80	239.12	348.99
12.4	0.49	0.10	43.98	224.31	325.47	475.01
12.6	0.73	0.15	65.52	334.18	484.88	707.67
12.8	0.92	0.18	82.58	421.15	611.09	891.86
13	1.07	0.21	96.04	489.82	710.72	1,037.27
13.2	1.17	0.23	105.02	535.60	777.14	1,134.21
13.4	1.24	0.25	111.30	567.64	823.64	1,202.07
13.6	1.29	0.26	115.79	590.53	856.85	1,250.54

Attachment 1 - Peak Stormwater Generation Rates						
Time (hr)	Stormwater Flow/5 Acres (cfs)	Stormwater Flow/Acre (cfs)	Stormwater Flow/Acre (gpm)	Stormwater Flow Cell 1 (gpm)	Stormwater Flow Cell 2 (gpm)	Stormwater Flow Cell 3 (gpm)
13.8	1.31	0.26	117.59	599.69	870.13	1,269.92
14	1.32	0.26	118.48	604.26	876.78	1,279.62
14.2	1.32	0.26	118.48	604.26	876.78	1,279.62
14.4	1.31	0.26	117.59	599.69	870.13	1,269.92
14.6	1.29	0.26	115.79	590.53	856.85	1,250.54
14.8	1.27	0.25	114.00	581.38	843.56	1,231.15
15	1.25	0.25	112.20	572.22	830.28	1,211.76
15.2	1.23	0.25	110.40	563.06	817.00	1,192.37
15.4	1.20	0.24	107.71	549.33	797.07	1,163.29
15.6	1.18	0.24	105.92	540.18	783.78	1,143.90
15.8	1.15	0.23	103.22	526.44	763.86	1,114.82
16	1.12	0.22	100.53	512.71	743.93	1,085.74
16.2	1.09	0.22	97.84	498.98	724.00	1,056.65
16.4	1.06	0.21	95.15	485.24	704.08	1,027.57
16.6	1.03	0.21	92.45	471.51	684.15	998.49
16.8	1.00	0.20	89.76	457.78	664.22	969.41
17	0.97	0.19	87.07	444.04	644.30	940.33
17.2	0.95	0.19	85.27	434.89	631.01	920.94
17.4	0.92	0.18	82.58	421.15	611.09	891.86
17.6	0.90	0.18	80.78	412.00	597.80	872.47
17.8	0.87	0.17	78.09	398.27	577.87	843.38
18	0.85	0.17	76.30	389.11	564.59	824.00
18.2	0.83	0.17	74.50	379.95	551.31	804.61
18.4	0.81	0.16	72.71	370.80	538.02	785.22
18.6	0.79	0.16	70.91	361.64	524.74	765.83
18.8	0.77	0.15	69.12	352.49	511.45	746.44
19	0.75	0.15	67.32	343.33	498.17	727.06
19.2	0.73	0.15	65.52	334.18	484.88	707.67
19.4	0.72	0.14	64.63	329.60	478.24	697.97
19.6	0.70	0.14	62.83	320.44	464.96	678.59
19.8	0.68	0.14	61.04	311.29	451.67	659.20
20	0.67	0.13	60.14	306.71	445.03	649.50
20.2	0.65	0.13	58.34	297.55	431.75	630.12
20.4	0.64	0.13	57.45	292.98	425.10	620.42
20.6	0.62	0.12	55.65	283.82	411.82	601.03
20.8	0.61	0.12	54.75	279.24	405.18	591.34
21	0.60	0.12	53.86	274.67	398.53	581.64
21.2	0.58	0.12	52.06	265.51	385.25	562.26
21.4	0.57	0.11	51.16	260.93	378.61	552.56
21.6	0.56	0.11	50.27	256.35	371.97	542.87
21.8	0.55	0.11	49.37	251.78	365.32	533.17
22	0.54	0.11	48.47	247.20	358.68	523.48
22.2	0.53	0.11	47.57	242.62	352.04	513.79
22.4	0.52	0.10	46.68	238.04	345.40	504.09
22.6	0.51	0.10	45.78	233.47	338.75	494.40
22.8	0.51	0.10	45.78	233.47	338.75	494.40
23	0.50	0.10	44.88	228.89	332.11	484.70
23.2	0.49	0.10	43.98	224.31	325.47	475.01
23.4	0.48	0.10	43.08	219.73	318.83	465.32
23.6	0.48	0.10	43.08	219.73	318.83	465.32
23.8	0.47	0.09	42.19	215.15	312.19	455.62
24	0.46	0.09	41.29	210.58	305.54	445.93
24.2	0.44	0.09	39.49	201.42	292.26	426.54
24.4	0.42	0.08	37.70	192.27	278.97	407.15
24.6	0.41	0.08	36.80	187.69	272.33	397.46
24.8	0.39	0.08	35.01	178.53	259.05	378.07
25	0.37	0.07	33.21	169.38	245.76	358.68
25.2	0.36	0.07	32.31	164.80	239.12	348.99
25.4	0.36	0.07	32.31	164.80	239.12	348.99
25.6	0.36	0.07	32.31	164.80	239.12	348.99
25.8	0.36	0.07	32.31	164.80	239.12	348.99
26	0.36	0.07	32.31	164.80	239.12	348.99
26.2	0.36	0.07	32.31	164.80	239.12	348.99
26.4	0.36	0.07	32.31	164.80	239.12	348.99
26.6	0.35	0.07	31.42	160.22	232.48	339.29
26.8	0.35	0.07	31.42	160.22	232.48	339.29
27	0.35	0.07	31.42	160.22	232.48	339.29
27.2	0.35	0.07	31.42	160.22	232.48	339.29
27.4	0.35	0.07	31.42	160.22	232.48	339.29

Attachment 1 - Peak Stormwater Generation Rates						
Time (hr)	Stormwater Flow/5 Acres (cfs)	Stormwater Flow/Acre (cfs)	Stormwater Flow/Acre (gpm)	Stormwater Flow Cell 1 (gpm)	Stormwater Flow Cell 2 (gpm)	Stormwater Flow Cell 3 (gpm)
27.6	0.35	0.07	31.42	160.22	232.48	339.29
27.8	0.35	0.07	31.42	160.22	232.48	339.29
28	0.35	0.07	31.42	160.22	232.48	339.29
28.2	0.35	0.07	31.42	160.22	232.48	339.29
28.4	0.35	0.07	31.42	160.22	232.48	339.29
28.6	0.35	0.07	31.42	160.22	232.48	339.29
28.8	0.35	0.07	31.42	160.22	232.48	339.29
29	0.35	0.07	31.42	160.22	232.48	339.29
29.2	0.34	0.07	30.52	155.64	225.84	329.60
29.4	0.34	0.07	30.52	155.64	225.84	329.60
29.6	0.34	0.07	30.52	155.64	225.84	329.60
29.8	0.34	0.07	30.52	155.64	225.84	329.60
30	0.34	0.07	30.52	155.64	225.84	329.60
30.2	0.34	0.07	30.52	155.64	225.84	329.60
30.4	0.34	0.07	30.52	155.64	225.84	329.60
30.6	0.34	0.07	30.52	155.64	225.84	329.60
30.8	0.34	0.07	30.52	155.64	225.84	329.60
31	0.34	0.07	30.52	155.64	225.84	329.60
31.2	0.34	0.07	30.52	155.64	225.84	329.60
31.4	0.33	0.07	29.62	151.07	219.19	319.90
31.6	0.33	0.07	29.62	151.07	219.19	319.90
31.8	0.33	0.07	29.62	151.07	219.19	319.90
32	0.33	0.07	29.62	151.07	219.19	319.90
32.2	0.33	0.07	29.62	151.07	219.19	319.90
32.4	0.33	0.07	29.62	151.07	219.19	319.90
32.6	0.33	0.07	29.62	151.07	219.19	319.90
32.8	0.33	0.07	29.62	151.07	219.19	319.90
33	0.33	0.07	29.62	151.07	219.19	319.90
33.2	0.33	0.07	29.62	151.07	219.19	319.90
33.4	0.33	0.07	29.62	151.07	219.19	319.90
33.6	0.33	0.07	29.62	151.07	219.19	319.90
33.8	0.32	0.06	28.72	146.49	212.55	310.21
34	0.32	0.06	28.72	146.49	212.55	310.21
34.2	0.32	0.06	28.72	146.49	212.55	310.21
34.4	0.32	0.06	28.72	146.49	212.55	310.21
34.6	0.32	0.06	28.72	146.49	212.55	310.21
34.8	0.32	0.06	28.72	146.49	212.55	310.21
35	0.32	0.06	28.72	146.49	212.55	310.21
35.2	0.32	0.06	28.72	146.49	212.55	310.21
35.4	0.32	0.06	28.72	146.49	212.55	310.21
35.6	0.32	0.06	28.72	146.49	212.55	310.21
35.8	0.32	0.06	28.72	146.49	212.55	310.21
36	0.32	0.06	28.72	146.49	212.55	310.21
36.2	0.32	0.06	28.72	146.49	212.55	310.21
36.4	0.31	0.06	27.83	141.91	205.91	300.52
36.6	0.31	0.06	27.83	141.91	205.91	300.52
36.8	0.31	0.06	27.83	141.91	205.91	300.52
37	0.31	0.06	27.83	141.91	205.91	300.52
37.2	0.31	0.06	27.83	141.91	205.91	300.52
37.4	0.31	0.06	27.83	141.91	205.91	300.52
37.6	0.31	0.06	27.83	141.91	205.91	300.52
37.8	0.31	0.06	27.83	141.91	205.91	300.52
38	0.31	0.06	27.83	141.91	205.91	300.52
38.2	0.31	0.06	27.83	141.91	205.91	300.52
38.4	0.31	0.06	27.83	141.91	205.91	300.52
38.6	0.30	0.06	26.93	137.33	199.27	290.82
38.8	0.30	0.06	26.93	137.33	199.27	290.82
39	0.30	0.06	26.93	137.33	199.27	290.82
39.2	0.30	0.06	26.93	137.33	199.27	290.82
39.4	0.30	0.06	26.93	137.33	199.27	290.82
39.6	0.30	0.06	26.93	137.33	199.27	290.82
39.8	0.30	0.06	26.93	137.33	199.27	290.82
40	0.30	0.06	26.93	137.33	199.27	290.82
40.2	0.30	0.06	26.93	137.33	199.27	290.82
40.4	0.30	0.06	26.93	137.33	199.27	290.82
40.6	0.30	0.06	26.93	137.33	199.27	290.82
40.8	0.30	0.06	26.93	137.33	199.27	290.82
41	0.30	0.06	26.93	137.33	199.27	290.82
41.2	0.29	0.06	26.03	132.76	192.62	281.13

Attachment 1 - Peak Stormwater Generation Rates						
Time (hr)	Stormwater Flow/5 Acres (cfs)	Stormwater Flow/Acre (cfs)	Stormwater Flow/Acre (gpm)	Stormwater Flow Cell 1 (gpm)	Stormwater Flow Cell 2 (gpm)	Stormwater Flow Cell 3 (gpm)
41.4	0.29	0.06	26.03	132.76	192.62	281.13
41.6	0.29	0.06	26.03	132.76	192.62	281.13
41.8	0.29	0.06	26.03	132.76	192.62	281.13
42	0.29	0.06	26.03	132.76	192.62	281.13
42.2	0.29	0.06	26.03	132.76	192.62	281.13
42.4	0.29	0.06	26.03	132.76	192.62	281.13
42.6	0.29	0.06	26.03	132.76	192.62	281.13
42.8	0.29	0.06	26.03	132.76	192.62	281.13
43	0.29	0.06	26.03	132.76	192.62	281.13
43.2	0.29	0.06	26.03	132.76	192.62	281.13
43.4	0.29	0.06	26.03	132.76	192.62	281.13
43.6	0.28	0.06	25.13	128.18	185.98	271.43
43.8	0.28	0.06	25.13	128.18	185.98	271.43
44	0.28	0.06	25.13	128.18	185.98	271.43
44.2	0.28	0.06	25.13	128.18	185.98	271.43
44.4	0.28	0.06	25.13	128.18	185.98	271.43
44.6	0.28	0.06	25.13	128.18	185.98	271.43
44.8	0.28	0.06	25.13	128.18	185.98	271.43
45	0.28	0.06	25.13	128.18	185.98	271.43
45.2	0.28	0.06	25.13	128.18	185.98	271.43
45.4	0.28	0.06	25.13	128.18	185.98	271.43
45.6	0.28	0.06	25.13	128.18	185.98	271.43
45.8	0.28	0.06	25.13	128.18	185.98	271.43
46	0.27	0.05	24.24	123.60	179.34	261.74
46.2	0.27	0.05	24.24	123.60	179.34	261.74
46.4	0.27	0.05	24.24	123.60	179.34	261.74
46.6	0.27	0.05	24.24	123.60	179.34	261.74
46.8	0.27	0.05	24.24	123.60	179.34	261.74
47	0.27	0.05	24.24	123.60	179.34	261.74
47.2	0.27	0.05	24.24	123.60	179.34	261.74
47.4	0.27	0.05	24.24	123.60	179.34	261.74
47.6	0.27	0.05	24.24	123.60	179.34	261.74
47.8	0.27	0.05	24.24	123.60	179.34	261.74
48	0.27	0.05	24.24	123.60	179.34	261.74
48.2	0.27	0.05	24.24	123.60	179.34	261.74
48.4	0.27	0.05	24.24	123.60	179.34	261.74
48.6	0.26	0.05	23.34	119.02	172.70	252.05
48.8	0.26	0.05	23.34	119.02	172.70	252.05
49	0.26	0.05	23.34	119.02	172.70	252.05
49.2	0.26	0.05	23.34	119.02	172.70	252.05
49.4	0.26	0.05	23.34	119.02	172.70	252.05
49.6	0.26	0.05	23.34	119.02	172.70	252.05
49.8	0.26	0.05	23.34	119.02	172.70	252.05
50	0.26	0.05	23.34	119.02	172.70	252.05
50.2	0.26	0.05	23.34	119.02	172.70	252.05
50.4	0.26	0.05	23.34	119.02	172.70	252.05
50.6	0.26	0.05	23.34	119.02	172.70	252.05
50.8	0.25	0.05	22.44	114.44	166.06	242.35
51	0.25	0.05	22.44	114.44	166.06	242.35
51.2	0.25	0.05	22.44	114.44	166.06	242.35
51.4	0.25	0.05	22.44	114.44	166.06	242.35
51.6	0.25	0.05	22.44	114.44	166.06	242.35
51.8	0.25	0.05	22.44	114.44	166.06	242.35
52	0.25	0.05	22.44	114.44	166.06	242.35
52.2	0.25	0.05	22.44	114.44	166.06	242.35
52.4	0.25	0.05	22.44	114.44	166.06	242.35
52.6	0.25	0.05	22.44	114.44	166.06	242.35
52.8	0.25	0.05	22.44	114.44	166.06	242.35
53	0.25	0.05	22.44	114.44	166.06	242.35
53.2	0.25	0.05	22.44	114.44	166.06	242.35
53.4	0.25	0.05	22.44	114.44	166.06	242.35
53.6	0.24	0.05	21.54	109.87	159.41	232.66
53.8	0.24	0.05	21.54	109.87	159.41	232.66
54	0.24	0.05	21.54	109.87	159.41	232.66
54.2	0.24	0.05	21.54	109.87	159.41	232.66
54.4	0.24	0.05	21.54	109.87	159.41	232.66
54.6	0.24	0.05	21.54	109.87	159.41	232.66
54.8	0.24	0.05	21.54	109.87	159.41	232.66
55	0.24	0.05	21.54	109.87	159.41	232.66

Attachment 1 - Peak Stormwater Generation Rates						
Time (hr)	Stormwater Flow/5 Acres (cfs)	Stormwater Flow/Acre (cfs)	Stormwater Flow/Acre (gpm)	Stormwater Flow Cell 1 (gpm)	Stormwater Flow Cell 2 (gpm)	Stormwater Flow Cell 3 (gpm)
55.2	0.24	0.05	21.54	109.87	159.41	232.66
55.4	0.24	0.05	21.54	109.87	159.41	232.66
55.6	0.24	0.05	21.54	109.87	159.41	232.66
55.8	0.24	0.05	21.54	109.87	159.41	232.66
56	0.23	0.05	20.64	105.29	152.77	222.96
56.2	0.23	0.05	20.64	105.29	152.77	222.96
56.4	0.23	0.05	20.64	105.29	152.77	222.96
56.6	0.23	0.05	20.64	105.29	152.77	222.96
56.8	0.23	0.05	20.64	105.29	152.77	222.96
57	0.23	0.05	20.64	105.29	152.77	222.96
57.2	0.23	0.05	20.64	105.29	152.77	222.96
57.4	0.23	0.05	20.64	105.29	152.77	222.96
57.6	0.23	0.05	20.64	105.29	152.77	222.96
57.8	0.23	0.05	20.64	105.29	152.77	222.96
58	0.23	0.05	20.64	105.29	152.77	222.96
58.2	0.23	0.05	20.64	105.29	152.77	222.96
58.4	0.22	0.04	19.75	100.71	146.13	213.27
58.6	0.22	0.04	19.75	100.71	146.13	213.27
58.8	0.22	0.04	19.75	100.71	146.13	213.27
59	0.22	0.04	19.75	100.71	146.13	213.27
59.2	0.22	0.04	19.75	100.71	146.13	213.27
59.4	0.22	0.04	19.75	100.71	146.13	213.27
59.6	0.22	0.04	19.75	100.71	146.13	213.27
59.8	0.22	0.04	19.75	100.71	146.13	213.27
60	0.22	0.04	19.75	100.71	146.13	213.27
60.2	0.22	0.04	19.75	100.71	146.13	213.27
60.4	0.22	0.04	19.75	100.71	146.13	213.27
60.6	0.22	0.04	19.75	100.71	146.13	213.27
60.8	0.22	0.04	19.75	100.71	146.13	213.27
61	0.22	0.04	19.75	100.71	146.13	213.27
61.2	0.21	0.04	18.85	96.13	139.49	203.58
61.4	0.21	0.04	18.85	96.13	139.49	203.58
61.6	0.21	0.04	18.85	96.13	139.49	203.58
61.8	0.21	0.04	18.85	96.13	139.49	203.58
62	0.21	0.04	18.85	96.13	139.49	203.58
62.2	0.21	0.04	18.85	96.13	139.49	203.58
62.4	0.21	0.04	18.85	96.13	139.49	203.58
62.6	0.21	0.04	18.85	96.13	139.49	203.58
62.8	0.21	0.04	18.85	96.13	139.49	203.58
63	0.21	0.04	18.85	96.13	139.49	203.58
63.2	0.21	0.04	18.85	96.13	139.49	203.58
63.4	0.21	0.04	18.85	96.13	139.49	203.58
63.6	0.20	0.04	17.95	91.56	132.84	193.88
63.8	0.20	0.04	17.95	91.56	132.84	193.88
64	0.20	0.04	17.95	91.56	132.84	193.88
64.2	0.20	0.04	17.95	91.56	132.84	193.88
64.4	0.20	0.04	17.95	91.56	132.84	193.88
64.6	0.20	0.04	17.95	91.56	132.84	193.88
64.8	0.20	0.04	17.95	91.56	132.84	193.88
65	0.20	0.04	17.95	91.56	132.84	193.88
65.2	0.20	0.04	17.95	91.56	132.84	193.88
65.4	0.20	0.04	17.95	91.56	132.84	193.88
65.6	0.20	0.04	17.95	91.56	132.84	193.88
65.8	0.20	0.04	17.95	91.56	132.84	193.88
66	0.20	0.04	17.95	91.56	132.84	193.88
66.2	0.20	0.04	17.95	91.56	132.84	193.88
66.4	0.19	0.04	17.05	86.98	126.20	184.19
66.6	0.19	0.04	17.05	86.98	126.20	184.19
66.8	0.19	0.04	17.05	86.98	126.20	184.19
67	0.19	0.04	17.05	86.98	126.20	184.19
67.2	0.19	0.04	17.05	86.98	126.20	184.19
67.4	0.19	0.04	17.05	86.98	126.20	184.19
67.6	0.19	0.04	17.05	86.98	126.20	184.19
67.8	0.19	0.04	17.05	86.98	126.20	184.19
68	0.19	0.04	17.05	86.98	126.20	184.19
68.2	0.19	0.04	17.05	86.98	126.20	184.19
68.4	0.19	0.04	17.05	86.98	126.20	184.19
68.6	0.19	0.04	17.05	86.98	126.20	184.19
68.8	0.18	0.04	16.16	82.40	119.56	174.49

Attachment 1 - Peak Stormwater Generation Rates						
Time (hr)	Stormwater Flow/5 Acres (cfs)	Stormwater Flow/Acre (cfs)	Stormwater Flow/Acre (gpm)	Stormwater Flow Cell 1 (gpm)	Stormwater Flow Cell 2 (gpm)	Stormwater Flow Cell 3 (gpm)
69	0.18	0.04	16.16	82.40	119.56	174.49
69.2	0.18	0.04	16.16	82.40	119.56	174.49
69.4	0.18	0.04	16.16	82.40	119.56	174.49
69.6	0.18	0.04	16.16	82.40	119.56	174.49
69.8	0.18	0.04	16.16	82.40	119.56	174.49
70	0.18	0.04	16.16	82.40	119.56	174.49
70.2	0.18	0.04	16.16	82.40	119.56	174.49
70.4	0.18	0.04	16.16	82.40	119.56	174.49
70.6	0.18	0.04	16.16	82.40	119.56	174.49
70.8	0.18	0.04	16.16	82.40	119.56	174.49
71	0.18	0.04	16.16	82.40	119.56	174.49
71.2	0.18	0.04	16.16	82.40	119.56	174.49
71.4	0.17	0.03	15.26	77.82	112.92	164.80
71.6	0.17	0.03	15.26	77.82	112.92	164.80
71.8	0.17	0.03	15.26	77.82	112.92	164.80
72	0.17	0.03	15.26	77.82	112.92	164.80
72.2	0.17	0.03	15.26	77.82	112.92	164.80
72.4	0.17	0.03	15.26	77.82	112.92	164.80
72.6	0.17	0.03	15.26	77.82	112.92	164.80
72.8	0.17	0.03	15.26	77.82	112.92	164.80
73	0.17	0.03	15.26	77.82	112.92	164.80
73.2	0.17	0.03	15.26	77.82	112.92	164.80
73.4	0.17	0.03	15.26	77.82	112.92	164.80
73.6	0.17	0.03	15.26	77.82	112.92	164.80
73.8	0.17	0.03	15.26	77.82	112.92	164.80
74	0.16	0.03	14.36	73.24	106.28	155.11
74.2	0.16	0.03	14.36	73.24	106.28	155.11
74.4	0.16	0.03	14.36	73.24	106.28	155.11
74.6	0.16	0.03	14.36	73.24	106.28	155.11
74.8	0.16	0.03	14.36	73.24	106.28	155.11
75	0.16	0.03	14.36	73.24	106.28	155.11
75.2	0.16	0.03	14.36	73.24	106.28	155.11
75.4	0.16	0.03	14.36	73.24	106.28	155.11
75.6	0.16	0.03	14.36	73.24	106.28	155.11
75.8	0.16	0.03	14.36	73.24	106.28	155.11
76	0.16	0.03	14.36	73.24	106.28	155.11
76.2	0.16	0.03	14.36	73.24	106.28	155.11
76.4	0.16	0.03	14.36	73.24	106.28	155.11
76.6	0.15	0.03	13.46	68.67	99.63	145.41
76.8	0.15	0.03	13.46	68.67	99.63	145.41
77	0.15	0.03	13.46	68.67	99.63	145.41
77.2	0.15	0.03	13.46	68.67	99.63	145.41
77.4	0.15	0.03	13.46	68.67	99.63	145.41
77.6	0.15	0.03	13.46	68.67	99.63	145.41
77.8	0.15	0.03	13.46	68.67	99.63	145.41
78	0.15	0.03	13.46	68.67	99.63	145.41
78.2	0.15	0.03	13.46	68.67	99.63	145.41
78.4	0.15	0.03	13.46	68.67	99.63	145.41
78.6	0.15	0.03	13.46	68.67	99.63	145.41
78.8	0.15	0.03	13.46	68.67	99.63	145.41
79	0.15	0.03	13.46	68.67	99.63	145.41
79.2	0.15	0.03	13.46	68.67	99.63	145.41
79.4	0.14	0.03	12.57	64.09	92.99	135.72
79.6	0.14	0.03	12.57	64.09	92.99	135.72
79.8	0.14	0.03	12.57	64.09	92.99	135.72
80	0.14	0.03	12.57	64.09	92.99	135.72
80.2	0.14	0.03	12.57	64.09	92.99	135.72
80.4	0.14	0.03	12.57	64.09	92.99	135.72
80.6	0.14	0.03	12.57	64.09	92.99	135.72
80.8	0.14	0.03	12.57	64.09	92.99	135.72
81	0.14	0.03	12.57	64.09	92.99	135.72
81.2	0.14	0.03	12.57	64.09	92.99	135.72
81.4	0.14	0.03	12.57	64.09	92.99	135.72
81.6	0.14	0.03	12.57	64.09	92.99	135.72
81.8	0.14	0.03	12.57	64.09	92.99	135.72
82	0.13	0.03	11.67	59.51	86.35	126.02
82.2	0.13	0.03	11.67	59.51	86.35	126.02
82.4	0.13	0.03	11.67	59.51	86.35	126.02
82.6	0.13	0.03	11.67	59.51	86.35	126.02

Attachment 1 - Peak Stormwater Generation Rates						
Time (hr)	Stormwater Flow/5 Acres (cfs)	Stormwater Flow/Acre (cfs)	Stormwater Flow/Acre (gpm)	Stormwater Flow Cell 1 (gpm)	Stormwater Flow Cell 2 (gpm)	Stormwater Flow Cell 3 (gpm)
82.8	0.13	0.03	11.67	59.51	86.35	126.02
83	0.13	0.03	11.67	59.51	86.35	126.02
83.2	0.13	0.03	11.67	59.51	86.35	126.02
83.4	0.13	0.03	11.67	59.51	86.35	126.02
83.6	0.13	0.03	11.67	59.51	86.35	126.02
83.8	0.13	0.03	11.67	59.51	86.35	126.02
84	0.13	0.03	11.67	59.51	86.35	126.02
84.2	0.13	0.03	11.67	59.51	86.35	126.02
84.4	0.13	0.03	11.67	59.51	86.35	126.02
84.6	0.13	0.03	11.67	59.51	86.35	126.02
84.8	0.12	0.02	10.77	54.93	79.71	116.33
85	0.12	0.02	10.77	54.93	79.71	116.33
85.2	0.12	0.02	10.77	54.93	79.71	116.33
85.4	0.12	0.02	10.77	54.93	79.71	116.33
85.6	0.12	0.02	10.77	54.93	79.71	116.33
85.8	0.12	0.02	10.77	54.93	79.71	116.33
86	0.12	0.02	10.77	54.93	79.71	116.33
86.2	0.12	0.02	10.77	54.93	79.71	116.33
86.4	0.12	0.02	10.77	54.93	79.71	116.33
86.6	0.12	0.02	10.77	54.93	79.71	116.33
86.8	0.12	0.02	10.77	54.93	79.71	116.33
87	0.12	0.02	10.77	54.93	79.71	116.33
87.2	0.12	0.02	10.77	54.93	79.71	116.33
87.4	0.12	0.02	10.77	54.93	79.71	116.33
87.6	0.12	0.02	10.77	54.93	79.71	116.33
87.8	0.11	0.02	9.87	50.36	73.06	106.63
88	0.11	0.02	9.87	50.36	73.06	106.63
88.2	0.11	0.02	9.87	50.36	73.06	106.63
88.4	0.11	0.02	9.87	50.36	73.06	106.63
88.6	0.11	0.02	9.87	50.36	73.06	106.63
88.8	0.11	0.02	9.87	50.36	73.06	106.63
89	0.11	0.02	9.87	50.36	73.06	106.63
89.2	0.11	0.02	9.87	50.36	73.06	106.63
89.4	0.11	0.02	9.87	50.36	73.06	106.63
89.6	0.11	0.02	9.87	50.36	73.06	106.63
89.8	0.11	0.02	9.87	50.36	73.06	106.63
90	0.11	0.02	9.87	50.36	73.06	106.63
90.2	0.11	0.02	9.87	50.36	73.06	106.63
90.4	0.10	0.02	8.98	45.78	66.42	96.94
90.6	0.10	0.02	8.98	45.78	66.42	96.94
90.8	0.10	0.02	8.98	45.78	66.42	96.94
91	0.10	0.02	8.98	45.78	66.42	96.94
91.2	0.10	0.02	8.98	45.78	66.42	96.94
91.4	0.10	0.02	8.98	45.78	66.42	96.94
91.6	0.10	0.02	8.98	45.78	66.42	96.94
91.8	0.10	0.02	8.98	45.78	66.42	96.94
92	0.10	0.02	8.98	45.78	66.42	96.94
92.2	0.10	0.02	8.98	45.78	66.42	96.94
92.4	0.10	0.02	8.98	45.78	66.42	96.94
92.6	0.10	0.02	8.98	45.78	66.42	96.94
92.8	0.10	0.02	8.98	45.78	66.42	96.94
93	0.10	0.02	8.98	45.78	66.42	96.94
93.2	0.10	0.02	8.98	45.78	66.42	96.94
93.4	0.10	0.02	8.98	45.78	66.42	96.94
93.6	0.09	0.02	8.08	41.20	59.78	87.25
93.8	0.09	0.02	8.08	41.20	59.78	87.25
94	0.09	0.02	8.08	41.20	59.78	87.25
94.2	0.09	0.02	8.08	41.20	59.78	87.25
94.4	0.09	0.02	8.08	41.20	59.78	87.25
94.6	0.09	0.02	8.08	41.20	59.78	87.25
94.8	0.09	0.02	8.08	41.20	59.78	87.25
95	0.09	0.02	8.08	41.20	59.78	87.25
95.2	0.09	0.02	8.08	41.20	59.78	87.25
95.4	0.09	0.02	8.08	41.20	59.78	87.25
95.6	0.09	0.02	8.08	41.20	59.78	87.25
95.8	0.09	0.02	8.08	41.20	59.78	87.25
96	0.08	0.02	7.18	36.62	53.14	77.55
96.2	0.08	0.02	7.18	36.62	53.14	77.55
96.4	0.08	0.02	7.18	36.62	53.14	77.55

Attachment 1 - Peak Stormwater Generation Rates						
Time (hr)	Stormwater Flow/5 Acres (cfs)	Stormwater Flow/Acre (cfs)	Stormwater Flow/Acre (gpm)	Stormwater Flow Cell 1 (gpm)	Stormwater Flow Cell 2 (gpm)	Stormwater Flow Cell 3 (gpm)
96.6	0.08	0.02	7.18	36.62	53.14	77.55
96.8	0.08	0.02	7.18	36.62	53.14	77.55
97	0.08	0.02	7.18	36.62	53.14	77.55
97.2	0.08	0.02	7.18	36.62	53.14	77.55
97.4	0.08	0.02	7.18	36.62	53.14	77.55
97.6	0.08	0.02	7.18	36.62	53.14	77.55
97.8	0.08	0.02	7.18	36.62	53.14	77.55
98	0.08	0.02	7.18	36.62	53.14	77.55
98.2	0.08	0.02	7.18	36.62	53.14	77.55
98.4	0.08	0.02	7.18	36.62	53.14	77.55
98.6	0.08	0.02	7.18	36.62	53.14	77.55
98.8	0.08	0.02	7.18	36.62	53.14	77.55
99	0.08	0.02	7.18	36.62	53.14	77.55
99.2	0.08	0.02	7.18	36.62	53.14	77.55
99.4	0.08	0.02	7.18	36.62	53.14	77.55
99.6	0.07	0.01	6.28	32.04	46.50	67.86
99.8	0.07	0.01	6.28	32.04	46.50	67.86
100	0.07	0.01	6.28	32.04	46.50	67.86
100.2	0.07	0.01	6.28	32.04	46.50	67.86
100.4	0.07	0.01	6.28	32.04	46.50	67.86
100.6	0.07	0.01	6.28	32.04	46.50	67.86
100.8	0.07	0.01	6.28	32.04	46.50	67.86
101	0.07	0.01	6.28	32.04	46.50	67.86
101.2	0.07	0.01	6.28	32.04	46.50	67.86
101.4	0.07	0.01	6.28	32.04	46.50	67.86
101.6	0.07	0.01	6.28	32.04	46.50	67.86
101.8	0.07	0.01	6.28	32.04	46.50	67.86
102	0.07	0.01	6.28	32.04	46.50	67.86
102.2	0.07	0.01	6.28	32.04	46.50	67.86
102.4	0.07	0.01	6.28	32.04	46.50	67.86
102.6	0.06	0.01	5.39	27.47	39.85	58.16
102.8	0.06	0.01	5.39	27.47	39.85	58.16
103	0.06	0.01	5.39	27.47	39.85	58.16
103.2	0.06	0.01	5.39	27.47	39.85	58.16
103.4	0.06	0.01	5.39	27.47	39.85	58.16
103.6	0.06	0.01	5.39	27.47	39.85	58.16
103.8	0.06	0.01	5.39	27.47	39.85	58.16
104	0.06	0.01	5.39	27.47	39.85	58.16
104.2	0.06	0.01	5.39	27.47	39.85	58.16
104.4	0.06	0.01	5.39	27.47	39.85	58.16
104.6	0.06	0.01	5.39	27.47	39.85	58.16
104.8	0.06	0.01	5.39	27.47	39.85	58.16
105	0.06	0.01	5.39	27.47	39.85	58.16
105.2	0.06	0.01	5.39	27.47	39.85	58.16
105.4	0.06	0.01	5.39	27.47	39.85	58.16
105.6	0.06	0.01	5.39	27.47	39.85	58.16
105.8	0.06	0.01	5.39	27.47	39.85	58.16
106	0.05	0.01	4.49	22.89	33.21	48.47
106.2	0.05	0.01	4.49	22.89	33.21	48.47
106.4	0.05	0.01	4.49	22.89	33.21	48.47
106.6	0.05	0.01	4.49	22.89	33.21	48.47
106.8	0.05	0.01	4.49	22.89	33.21	48.47
107	0.05	0.01	4.49	22.89	33.21	48.47
107.2	0.05	0.01	4.49	22.89	33.21	48.47
107.4	0.05	0.01	4.49	22.89	33.21	48.47
107.6	0.05	0.01	4.49	22.89	33.21	48.47
107.8	0.05	0.01	4.49	22.89	33.21	48.47
108	0.05	0.01	4.49	22.89	33.21	48.47
108.2	0.05	0.01	4.49	22.89	33.21	48.47
108.4	0.05	0.01	4.49	22.89	33.21	48.47
108.6	0.05	0.01	4.49	22.89	33.21	48.47
108.8	0.05	0.01	4.49	22.89	33.21	48.47
109	0.05	0.01	4.49	22.89	33.21	48.47
109.2	0.05	0.01	4.49	22.89	33.21	48.47
109.4	0.05	0.01	4.49	22.89	33.21	48.47
109.6	0.05	0.01	4.49	22.89	33.21	48.47
109.8	0.04	0.01	3.59	18.31	26.57	38.78
110	0.04	0.01	3.59	18.31	26.57	38.78
110.2	0.04	0.01	3.59	18.31	26.57	38.78

Attachment 1 - Peak Stormwater Generation Rates						
Time (hr)	Stormwater Flow/5 Acres (cfs)	Stormwater Flow/Acre (cfs)	Stormwater Flow/Acre (gpm)	Stormwater Flow Cell 1 (gpm)	Stormwater Flow Cell 2 (gpm)	Stormwater Flow Cell 3 (gpm)
110.4	0.04	0.01	3.59	18.31	26.57	38.78
110.6	0.04	0.01	3.59	18.31	26.57	38.78
110.8	0.04	0.01	3.59	18.31	26.57	38.78
111	0.04	0.01	3.59	18.31	26.57	38.78
111.2	0.04	0.01	3.59	18.31	26.57	38.78
111.4	0.04	0.01	3.59	18.31	26.57	38.78
111.6	0.04	0.01	3.59	18.31	26.57	38.78
111.8	0.04	0.01	3.59	18.31	26.57	38.78
112	0.04	0.01	3.59	18.31	26.57	38.78
112.2	0.04	0.01	3.59	18.31	26.57	38.78
112.4	0.04	0.01	3.59	18.31	26.57	38.78
112.6	0.04	0.01	3.59	18.31	26.57	38.78
112.8	0.04	0.01	3.59	18.31	26.57	38.78
113	0.04	0.01	3.59	18.31	26.57	38.78
113.2	0.04	0.01	3.59	18.31	26.57	38.78
113.4	0.04	0.01	3.59	18.31	26.57	38.78
113.6	0.03	0.01	2.69	13.73	19.93	29.08
113.8	0.03	0.01	2.69	13.73	19.93	29.08
114	0.03	0.01	2.69	13.73	19.93	29.08
114.2	0.03	0.01	2.69	13.73	19.93	29.08
114.4	0.03	0.01	2.69	13.73	19.93	29.08
114.6	0.03	0.01	2.69	13.73	19.93	29.08
114.8	0.03	0.01	2.69	13.73	19.93	29.08
115	0.03	0.01	2.69	13.73	19.93	29.08
115.2	0.03	0.01	2.69	13.73	19.93	29.08
115.4	0.03	0.01	2.69	13.73	19.93	29.08
115.6	0.03	0.01	2.69	13.73	19.93	29.08
115.8	0.03	0.01	2.69	13.73	19.93	29.08
116	0.03	0.01	2.69	13.73	19.93	29.08
116.2	0.03	0.01	2.69	13.73	19.93	29.08
116.4	0.03	0.01	2.69	13.73	19.93	29.08
116.6	0.03	0.01	2.69	13.73	19.93	29.08
116.8	0.03	0.01	2.69	13.73	19.93	29.08
117	0.03	0.01	2.69	13.73	19.93	29.08
117.2	0.03	0.01	2.69	13.73	19.93	29.08
117.4	0.02	0.00	1.80	9.16	13.28	19.39
117.6	0.02	0.00	1.80	9.16	13.28	19.39
117.8	0.02	0.00	1.80	9.16	13.28	19.39
118	0.02	0.00	1.80	9.16	13.28	19.39
118.2	0.02	0.00	1.80	9.16	13.28	19.39
118.4	0.02	0.00	1.80	9.16	13.28	19.39
118.6	0.02	0.00	1.80	9.16	13.28	19.39
118.8	0.02	0.00	1.80	9.16	13.28	19.39
119	0.02	0.00	1.80	9.16	13.28	19.39
119.2	0.02	0.00	1.80	9.16	13.28	19.39
119.4	0.02	0.00	1.80	9.16	13.28	19.39
119.6	0.02	0.00	1.80	9.16	13.28	19.39
119.8	0.02	0.00	1.80	9.16	13.28	19.39
120	0.02	0.00	1.80	9.16	13.28	19.39

ATTACHMENT 2

Cell 1 Leakage Detection Sump – Average Conditions

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
0	0.0	0.00	0	0.008	0.000	0	0	1,795	0.9999
12	0.2	0.01	0	0.008	0.102	0	0	1,795	0.9999
24	0.4	0.02	0	0.008	0.102	0	0	1,795	1.0000
36	0.6	0.03	0	0.008	0.102	100	1200	595	0.3316
48	0.8	0.03	0	0.008	0.102	0	0	595	0.3317
60	1.0	0.04	0	0.008	0.102	0	0	596	0.3317
72	1.2	0.05	0	0.008	0.102	0	0	596	0.3318
84	1.4	0.06	0	0.008	0.102	0	0	596	0.3318
96	1.6	0.07	0	0.008	0.102	0	0	596	0.3319
108	1.8	0.08	0	0.008	0.102	0	0	596	0.3319
120	2.0	0.08	0	0.008	0.102	0	0	596	0.3320
132	2.2	0.09	0	0.008	0.102	0	0	596	0.3321
144	2.4	0.10	0	0.008	0.102	0	0	596	0.3321
156	2.6	0.11	0	0.008	0.102	0	0	596	0.3322
168	2.8	0.12	0	0.008	0.102	0	0	596	0.3322
180	3.0	0.13	0	0.008	0.102	0	0	597	0.3323
192	3.2	0.13	0	0.008	0.102	0	0	597	0.3323
204	3.4	0.14	0	0.008	0.102	0	0	597	0.3324
216	3.6	0.15	0	0.008	0.102	0	0	597	0.3325
228	3.8	0.16	0	0.008	0.102	0	0	597	0.3325
240	4.0	0.17	0	0.008	0.102	0	0	597	0.3326
252	4.2	0.18	0	0.008	0.102	0	0	597	0.3326
264	4.4	0.18	0	0.008	0.102	0	0	597	0.3327
276	4.6	0.19	0	0.008	0.102	0	0	597	0.3327
288	4.8	0.20	0	0.008	0.102	0	0	597	0.3328
300	5.0	0.21	0	0.008	0.102	0	0	598	0.3329
312	5.2	0.22	0	0.008	0.102	0	0	598	0.3329
324	5.4	0.23	0	0.008	0.102	0	0	598	0.3330
336	5.6	0.23	0	0.008	0.102	0	0	598	0.3330
348	5.8	0.24	0	0.008	0.102	0	0	598	0.3331
360	6.0	0.25	0	0.008	0.102	0	0	598	0.3331
372	6.2	0.26	0	0.008	0.102	0	0	598	0.3332
384	6.4	0.27	0	0.008	0.102	0	0	598	0.3333
396	6.6	0.28	0	0.008	0.102	0	0	598	0.3333
408	6.8	0.28	0	0.008	0.102	0	0	598	0.3334
420	7.0	0.29	0	0.008	0.102	0	0	599	0.3334
432	7.2	0.30	0	0.008	0.102	0	0	599	0.3335
444	7.4	0.31	0	0.008	0.102	0	0	599	0.3335
456	7.6	0.32	0	0.008	0.102	0	0	599	0.3336
468	7.8	0.33	0	0.008	0.102	0	0	599	0.3336
480	8.0	0.33	0	0.008	0.102	0	0	599	0.3337
492	8.2	0.34	0	0.008	0.102	0	0	599	0.3338
504	8.4	0.35	0	0.008	0.102	0	0	599	0.3338
516	8.6	0.36	0	0.008	0.102	0	0	599	0.3339
528	8.8	0.37	0	0.008	0.102	0	0	599	0.3339
540	9.0	0.38	0	0.008	0.102	0	0	600	0.3340
552	9.2	0.38	0	0.008	0.102	0	0	600	0.3340
564	9.4	0.39	0	0.008	0.102	0	0	600	0.3341
576	9.6	0.40	0	0.008	0.102	0	0	600	0.3342
588	9.8	0.41	0	0.008	0.102	0	0	600	0.3342
600	10.0	0.42	0	0.008	0.102	0	0	600	0.3343
612	10.2	0.43	0	0.008	0.102	0	0	600	0.3343
624	10.4	0.43	0	0.008	0.102	0	0	600	0.3344

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
636	10.6	0.44	0	0.008	0.102	0	0	600	0.3344
648	10.8	0.45	0	0.008	0.102	0	0	600	0.3345
660	11.0	0.46	0	0.008	0.102	0	0	601	0.3346
672	11.2	0.47	0	0.008	0.102	0	0	601	0.3346
684	11.4	0.48	0	0.008	0.102	0	0	601	0.3347
696	11.6	0.48	0	0.008	0.102	0	0	601	0.3347
708	11.8	0.49	0	0.008	0.102	0	0	601	0.3348
720	12.0	0.50	0	0.008	0.102	0	0	601	0.3348
732	12.2	0.51	0	0.008	0.102	0	0	601	0.3349
744	12.4	0.52	0	0.008	0.102	0	0	601	0.3349
756	12.6	0.53	0	0.008	0.102	0	0	601	0.3350
768	12.8	0.53	0	0.008	0.102	0	0	602	0.3351
780	13.0	0.54	0	0.008	0.102	0	0	602	0.3351
792	13.2	0.55	0	0.008	0.102	0	0	602	0.3352
804	13.4	0.56	0	0.008	0.102	0	0	602	0.3352
816	13.6	0.57	0	0.008	0.102	0	0	602	0.3353
828	13.8	0.58	0	0.008	0.102	0	0	602	0.3353
840	14.0	0.58	0	0.008	0.102	0	0	602	0.3354
852	14.2	0.59	0	0.008	0.102	0	0	602	0.3355
864	14.4	0.60	0	0.008	0.102	0	0	602	0.3355
876	14.6	0.61	0	0.008	0.102	0	0	602	0.3356
888	14.8	0.62	0	0.008	0.102	0	0	603	0.3356
900	15.0	0.63	0	0.008	0.102	0	0	603	0.3357
912	15.2	0.63	0	0.008	0.102	0	0	603	0.3357
924	15.4	0.64	0	0.008	0.102	0	0	603	0.3358
936	15.6	0.65	0	0.008	0.102	0	0	603	0.3359
948	15.8	0.66	0	0.008	0.102	0	0	603	0.3359
960	16.0	0.67	0	0.008	0.102	0	0	603	0.3360
972	16.2	0.68	0	0.008	0.102	0	0	603	0.3360
984	16.4	0.68	0	0.008	0.102	0	0	603	0.3361
996	16.6	0.69	0	0.008	0.102	0	0	603	0.3361
1,008	16.8	0.70	0	0.008	0.102	0	0	604	0.3362
1,020	17.0	0.71	0	0.008	0.102	0	0	604	0.3362
1,032	17.2	0.72	0	0.008	0.102	0	0	604	0.3363
1,044	17.4	0.73	0	0.008	0.102	0	0	604	0.3364
1,056	17.6	0.73	0	0.008	0.102	0	0	604	0.3364
1,068	17.8	0.74	0	0.008	0.102	0	0	604	0.3365
1,080	18.0	0.75	0	0.008	0.102	0	0	604	0.3365
1,092	18.2	0.76	0	0.008	0.102	0	0	604	0.3366
1,104	18.4	0.77	0	0.008	0.102	0	0	604	0.3366
1,116	18.6	0.78	0	0.008	0.102	0	0	604	0.3367
1,128	18.8	0.78	0	0.008	0.102	0	0	605	0.3368
1,140	19.0	0.79	0	0.008	0.102	0	0	605	0.3368
1,152	19.2	0.80	0	0.008	0.102	0	0	605	0.3369
1,164	19.4	0.81	0	0.008	0.102	0	0	605	0.3369
1,176	19.6	0.82	0	0.008	0.102	0	0	605	0.3370
1,188	19.8	0.83	0	0.008	0.102	0	0	605	0.3370
1,200	20.0	0.83	0	0.008	0.102	0	0	605	0.3371
1,212	20.2	0.84	0	0.008	0.102	0	0	605	0.3372
1,224	20.4	0.85	0	0.008	0.102	0	0	605	0.3372
1,236	20.6	0.86	0	0.008	0.102	0	0	605	0.3373
1,248	20.8	0.87	0	0.008	0.102	0	0	606	0.3373
1,260	21.0	0.88	0	0.008	0.102	0	0	606	0.3374

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,272	21.2	0.88	0	0.008	0.102	0	0	606	0.3374
1,284	21.4	0.89	0	0.008	0.102	0	0	606	0.3375
1,296	21.6	0.90	0	0.008	0.102	0	0	606	0.3376
1,308	21.8	0.91	0	0.008	0.102	0	0	606	0.3376
1,320	22.0	0.92	0	0.008	0.102	0	0	606	0.3377
1,332	22.2	0.93	0	0.008	0.102	0	0	606	0.3377
1,344	22.4	0.93	0	0.008	0.102	0	0	606	0.3378
1,356	22.6	0.94	0	0.008	0.102	0	0	606	0.3378
1,368	22.8	0.95	0	0.008	0.102	0	0	607	0.3379
1,380	23.0	0.96	0	0.008	0.102	0	0	607	0.3379
1,392	23.2	0.97	0	0.008	0.102	0	0	607	0.3380
1,404	23.4	0.98	0	0.008	0.102	0	0	607	0.3381
1,416	23.6	0.98	0	0.008	0.102	0	0	607	0.3381
1,428	23.8	0.99	0	0.008	0.102	0	0	607	0.3382
1,440	24.0	1.00	0	0.008	0.102	0	0	607	0.3382
1,452	24.2	1.01	0	0.008	0.102	0	0	607	0.3383
1,464	24.4	1.02	0	0.008	0.102	0	0	607	0.3383
1,476	24.6	1.03	0	0.008	0.102	0	0	607	0.3384
1,488	24.8	1.03	0	0.008	0.102	0	0	608	0.3385
1,500	25.0	1.04	0	0.008	0.102	0	0	608	0.3385
1,512	25.2	1.05	0	0.008	0.102	0	0	608	0.3386
1,524	25.4	1.06	0	0.008	0.102	0	0	608	0.3386
1,536	25.6	1.07	0	0.008	0.102	0	0	608	0.3387
1,548	25.8	1.08	0	0.008	0.102	0	0	608	0.3387
1,560	26.0	1.08	0	0.008	0.102	0	0	608	0.3388
1,572	26.2	1.09	0	0.008	0.102	0	0	608	0.3389
1,584	26.4	1.10	0	0.008	0.102	0	0	608	0.3389
1,596	26.6	1.11	0	0.008	0.102	0	0	609	0.3390
1,608	26.8	1.12	0	0.008	0.102	0	0	609	0.3390
1,620	27.0	1.13	0	0.008	0.102	0	0	609	0.3391
1,632	27.2	1.13	0	0.008	0.102	0	0	609	0.3391
1,644	27.4	1.14	0	0.008	0.102	0	0	609	0.3392
1,656	27.6	1.15	0	0.008	0.102	0	0	609	0.3392
1,668	27.8	1.16	0	0.008	0.102	0	0	609	0.3393
1,680	28.0	1.17	0	0.008	0.102	0	0	609	0.3394
1,692	28.2	1.18	0	0.008	0.102	0	0	609	0.3394
1,704	28.4	1.18	0	0.008	0.102	0	0	609	0.3395
1,716	28.6	1.19	0	0.008	0.102	0	0	610	0.3395
1,728	28.8	1.20	0	0.008	0.102	0	0	610	0.3396
1,740	29.0	1.21	0	0.008	0.102	0	0	610	0.3396
1,752	29.2	1.22	0	0.008	0.102	0	0	610	0.3397
1,764	29.4	1.23	0	0.008	0.102	0	0	610	0.3398
1,776	29.6	1.23	0	0.008	0.102	0	0	610	0.3398
1,788	29.8	1.24	0	0.008	0.102	0	0	610	0.3399
1,800	30.0	1.25	0	0.008	0.102	0	0	610	0.3399
1,812	30.2	1.26	0	0.008	0.102	0	0	610	0.3400
1,824	30.4	1.27	0	0.008	0.102	0	0	610	0.3400
1,836	30.6	1.28	0	0.008	0.102	0	0	611	0.3401
1,848	30.8	1.28	0	0.008	0.102	0	0	611	0.3402
1,860	31.0	1.29	0	0.008	0.102	0	0	611	0.3402
1,872	31.2	1.30	0	0.008	0.102	0	0	611	0.3403
1,884	31.4	1.31	0	0.008	0.102	0	0	611	0.3403
1,896	31.6	1.32	0	0.008	0.102	0	0	611	0.3404

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,908	31.8	1.33	0	0.008	0.102	0	0	611	0.3404
1,920	32.0	1.33	0	0.008	0.102	0	0	611	0.3405
1,932	32.2	1.34	0	0.008	0.102	0	0	611	0.3405
1,944	32.4	1.35	0	0.008	0.102	0	0	611	0.3406
1,956	32.6	1.36	0	0.008	0.102	0	0	612	0.3407
1,968	32.8	1.37	0	0.008	0.102	0	0	612	0.3407
1,980	33.0	1.38	0	0.008	0.102	0	0	612	0.3408
1,992	33.2	1.38	0	0.008	0.102	0	0	612	0.3408
2,004	33.4	1.39	0	0.008	0.102	0	0	612	0.3409
2,016	33.6	1.40	0	0.008	0.102	0	0	612	0.3409
2,028	33.8	1.41	0	0.008	0.102	0	0	612	0.3410
2,040	34.0	1.42	0	0.008	0.102	0	0	612	0.3411
2,052	34.2	1.43	0	0.008	0.102	0	0	612	0.3411
2,064	34.4	1.43	0	0.008	0.102	0	0	612	0.3412
2,076	34.6	1.44	0	0.008	0.102	0	0	613	0.3412
2,088	34.8	1.45	0	0.008	0.102	0	0	613	0.3413
2,100	35.0	1.46	0	0.008	0.102	0	0	613	0.3413
2,112	35.2	1.47	0	0.008	0.102	0	0	613	0.3414
2,124	35.4	1.48	0	0.008	0.102	0	0	613	0.3415
2,136	35.6	1.48	0	0.008	0.102	0	0	613	0.3415
2,148	35.8	1.49	0	0.008	0.102	0	0	613	0.3416
2,160	36.0	1.50	0	0.008	0.102	0	0	613	0.3416
2,172	36.2	1.51	0	0.008	0.102	0	0	613	0.3417
2,184	36.4	1.52	0	0.008	0.102	0	0	613	0.3417
2,196	36.6	1.53	0	0.008	0.102	0	0	614	0.3418
2,208	36.8	1.53	0	0.008	0.102	0	0	614	0.3419
2,220	37.0	1.54	0	0.008	0.102	0	0	614	0.3419
2,232	37.2	1.55	0	0.008	0.102	0	0	614	0.3420
2,244	37.4	1.56	0	0.008	0.102	0	0	614	0.3420
2,256	37.6	1.57	0	0.008	0.102	0	0	614	0.3421
2,268	37.8	1.58	0	0.008	0.102	0	0	614	0.3421
2,280	38.0	1.58	0	0.008	0.102	0	0	614	0.3422
2,292	38.2	1.59	0	0.008	0.102	0	0	614	0.3422
2,304	38.4	1.60	0	0.008	0.102	0	0	615	0.3423
2,316	38.6	1.61	0	0.008	0.102	0	0	615	0.3424
2,328	38.8	1.62	0	0.008	0.102	0	0	615	0.3424
2,340	39.0	1.63	0	0.008	0.102	0	0	615	0.3425
2,352	39.2	1.63	0	0.008	0.102	0	0	615	0.3425
2,364	39.4	1.64	0	0.008	0.102	0	0	615	0.3426
2,376	39.6	1.65	0	0.008	0.102	0	0	615	0.3426
2,388	39.8	1.66	0	0.008	0.102	0	0	615	0.3427
2,400	40.0	1.67	0	0.008	0.102	0	0	615	0.3428
2,412	40.2	1.68	0	0.008	0.102	0	0	615	0.3428
2,424	40.4	1.68	0	0.008	0.102	0	0	616	0.3429
2,436	40.6	1.69	0	0.008	0.102	0	0	616	0.3429
2,448	40.8	1.70	0	0.008	0.102	0	0	616	0.3430
2,460	41.0	1.71	0	0.008	0.102	0	0	616	0.3430
2,472	41.2	1.72	0	0.008	0.102	0	0	616	0.3431
2,484	41.4	1.73	0	0.008	0.102	0	0	616	0.3432
2,496	41.6	1.73	0	0.008	0.102	0	0	616	0.3432
2,508	41.8	1.74	0	0.008	0.102	0	0	616	0.3433
2,520	42.0	1.75	0	0.008	0.102	0	0	616	0.3433
2,532	42.2	1.76	0	0.008	0.102	0	0	616	0.3434

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
2,544	42.4	1.77	0	0.008	0.102	0	0	617	0.3434
2,556	42.6	1.78	0	0.008	0.102	0	0	617	0.3435
2,568	42.8	1.78	0	0.008	0.102	0	0	617	0.3435
2,580	43.0	1.79	0	0.008	0.102	0	0	617	0.3436
2,592	43.2	1.80	0	0.008	0.102	0	0	617	0.3437
2,604	43.4	1.81	0	0.008	0.102	0	0	617	0.3437
2,616	43.6	1.82	0	0.008	0.102	0	0	617	0.3438
2,628	43.8	1.83	0	0.008	0.102	0	0	617	0.3438
2,640	44.0	1.83	0	0.008	0.102	0	0	617	0.3439
2,652	44.2	1.84	0	0.008	0.102	0	0	617	0.3439
2,664	44.4	1.85	0	0.008	0.102	0	0	618	0.3440
2,676	44.6	1.86	0	0.008	0.102	0	0	618	0.3441
2,688	44.8	1.87	0	0.008	0.102	0	0	618	0.3441
2,700	45.0	1.88	0	0.008	0.102	0	0	618	0.3442
2,712	45.2	1.88	0	0.008	0.102	0	0	618	0.3442
2,724	45.4	1.89	0	0.008	0.102	0	0	618	0.3443
2,736	45.6	1.90	0	0.008	0.102	0	0	618	0.3443
2,748	45.8	1.91	0	0.008	0.102	0	0	618	0.3444
2,760	46.0	1.92	0	0.008	0.102	0	0	618	0.3445
2,772	46.2	1.93	0	0.008	0.102	0	0	618	0.3445
2,784	46.4	1.93	0	0.008	0.102	0	0	619	0.3446
2,796	46.6	1.94	0	0.008	0.102	0	0	619	0.3446
2,808	46.8	1.95	0	0.008	0.102	0	0	619	0.3447
2,820	47.0	1.96	0	0.008	0.102	0	0	619	0.3447
2,832	47.2	1.97	0	0.008	0.102	0	0	619	0.3448
2,844	47.4	1.98	0	0.008	0.102	0	0	619	0.3448
2,856	47.6	1.98	0	0.008	0.102	0	0	619	0.3449
2,868	47.8	1.99	0	0.008	0.102	0	0	619	0.3450
2,880	48.0	2.00	0	0.008	0.102	0	0	619	0.3450
2,892	48.2	2.01	0	0.008	0.102	0	0	619	0.3451
2,904	48.4	2.02	0	0.008	0.102	0	0	620	0.3451
2,916	48.6	2.03	0	0.008	0.102	0	0	620	0.3452
2,928	48.8	2.03	0	0.008	0.102	0	0	620	0.3452
2,940	49.0	2.04	0	0.008	0.102	0	0	620	0.3453
2,952	49.2	2.05	0	0.008	0.102	0	0	620	0.3454
2,964	49.4	2.06	0	0.008	0.102	0	0	620	0.3454
2,976	49.6	2.07	0	0.008	0.102	0	0	620	0.3455
2,988	49.8	2.08	0	0.008	0.102	0	0	620	0.3455
3,000	50.0	2.08	0	0.008	0.102	0	0	620	0.3456
3,012	50.2	2.09	0	0.008	0.102	0	0	620	0.3456
3,024	50.4	2.10	0	0.008	0.102	0	0	621	0.3457
3,036	50.6	2.11	0	0.008	0.102	0	0	621	0.3458
3,048	50.8	2.12	0	0.008	0.102	0	0	621	0.3458
3,060	51.0	2.13	0	0.008	0.102	0	0	621	0.3459
3,072	51.2	2.13	0	0.008	0.102	0	0	621	0.3459
3,084	51.4	2.14	0	0.008	0.102	0	0	621	0.3460
3,096	51.6	2.15	0	0.008	0.102	0	0	621	0.3460
3,108	51.8	2.16	0	0.008	0.102	0	0	621	0.3461
3,120	52.0	2.17	0	0.008	0.102	0	0	621	0.3462
3,132	52.2	2.18	0	0.008	0.102	0	0	622	0.3462
3,144	52.4	2.18	0	0.008	0.102	0	0	622	0.3463
3,156	52.6	2.19	0	0.008	0.102	0	0	622	0.3463
3,168	52.8	2.20	0	0.008	0.102	0	0	622	0.3464

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,180	53.0	2.21	0	0.008	0.102	0	0	622	0.3464
3,192	53.2	2.22	0	0.008	0.102	0	0	622	0.3465
3,204	53.4	2.23	0	0.008	0.102	0	0	622	0.3465
3,216	53.6	2.23	0	0.008	0.102	0	0	622	0.3466
3,228	53.8	2.24	0	0.008	0.102	0	0	622	0.3467
3,240	54.0	2.25	0	0.008	0.102	0	0	622	0.3467
3,252	54.2	2.26	0	0.008	0.102	0	0	623	0.3468
3,264	54.4	2.27	0	0.008	0.102	0	0	623	0.3468
3,276	54.6	2.28	0	0.008	0.102	0	0	623	0.3469
3,288	54.8	2.28	0	0.008	0.102	0	0	623	0.3469
3,300	55.0	2.29	0	0.008	0.102	0	0	623	0.3470
3,312	55.2	2.30	0	0.008	0.102	0	0	623	0.3471
3,324	55.4	2.31	0	0.008	0.102	0	0	623	0.3471
3,336	55.6	2.32	0	0.008	0.102	0	0	623	0.3472
3,348	55.8	2.33	0	0.008	0.102	0	0	623	0.3472
3,360	56.0	2.33	0	0.008	0.102	0	0	623	0.3473
3,372	56.2	2.34	0	0.008	0.102	0	0	624	0.3473
3,384	56.4	2.35	0	0.008	0.102	0	0	624	0.3474
3,396	56.6	2.36	0	0.008	0.102	0	0	624	0.3475
3,408	56.8	2.37	0	0.008	0.102	0	0	624	0.3475
3,420	57.0	2.38	0	0.008	0.102	0	0	624	0.3476
3,432	57.2	2.38	0	0.008	0.102	0	0	624	0.3476
3,444	57.4	2.39	0	0.008	0.102	0	0	624	0.3477
3,456	57.6	2.40	0	0.008	0.102	0	0	624	0.3477
3,468	57.8	2.41	0	0.008	0.102	0	0	624	0.3478
3,480	58.0	2.42	0	0.008	0.102	0	0	624	0.3478
3,492	58.2	2.43	0	0.008	0.102	0	0	625	0.3479
3,504	58.4	2.43	0	0.008	0.102	0	0	625	0.3480
3,516	58.6	2.44	0	0.008	0.102	0	0	625	0.3480
3,528	58.8	2.45	0	0.008	0.102	0	0	625	0.3481
3,540	59.0	2.46	0	0.008	0.102	0	0	625	0.3481
3,552	59.2	2.47	0	0.008	0.102	0	0	625	0.3482
3,564	59.4	2.48	0	0.008	0.102	0	0	625	0.3482
3,576	59.6	2.48	0	0.008	0.102	0	0	625	0.3483
3,588	59.8	2.49	0	0.008	0.102	0	0	625	0.3484
3,600	60.0	2.50	0	0.008	0.102	0	0	625	0.3484
3,612	60.2	2.51	0	0.008	0.102	0	0	626	0.3485
3,624	60.4	2.52	0	0.008	0.102	0	0	626	0.3485
3,636	60.6	2.53	0	0.008	0.102	0	0	626	0.3486
3,648	60.8	2.53	0	0.008	0.102	0	0	626	0.3486
3,660	61.0	2.54	0	0.008	0.102	0	0	626	0.3487
3,672	61.2	2.55	0	0.008	0.102	0	0	626	0.3488
3,684	61.4	2.56	0	0.008	0.102	0	0	626	0.3488
3,696	61.6	2.57	0	0.008	0.102	0	0	626	0.3489
3,708	61.8	2.58	0	0.008	0.102	0	0	626	0.3489
3,720	62.0	2.58	0	0.008	0.102	0	0	626	0.3490
3,732	62.2	2.59	0	0.008	0.102	0	0	627	0.3490
3,744	62.4	2.60	0	0.008	0.102	0	0	627	0.3491
3,756	62.6	2.61	0	0.008	0.102	0	0	627	0.3491
3,768	62.8	2.62	0	0.008	0.102	0	0	627	0.3492
3,780	63.0	2.63	0	0.008	0.102	0	0	627	0.3493
3,792	63.2	2.63	0	0.008	0.102	0	0	627	0.3493
3,804	63.4	2.64	0	0.008	0.102	0	0	627	0.3494

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,816	63.6	2.65	0	0.008	0.102	0	0	627	0.3494
3,828	63.8	2.66	0	0.008	0.102	0	0	627	0.3495
3,840	64.0	2.67	0	0.008	0.102	0	0	628	0.3495
3,852	64.2	2.68	0	0.008	0.102	0	0	628	0.3496
3,864	64.4	2.68	0	0.008	0.102	0	0	628	0.3497
3,876	64.6	2.69	0	0.008	0.102	0	0	628	0.3497
3,888	64.8	2.70	0	0.008	0.102	0	0	628	0.3498
3,900	65.0	2.71	0	0.008	0.102	0	0	628	0.3498
3,912	65.2	2.72	0	0.008	0.102	0	0	628	0.3499
3,924	65.4	2.73	0	0.008	0.102	0	0	628	0.3499
3,936	65.6	2.73	0	0.008	0.102	0	0	628	0.3500
3,948	65.8	2.74	0	0.008	0.102	0	0	628	0.3501
3,960	66.0	2.75	0	0.008	0.102	0	0	629	0.3501
3,972	66.2	2.76	0	0.008	0.102	0	0	629	0.3502
3,984	66.4	2.77	0	0.008	0.102	0	0	629	0.3502
3,996	66.6	2.78	0	0.008	0.102	0	0	629	0.3503
4,008	66.8	2.78	0	0.008	0.102	0	0	629	0.3503
4,020	67.0	2.79	0	0.008	0.102	0	0	629	0.3504
4,032	67.2	2.80	0	0.008	0.102	0	0	629	0.3505
4,044	67.4	2.81	0	0.008	0.102	0	0	629	0.3505
4,056	67.6	2.82	0	0.008	0.102	0	0	629	0.3506
4,068	67.8	2.83	0	0.008	0.102	0	0	629	0.3506
4,080	68.0	2.83	0	0.008	0.102	0	0	630	0.3507
4,092	68.2	2.84	0	0.008	0.102	0	0	630	0.3507
4,104	68.4	2.85	0	0.008	0.102	0	0	630	0.3508
4,116	68.6	2.86	0	0.008	0.102	0	0	630	0.3508
4,128	68.8	2.87	0	0.008	0.102	0	0	630	0.3509
4,140	69.0	2.88	0	0.008	0.102	0	0	630	0.3510
4,152	69.2	2.88	0	0.008	0.102	0	0	630	0.3510
4,164	69.4	2.89	0	0.008	0.102	0	0	630	0.3511
4,176	69.6	2.90	0	0.008	0.102	0	0	630	0.3511
4,188	69.8	2.91	0	0.008	0.102	0	0	630	0.3512
4,200	70.0	2.92	0	0.008	0.102	0	0	631	0.3512
4,212	70.2	2.93	0	0.008	0.102	0	0	631	0.3513
4,224	70.4	2.93	0	0.008	0.102	0	0	631	0.3514
4,236	70.6	2.94	0	0.008	0.102	0	0	631	0.3514
4,248	70.8	2.95	0	0.008	0.102	0	0	631	0.3515
4,260	71.0	2.96	0	0.008	0.102	0	0	631	0.3515
4,272	71.2	2.97	0	0.008	0.102	0	0	631	0.3516
4,284	71.4	2.98	0	0.008	0.102	0	0	631	0.3516
4,296	71.6	2.98	0	0.008	0.102	0	0	631	0.3517
4,308	71.8	2.99	0	0.008	0.102	0	0	631	0.3518
4,320	72.0	3.00	0	0.008	0.102	0	0	632	0.3518
4,332	72.2	3.01	0	0.008	0.102	0	0	632	0.3519
4,344	72.4	3.02	0	0.008	0.102	0	0	632	0.3519
4,356	72.6	3.03	0	0.008	0.102	0	0	632	0.3520
4,368	72.8	3.03	0	0.008	0.102	0	0	632	0.3520
4,380	73.0	3.04	0	0.008	0.102	0	0	632	0.3521
4,392	73.2	3.05	0	0.008	0.102	0	0	632	0.3521
4,404	73.4	3.06	0	0.008	0.102	0	0	632	0.3522
4,416	73.6	3.07	0	0.008	0.102	0	0	632	0.3523
4,428	73.8	3.08	0	0.008	0.102	0	0	632	0.3523
4,440	74.0	3.08	0	0.008	0.102	0	0	633	0.3524

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,452	74.2	3.09	0	0.008	0.102	0	0	633	0.3524
4,464	74.4	3.10	0	0.008	0.102	0	0	633	0.3525
4,476	74.6	3.11	0	0.008	0.102	0	0	633	0.3525
4,488	74.8	3.12	0	0.008	0.102	0	0	633	0.3526
4,500	75.0	3.13	0	0.008	0.102	0	0	633	0.3527
4,512	75.2	3.13	0	0.008	0.102	0	0	633	0.3527
4,524	75.4	3.14	0	0.008	0.102	0	0	633	0.3528
4,536	75.6	3.15	0	0.008	0.102	0	0	633	0.3528
4,548	75.8	3.16	0	0.008	0.102	0	0	633	0.3529
4,560	76.0	3.17	0	0.008	0.102	0	0	634	0.3529
4,572	76.2	3.18	0	0.008	0.102	0	0	634	0.3530
4,584	76.4	3.18	0	0.008	0.102	0	0	634	0.3531
4,596	76.6	3.19	0	0.008	0.102	0	0	634	0.3531
4,608	76.8	3.20	0	0.008	0.102	0	0	634	0.3532
4,620	77.0	3.21	0	0.008	0.102	0	0	634	0.3532
4,632	77.2	3.22	0	0.008	0.102	0	0	634	0.3533
4,644	77.4	3.23	0	0.008	0.102	0	0	634	0.3533
4,656	77.6	3.23	0	0.008	0.102	0	0	634	0.3534
4,668	77.8	3.24	0	0.008	0.102	0	0	635	0.3534
4,680	78.0	3.25	0	0.008	0.102	0	0	635	0.3535
4,692	78.2	3.26	0	0.008	0.102	0	0	635	0.3536
4,704	78.4	3.27	0	0.008	0.102	0	0	635	0.3536
4,716	78.6	3.28	0	0.008	0.102	0	0	635	0.3537
4,728	78.8	3.28	0	0.008	0.102	0	0	635	0.3537
4,740	79.0	3.29	0	0.008	0.102	0	0	635	0.3538
4,752	79.2	3.30	0	0.008	0.102	0	0	635	0.3538
4,764	79.4	3.31	0	0.008	0.102	0	0	635	0.3539
4,776	79.6	3.32	0	0.008	0.102	0	0	635	0.3540
4,788	79.8	3.33	0	0.008	0.102	0	0	636	0.3540
4,800	80.0	3.33	0	0.008	0.102	0	0	636	0.3541
4,812	80.2	3.34	0	0.008	0.102	0	0	636	0.3541
4,824	80.4	3.35	0	0.008	0.102	0	0	636	0.3542
4,836	80.6	3.36	0	0.008	0.102	0	0	636	0.3542
4,848	80.8	3.37	0	0.008	0.102	0	0	636	0.3543
4,860	81.0	3.38	0	0.008	0.102	0	0	636	0.3544
4,872	81.2	3.38	0	0.008	0.102	0	0	636	0.3544
4,884	81.4	3.39	0	0.008	0.102	0	0	636	0.3545
4,896	81.6	3.40	0	0.008	0.102	0	0	636	0.3545
4,908	81.8	3.41	0	0.008	0.102	0	0	637	0.3546
4,920	82.0	3.42	0	0.008	0.102	0	0	637	0.3546
4,932	82.2	3.43	0	0.008	0.102	0	0	637	0.3547
4,944	82.4	3.43	0	0.008	0.102	0	0	637	0.3548
4,956	82.6	3.44	0	0.008	0.102	0	0	637	0.3548
4,968	82.8	3.45	0	0.008	0.102	0	0	637	0.3549
4,980	83.0	3.46	0	0.008	0.102	0	0	637	0.3549
4,992	83.2	3.47	0	0.008	0.102	0	0	637	0.3550
5,004	83.4	3.48	0	0.008	0.102	0	0	637	0.3550
5,016	83.6	3.48	0	0.008	0.102	0	0	637	0.3551
5,028	83.8	3.49	0	0.008	0.102	0	0	638	0.3551
5,040	84.0	3.50	0	0.008	0.102	0	0	638	0.3552
5,052	84.2	3.51	0	0.008	0.102	0	0	638	0.3553
5,064	84.4	3.52	0	0.008	0.102	0	0	638	0.3553
5,076	84.6	3.53	0	0.008	0.102	0	0	638	0.3554

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,088	84.8	3.53	0	0.008	0.102	0	0	638	0.3554
5,100	85.0	3.54	0	0.008	0.102	0	0	638	0.3555
5,112	85.2	3.55	0	0.008	0.102	0	0	638	0.3555
5,124	85.4	3.56	0	0.008	0.102	0	0	638	0.3556
5,136	85.6	3.57	0	0.008	0.102	0	0	638	0.3557
5,148	85.8	3.58	0	0.008	0.102	0	0	639	0.3557
5,160	86.0	3.58	0	0.008	0.102	0	0	639	0.3558
5,172	86.2	3.59	0	0.008	0.102	0	0	639	0.3558
5,184	86.4	3.60	0	0.008	0.102	0	0	639	0.3559
5,196	86.6	3.61	0	0.008	0.102	0	0	639	0.3559
5,208	86.8	3.62	0	0.008	0.102	0	0	639	0.3560
5,220	87.0	3.63	0	0.008	0.102	0	0	639	0.3561
5,232	87.2	3.63	0	0.008	0.102	0	0	639	0.3561
5,244	87.4	3.64	0	0.008	0.102	0	0	639	0.3562
5,256	87.6	3.65	0	0.008	0.102	0	0	639	0.3562
5,268	87.8	3.66	0	0.008	0.102	0	0	640	0.3563
5,280	88.0	3.67	0	0.008	0.102	0	0	640	0.3563
5,292	88.2	3.68	0	0.008	0.102	0	0	640	0.3564
5,304	88.4	3.68	0	0.008	0.102	0	0	640	0.3564
5,316	88.6	3.69	0	0.008	0.102	0	0	640	0.3565
5,328	88.8	3.70	0	0.008	0.102	0	0	640	0.3566
5,340	89.0	3.71	0	0.008	0.102	0	0	640	0.3566
5,352	89.2	3.72	0	0.008	0.102	0	0	640	0.3567
5,364	89.4	3.73	0	0.008	0.102	0	0	640	0.3567
5,376	89.6	3.73	0	0.008	0.102	0	0	641	0.3568
5,388	89.8	3.74	0	0.008	0.102	0	0	641	0.3568
5,400	90.0	3.75	0	0.008	0.102	0	0	641	0.3569
5,412	90.2	3.76	0	0.008	0.102	0	0	641	0.3570
5,424	90.4	3.77	0	0.008	0.102	0	0	641	0.3570
5,436	90.6	3.78	0	0.008	0.102	0	0	641	0.3571
5,448	90.8	3.78	0	0.008	0.102	0	0	641	0.3571
5,460	91.0	3.79	0	0.008	0.102	0	0	641	0.3572
5,472	91.2	3.80	0	0.008	0.102	0	0	641	0.3572
5,484	91.4	3.81	0	0.008	0.102	0	0	641	0.3573
5,496	91.6	3.82	0	0.008	0.102	0	0	642	0.3574
5,508	91.8	3.83	0	0.008	0.102	0	0	642	0.3574
5,520	92.0	3.83	0	0.008	0.102	0	0	642	0.3575
5,532	92.2	3.84	0	0.008	0.102	0	0	642	0.3575
5,544	92.4	3.85	0	0.008	0.102	0	0	642	0.3576
5,556	92.6	3.86	0	0.008	0.102	0	0	642	0.3576
5,568	92.8	3.87	0	0.008	0.102	0	0	642	0.3577
5,580	93.0	3.88	0	0.008	0.102	0	0	642	0.3577
5,592	93.2	3.88	0	0.008	0.102	0	0	642	0.3578
5,604	93.4	3.89	0	0.008	0.102	0	0	642	0.3579
5,616	93.6	3.90	0	0.008	0.102	0	0	643	0.3579
5,628	93.8	3.91	0	0.008	0.102	0	0	643	0.3580
5,640	94.0	3.92	0	0.008	0.102	0	0	643	0.3580
5,652	94.2	3.93	0	0.008	0.102	0	0	643	0.3581
5,664	94.4	3.93	0	0.008	0.102	0	0	643	0.3581
5,676	94.6	3.94	0	0.008	0.102	0	0	643	0.3582
5,688	94.8	3.95	0	0.008	0.102	0	0	643	0.3583
5,700	95.0	3.96	0	0.008	0.102	0	0	643	0.3583
5,712	95.2	3.97	0	0.008	0.102	0	0	643	0.3584

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,724	95.4	3.98	0	0.008	0.102	0	0	643	0.3584
5,736	95.6	3.98	0	0.008	0.102	0	0	644	0.3585
5,748	95.8	3.99	0	0.008	0.102	0	0	644	0.3585
5,760	96.0	4.00	0	0.008	0.102	0	0	644	0.3586
5,772	96.2	4.01	0	0.008	0.102	0	0	644	0.3587
5,784	96.4	4.02	0	0.008	0.102	0	0	644	0.3587
5,796	96.6	4.03	0	0.008	0.102	0	0	644	0.3588
5,808	96.8	4.03	0	0.008	0.102	0	0	644	0.3588
5,820	97.0	4.04	0	0.008	0.102	0	0	644	0.3589
5,832	97.2	4.05	0	0.008	0.102	0	0	644	0.3589
5,844	97.4	4.06	0	0.008	0.102	0	0	644	0.3590
5,856	97.6	4.07	0	0.008	0.102	0	0	645	0.3591
5,868	97.8	4.08	0	0.008	0.102	0	0	645	0.3591
5,880	98.0	4.08	0	0.008	0.102	0	0	645	0.3592
5,892	98.2	4.09	0	0.008	0.102	0	0	645	0.3592
5,904	98.4	4.10	0	0.008	0.102	0	0	645	0.3593
5,916	98.6	4.11	0	0.008	0.102	0	0	645	0.3593
5,928	98.8	4.12	0	0.008	0.102	0	0	645	0.3594
5,940	99.0	4.13	0	0.008	0.102	0	0	645	0.3594
5,952	99.2	4.13	0	0.008	0.102	0	0	645	0.3595
5,964	99.4	4.14	0	0.008	0.102	0	0	645	0.3596
5,976	99.6	4.15	0	0.008	0.102	0	0	646	0.3596
5,988	99.8	4.16	0	0.008	0.102	0	0	646	0.3597
6,000	100.0	4.17	0	0.008	0.102	0	0	646	0.3597
6,012	100.2	4.18	0	0.008	0.102	0	0	646	0.3598
6,024	100.4	4.18	0	0.008	0.102	0	0	646	0.3598
6,036	100.6	4.19	0	0.008	0.102	0	0	646	0.3599
6,048	100.8	4.20	0	0.008	0.102	0	0	646	0.3600
6,060	101.0	4.21	0	0.008	0.102	0	0	646	0.3600
6,072	101.2	4.22	0	0.008	0.102	0	0	646	0.3601
6,084	101.4	4.23	0	0.008	0.102	0	0	646	0.3601
6,096	101.6	4.23	0	0.008	0.102	0	0	647	0.3602
6,108	101.8	4.24	0	0.008	0.102	0	0	647	0.3602
6,120	102.0	4.25	0	0.008	0.102	0	0	647	0.3603
6,132	102.2	4.26	0	0.008	0.102	0	0	647	0.3604
6,144	102.4	4.27	0	0.008	0.102	0	0	647	0.3604
6,156	102.6	4.28	0	0.008	0.102	0	0	647	0.3605
6,168	102.8	4.28	0	0.008	0.102	0	0	647	0.3605
6,180	103.0	4.29	0	0.008	0.102	0	0	647	0.3606
6,192	103.2	4.30	0	0.008	0.102	0	0	647	0.3606
6,204	103.4	4.31	0	0.008	0.102	0	0	648	0.3607
6,216	103.6	4.32	0	0.008	0.102	0	0	648	0.3607
6,228	103.8	4.33	0	0.008	0.102	0	0	648	0.3608
6,240	104.0	4.33	0	0.008	0.102	0	0	648	0.3609
6,252	104.2	4.34	0	0.008	0.102	0	0	648	0.3609
6,264	104.4	4.35	0	0.008	0.102	0	0	648	0.3610
6,276	104.6	4.36	0	0.008	0.102	0	0	648	0.3610
6,288	104.8	4.37	0	0.008	0.102	0	0	648	0.3611
6,300	105.0	4.38	0	0.008	0.102	0	0	648	0.3611
6,312	105.2	4.38	0	0.008	0.102	0	0	648	0.3612
6,324	105.4	4.39	0	0.008	0.102	0	0	649	0.3613
6,336	105.6	4.40	0	0.008	0.102	0	0	649	0.3613
6,348	105.8	4.41	0	0.008	0.102	0	0	649	0.3614

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,360	106.0	4.42	0	0.008	0.102	0	0	649	0.3614
6,372	106.2	4.43	0	0.008	0.102	0	0	649	0.3615
6,384	106.4	4.43	0	0.008	0.102	0	0	649	0.3615
6,396	106.6	4.44	0	0.008	0.102	0	0	649	0.3616
6,408	106.8	4.45	0	0.008	0.102	0	0	649	0.3617
6,420	107.0	4.46	0	0.008	0.102	0	0	649	0.3617
6,432	107.2	4.47	0	0.008	0.102	0	0	649	0.3618
6,444	107.4	4.48	0	0.008	0.102	0	0	650	0.3618
6,456	107.6	4.48	0	0.008	0.102	0	0	650	0.3619
6,468	107.8	4.49	0	0.008	0.102	0	0	650	0.3619
6,480	108.0	4.50	0	0.008	0.102	0	0	650	0.3620
6,492	108.2	4.51	0	0.008	0.102	0	0	650	0.3620
6,504	108.4	4.52	0	0.008	0.102	0	0	650	0.3621
6,516	108.6	4.53	0	0.008	0.102	0	0	650	0.3622
6,528	108.8	4.53	0	0.008	0.102	0	0	650	0.3622
6,540	109.0	4.54	0	0.008	0.102	0	0	650	0.3623
6,552	109.2	4.55	0	0.008	0.102	0	0	650	0.3623
6,564	109.4	4.56	0	0.008	0.102	0	0	651	0.3624
6,576	109.6	4.57	0	0.008	0.102	0	0	651	0.3624
6,588	109.8	4.58	0	0.008	0.102	0	0	651	0.3625
6,600	110.0	4.58	0	0.008	0.102	0	0	651	0.3626
6,612	110.2	4.59	0	0.008	0.102	0	0	651	0.3626
6,624	110.4	4.60	0	0.008	0.102	0	0	651	0.3627
6,636	110.6	4.61	0	0.008	0.102	0	0	651	0.3627
6,648	110.8	4.62	0	0.008	0.102	0	0	651	0.3628
6,660	111.0	4.63	0	0.008	0.102	0	0	651	0.3628
6,672	111.2	4.63	0	0.008	0.102	0	0	651	0.3629
6,684	111.4	4.64	0	0.008	0.102	0	0	652	0.3630
6,696	111.6	4.65	0	0.008	0.102	0	0	652	0.3630
6,708	111.8	4.66	0	0.008	0.102	0	0	652	0.3631
6,720	112.0	4.67	0	0.008	0.102	0	0	652	0.3631
6,732	112.2	4.68	0	0.008	0.102	0	0	652	0.3632
6,744	112.4	4.68	0	0.008	0.102	0	0	652	0.3632
6,756	112.6	4.69	0	0.008	0.102	0	0	652	0.3633
6,768	112.8	4.70	0	0.008	0.102	0	0	652	0.3634
6,780	113.0	4.71	0	0.008	0.102	0	0	652	0.3634
6,792	113.2	4.72	0	0.008	0.102	0	0	652	0.3635
6,804	113.4	4.73	0	0.008	0.102	0	0	653	0.3635
6,816	113.6	4.73	0	0.008	0.102	0	0	653	0.3636
6,828	113.8	4.74	0	0.008	0.102	0	0	653	0.3636
6,840	114.0	4.75	0	0.008	0.102	0	0	653	0.3637
6,852	114.2	4.76	0	0.008	0.102	0	0	653	0.3637
6,864	114.4	4.77	0	0.008	0.102	0	0	653	0.3638
6,876	114.6	4.78	0	0.008	0.102	0	0	653	0.3639
6,888	114.8	4.78	0	0.008	0.102	0	0	653	0.3639
6,900	115.0	4.79	0	0.008	0.102	0	0	653	0.3640
6,912	115.2	4.80	0	0.008	0.102	0	0	654	0.3640
6,924	115.4	4.81	0	0.008	0.102	0	0	654	0.3641
6,936	115.6	4.82	0	0.008	0.102	0	0	654	0.3641
6,948	115.8	4.83	0	0.008	0.102	0	0	654	0.3642
6,960	116.0	4.83	0	0.008	0.102	0	0	654	0.3643
6,972	116.2	4.84	0	0.008	0.102	0	0	654	0.3643
6,984	116.4	4.85	0	0.008	0.102	0	0	654	0.3644

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,996	116.6	4.86	0	0.008	0.102	0	0	654	0.3644
7,008	116.8	4.87	0	0.008	0.102	0	0	654	0.3645
7,020	117.0	4.88	0	0.008	0.102	0	0	654	0.3645
7,032	117.2	4.88	0	0.008	0.102	0	0	655	0.3646
7,044	117.4	4.89	0	0.008	0.102	0	0	655	0.3647
7,056	117.6	4.90	0	0.008	0.102	0	0	655	0.3647
7,068	117.8	4.91	0	0.008	0.102	0	0	655	0.3648
7,080	118.0	4.92	0	0.008	0.102	0	0	655	0.3648
7,092	118.2	4.93	0	0.008	0.102	0	0	655	0.3649
7,104	118.4	4.93	0	0.008	0.102	0	0	655	0.3649
7,116	118.6	4.94	0	0.008	0.102	0	0	655	0.3650
7,128	118.8	4.95	0	0.008	0.102	0	0	655	0.3650
7,140	119.0	4.96	0	0.008	0.102	0	0	655	0.3651
7,152	119.2	4.97	0	0.008	0.102	0	0	656	0.3652
7,164	119.4	4.98	0	0.008	0.102	0	0	656	0.3652
7,176	119.6	4.98	0	0.008	0.102	0	0	656	0.3653
7,188	119.8	4.99	0	0.008	0.102	0	0	656	0.3653
7,200	120.0	5.00	0	0.008	0.102	0	0	656	0.3654
7,212	120.2	5.01	0	0.008	0.102	0	0	656	0.3654
7,224	120.4	5.02	0	0.008	0.102	0	0	656	0.3655
7,236	120.6	5.03	0	0.008	0.102	0	0	656	0.3656
7,248	120.8	5.03	0	0.008	0.102	0	0	656	0.3656
7,260	121.0	5.04	0	0.008	0.102	0	0	656	0.3657
7,272	121.2	5.05	0	0.008	0.102	0	0	657	0.3657
7,284	121.4	5.06	0	0.008	0.102	0	0	657	0.3658
7,296	121.6	5.07	0	0.008	0.102	0	0	657	0.3658
7,308	121.8	5.08	0	0.008	0.102	0	0	657	0.3659
7,320	122.0	5.08	0	0.008	0.102	0	0	657	0.3660
7,332	122.2	5.09	0	0.008	0.102	0	0	657	0.3660
7,344	122.4	5.10	0	0.008	0.102	0	0	657	0.3661
7,356	122.6	5.11	0	0.008	0.102	0	0	657	0.3661
7,368	122.8	5.12	0	0.008	0.102	0	0	657	0.3662
7,380	123.0	5.13	0	0.008	0.102	0	0	657	0.3662
7,392	123.2	5.13	0	0.008	0.102	0	0	658	0.3663
7,404	123.4	5.14	0	0.008	0.102	0	0	658	0.3664
7,416	123.6	5.15	0	0.008	0.102	0	0	658	0.3664
7,428	123.8	5.16	0	0.008	0.102	0	0	658	0.3665
7,440	124.0	5.17	0	0.008	0.102	0	0	658	0.3665
7,452	124.2	5.18	0	0.008	0.102	0	0	658	0.3666
7,464	124.4	5.18	0	0.008	0.102	0	0	658	0.3666
7,476	124.6	5.19	0	0.008	0.102	0	0	658	0.3667
7,488	124.8	5.20	0	0.008	0.102	0	0	658	0.3667
7,500	125.0	5.21	0	0.008	0.102	0	0	658	0.3668
7,512	125.2	5.22	0	0.008	0.102	0	0	659	0.3669
7,524	125.4	5.23	0	0.008	0.102	0	0	659	0.3669
7,536	125.6	5.23	0	0.008	0.102	0	0	659	0.3670
7,548	125.8	5.24	0	0.008	0.102	0	0	659	0.3670
7,560	126.0	5.25	0	0.008	0.102	0	0	659	0.3671
7,572	126.2	5.26	0	0.008	0.102	0	0	659	0.3671
7,584	126.4	5.27	0	0.008	0.102	0	0	659	0.3672
7,596	126.6	5.28	0	0.008	0.102	0	0	659	0.3673
7,608	126.8	5.28	0	0.008	0.102	0	0	659	0.3673
7,620	127.0	5.29	0	0.008	0.102	0	0	660	0.3674

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,632	127.2	5.30	0	0.008	0.102	0	0	660	0.3674
7,644	127.4	5.31	0	0.008	0.102	0	0	660	0.3675
7,656	127.6	5.32	0	0.008	0.102	0	0	660	0.3675
7,668	127.8	5.33	0	0.008	0.102	0	0	660	0.3676
7,680	128.0	5.33	0	0.008	0.102	0	0	660	0.3677
7,692	128.2	5.34	0	0.008	0.102	0	0	660	0.3677
7,704	128.4	5.35	0	0.008	0.102	0	0	660	0.3678
7,716	128.6	5.36	0	0.008	0.102	0	0	660	0.3678
7,728	128.8	5.37	0	0.008	0.102	0	0	660	0.3679
7,740	129.0	5.38	0	0.008	0.102	0	0	661	0.3679
7,752	129.2	5.38	0	0.008	0.102	0	0	661	0.3680
7,764	129.4	5.39	0	0.008	0.102	0	0	661	0.3680
7,776	129.6	5.40	0	0.008	0.102	0	0	661	0.3681
7,788	129.8	5.41	0	0.008	0.102	0	0	661	0.3682
7,800	130.0	5.42	0	0.008	0.102	0	0	661	0.3682
7,812	130.2	5.43	0	0.008	0.102	0	0	661	0.3683
7,824	130.4	5.43	0	0.008	0.102	0	0	661	0.3683
7,836	130.6	5.44	0	0.008	0.102	0	0	661	0.3684
7,848	130.8	5.45	0	0.008	0.102	0	0	661	0.3684
7,860	131.0	5.46	0	0.008	0.102	0	0	662	0.3685
7,872	131.2	5.47	0	0.008	0.102	0	0	662	0.3686
7,884	131.4	5.48	0	0.008	0.102	0	0	662	0.3686
7,896	131.6	5.48	0	0.008	0.102	0	0	662	0.3687
7,908	131.8	5.49	0	0.008	0.102	0	0	662	0.3687
7,920	132.0	5.50	0	0.008	0.102	0	0	662	0.3688
7,932	132.2	5.51	0	0.008	0.102	0	0	662	0.3688
7,944	132.4	5.52	0	0.008	0.102	0	0	662	0.3689
7,956	132.6	5.53	0	0.008	0.102	0	0	662	0.3690
7,968	132.8	5.53	0	0.008	0.102	0	0	662	0.3690
7,980	133.0	5.54	0	0.008	0.102	0	0	663	0.3691
7,992	133.2	5.55	0	0.008	0.102	0	0	663	0.3691
8,004	133.4	5.56	0	0.008	0.102	0	0	663	0.3692
8,016	133.6	5.57	0	0.008	0.102	0	0	663	0.3692
8,028	133.8	5.58	0	0.008	0.102	0	0	663	0.3693
8,040	134.0	5.58	0	0.008	0.102	0	0	663	0.3693
8,052	134.2	5.59	0	0.008	0.102	0	0	663	0.3694
8,064	134.4	5.60	0	0.008	0.102	0	0	663	0.3695
8,076	134.6	5.61	0	0.008	0.102	0	0	663	0.3695
8,088	134.8	5.62	0	0.008	0.102	0	0	663	0.3696
8,100	135.0	5.63	0	0.008	0.102	0	0	664	0.3696
8,112	135.2	5.63	0	0.008	0.102	0	0	664	0.3697
8,124	135.4	5.64	0	0.008	0.102	0	0	664	0.3697
8,136	135.6	5.65	0	0.008	0.102	0	0	664	0.3698
8,148	135.8	5.66	0	0.008	0.102	0	0	664	0.3699
8,160	136.0	5.67	0	0.008	0.102	0	0	664	0.3699
8,172	136.2	5.68	0	0.008	0.102	0	0	664	0.3700
8,184	136.4	5.68	0	0.008	0.102	0	0	664	0.3700
8,196	136.6	5.69	0	0.008	0.102	0	0	664	0.3701
8,208	136.8	5.70	0	0.008	0.102	0	0	664	0.3701
8,220	137.0	5.71	0	0.008	0.102	0	0	665	0.3702
8,232	137.2	5.72	0	0.008	0.102	0	0	665	0.3703
8,244	137.4	5.73	0	0.008	0.102	0	0	665	0.3703
8,256	137.6	5.73	0	0.008	0.102	0	0	665	0.3704

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,268	137.8	5.74	0	0.008	0.102	0	0	665	0.3704
8,280	138.0	5.75	0	0.008	0.102	0	0	665	0.3705
8,292	138.2	5.76	0	0.008	0.102	0	0	665	0.3705
8,304	138.4	5.77	0	0.008	0.102	0	0	665	0.3706
8,316	138.6	5.78	0	0.008	0.102	0	0	665	0.3707
8,328	138.8	5.78	0	0.008	0.102	0	0	665	0.3707
8,340	139.0	5.79	0	0.008	0.102	0	0	666	0.3708
8,352	139.2	5.80	0	0.008	0.102	0	0	666	0.3708
8,364	139.4	5.81	0	0.008	0.102	0	0	666	0.3709
8,376	139.6	5.82	0	0.008	0.102	0	0	666	0.3709
8,388	139.8	5.83	0	0.008	0.102	0	0	666	0.3710
8,400	140.0	5.83	0	0.008	0.102	0	0	666	0.3710
8,412	140.2	5.84	0	0.008	0.102	0	0	666	0.3711
8,424	140.4	5.85	0	0.008	0.102	0	0	666	0.3712
8,436	140.6	5.86	0	0.008	0.102	0	0	666	0.3712
8,448	140.8	5.87	0	0.008	0.102	0	0	667	0.3713
8,460	141.0	5.88	0	0.008	0.102	0	0	667	0.3713
8,472	141.2	5.88	0	0.008	0.102	0	0	667	0.3714
8,484	141.4	5.89	0	0.008	0.102	0	0	667	0.3714
8,496	141.6	5.90	0	0.008	0.102	0	0	667	0.3715
8,508	141.8	5.91	0	0.008	0.102	0	0	667	0.3716
8,520	142.0	5.92	0	0.008	0.102	0	0	667	0.3716
8,532	142.2	5.93	0	0.008	0.102	0	0	667	0.3717
8,544	142.4	5.93	0	0.008	0.102	0	0	667	0.3717
8,556	142.6	5.94	0	0.008	0.102	0	0	667	0.3718
8,568	142.8	5.95	0	0.008	0.102	0	0	668	0.3718
8,580	143.0	5.96	0	0.008	0.102	0	0	668	0.3719
8,592	143.2	5.97	0	0.008	0.102	0	0	668	0.3720
8,604	143.4	5.98	0	0.008	0.102	0	0	668	0.3720
8,616	143.6	5.98	0	0.008	0.102	0	0	668	0.3721
8,628	143.8	5.99	0	0.008	0.102	0	0	668	0.3721
8,640	144.0	6.00	0	0.008	0.102	0	0	668	0.3722
8,652	144.2	6.01	0	0.008	0.102	0	0	668	0.3722
8,664	144.4	6.02	0	0.008	0.102	0	0	668	0.3723
8,676	144.6	6.03	0	0.008	0.102	0	0	668	0.3723
8,688	144.8	6.03	0	0.008	0.102	0	0	669	0.3724
8,700	145.0	6.04	0	0.008	0.102	0	0	669	0.3725
8,712	145.2	6.05	0	0.008	0.102	0	0	669	0.3725
8,724	145.4	6.06	0	0.008	0.102	0	0	669	0.3726
8,736	145.6	6.07	0	0.008	0.102	0	0	669	0.3726
8,748	145.8	6.08	0	0.008	0.102	0	0	669	0.3727
8,760	146.0	6.08	0	0.008	0.102	0	0	669	0.3727
8,772	146.2	6.09	0	0.008	0.102	0	0	669	0.3728
8,784	146.4	6.10	0	0.008	0.102	0	0	669	0.3729
8,796	146.6	6.11	0	0.008	0.102	0	0	669	0.3729
8,808	146.8	6.12	0	0.008	0.102	0	0	670	0.3730
8,820	147.0	6.13	0	0.008	0.102	0	0	670	0.3730
8,832	147.2	6.13	0	0.008	0.102	0	0	670	0.3731
8,844	147.4	6.14	0	0.008	0.102	0	0	670	0.3731
8,856	147.6	6.15	0	0.008	0.102	0	0	670	0.3732
8,868	147.8	6.16	0	0.008	0.102	0	0	670	0.3733
8,880	148.0	6.17	0	0.008	0.102	0	0	670	0.3733
8,892	148.2	6.18	0	0.008	0.102	0	0	670	0.3734

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,904	148.4	6.18	0	0.008	0.102	0	0	670	0.3734
8,916	148.6	6.19	0	0.008	0.102	0	0	670	0.3735
8,928	148.8	6.20	0	0.008	0.102	0	0	671	0.3735
8,940	149.0	6.21	0	0.008	0.102	0	0	671	0.3736
8,952	149.2	6.22	0	0.008	0.102	0	0	671	0.3736
8,964	149.4	6.23	0	0.008	0.102	0	0	671	0.3737
8,976	149.6	6.23	0	0.008	0.102	0	0	671	0.3738
8,988	149.8	6.24	0	0.008	0.102	0	0	671	0.3738
9,000	150.0	6.25	0	0.008	0.102	0	0	671	0.3739
9,012	150.2	6.26	0	0.008	0.102	0	0	671	0.3739
9,024	150.4	6.27	0	0.008	0.102	0	0	671	0.3740
9,036	150.6	6.28	0	0.008	0.102	0	0	671	0.3740
9,048	150.8	6.28	0	0.008	0.102	0	0	672	0.3741
9,060	151.0	6.29	0	0.008	0.102	0	0	672	0.3742
9,072	151.2	6.30	0	0.008	0.102	0	0	672	0.3742
9,084	151.4	6.31	0	0.008	0.102	0	0	672	0.3743
9,096	151.6	6.32	0	0.008	0.102	0	0	672	0.3743
9,108	151.8	6.33	0	0.008	0.102	0	0	672	0.3744
9,120	152.0	6.33	0	0.008	0.102	0	0	672	0.3744
9,132	152.2	6.34	0	0.008	0.102	0	0	672	0.3745
9,144	152.4	6.35	0	0.008	0.102	0	0	672	0.3746
9,156	152.6	6.36	0	0.008	0.102	0	0	673	0.3746
9,168	152.8	6.37	0	0.008	0.102	0	0	673	0.3747
9,180	153.0	6.38	0	0.008	0.102	0	0	673	0.3747
9,192	153.2	6.38	0	0.008	0.102	0	0	673	0.3748
9,204	153.4	6.39	0	0.008	0.102	0	0	673	0.3748
9,216	153.6	6.40	0	0.008	0.102	0	0	673	0.3749
9,228	153.8	6.41	0	0.008	0.102	0	0	673	0.3750
9,240	154.0	6.42	0	0.008	0.102	0	0	673	0.3750
9,252	154.2	6.43	0	0.008	0.102	0	0	673	0.3751
9,264	154.4	6.43	0	0.008	0.102	0	0	673	0.3751
9,276	154.6	6.44	0	0.008	0.102	0	0	674	0.3752
9,288	154.8	6.45	0	0.008	0.102	0	0	674	0.3752
9,300	155.0	6.46	0	0.008	0.102	0	0	674	0.3753
9,312	155.2	6.47	0	0.008	0.102	0	0	674	0.3753
9,324	155.4	6.48	0	0.008	0.102	0	0	674	0.3754
9,336	155.6	6.48	0	0.008	0.102	0	0	674	0.3755
9,348	155.8	6.49	0	0.008	0.102	0	0	674	0.3755
9,360	156.0	6.50	0	0.008	0.102	0	0	674	0.3756
9,372	156.2	6.51	0	0.008	0.102	0	0	674	0.3756
9,384	156.4	6.52	0	0.008	0.102	0	0	674	0.3757
9,396	156.6	6.53	0	0.008	0.102	0	0	675	0.3757
9,408	156.8	6.53	0	0.008	0.102	0	0	675	0.3758
9,420	157.0	6.54	0	0.008	0.102	0	0	675	0.3759
9,432	157.2	6.55	0	0.008	0.102	0	0	675	0.3759
9,444	157.4	6.56	0	0.008	0.102	0	0	675	0.3760
9,456	157.6	6.57	0	0.008	0.102	0	0	675	0.3760
9,468	157.8	6.58	0	0.008	0.102	0	0	675	0.3761
9,480	158.0	6.58	0	0.008	0.102	0	0	675	0.3761
9,492	158.2	6.59	0	0.008	0.102	0	0	675	0.3762
9,504	158.4	6.60	0	0.008	0.102	0	0	675	0.3763
9,516	158.6	6.61	0	0.008	0.102	0	0	676	0.3763
9,528	158.8	6.62	0	0.008	0.102	0	0	676	0.3764

Attachment 2 - Cell 1 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
9,540	159.0	6.63	0	0.008	0.102	0	0	676	0.3764
9,552	159.2	6.63	0	0.008	0.102	0	0	676	0.3765
9,564	159.4	6.64	0	0.008	0.102	0	0	676	0.3765
9,576	159.6	6.65	0	0.008	0.102	0	0	676	0.3766
9,588	159.8	6.66	0	0.008	0.102	0	0	676	0.3766
9,600	160.0	6.67	0	0.008	0.102	0	0	676	0.3767
9,612	160.2	6.68	0	0.008	0.102	0	0	676	0.3768
9,624	160.4	6.68	0	0.008	0.102	0	0	676	0.3768
9,636	160.6	6.69	0	0.008	0.102	0	0	677	0.3769
9,648	160.8	6.70	0	0.008	0.102	0	0	677	0.3769
9,660	161.0	6.71	0	0.008	0.102	0	0	677	0.3770
9,672	161.2	6.72	0	0.008	0.102	0	0	677	0.3770
9,684	161.4	6.73	0	0.008	0.102	0	0	677	0.3771
9,696	161.6	6.73	0	0.008	0.102	0	0	677	0.3772
9,708	161.8	6.74	0	0.008	0.102	0	0	677	0.3772
9,720	162.0	6.75	0	0.008	0.102	0	0	677	0.3773
9,732	162.2	6.76	0	0.008	0.102	0	0	677	0.3773
9,744	162.4	6.77	0	0.008	0.102	0	0	677	0.3774
9,756	162.6	6.78	0	0.008	0.102	0	0	678	0.3774
9,768	162.8	6.78	0	0.008	0.102	0	0	678	0.3775
9,780	163.0	6.79	0	0.008	0.102	0	0	678	0.3776
9,792	163.2	6.80	0	0.008	0.102	0	0	678	0.3776
9,804	163.4	6.81	0	0.008	0.102	0	0	678	0.3777
9,816	163.6	6.82	0	0.008	0.102	0	0	678	0.3777
9,828	163.8	6.83	0	0.008	0.102	0	0	678	0.3778
9,840	164.0	6.83	0	0.008	0.102	0	0	678	0.3778
9,852	164.2	6.84	0	0.008	0.102	0	0	678	0.3779
9,864	164.4	6.85	0	0.008	0.102	0	0	678	0.3779
9,876	164.6	6.86	0	0.008	0.102	0	0	679	0.3780
9,888	164.8	6.87	0	0.008	0.102	0	0	679	0.3781
9,900	165.0	6.88	0	0.008	0.102	0	0	679	0.3781
9,912	165.2	6.88	0	0.008	0.102	0	0	679	0.3782
9,924	165.4	6.89	0	0.008	0.102	0	0	679	0.3782
9,936	165.6	6.90	0	0.008	0.102	0	0	679	0.3783
9,948	165.8	6.91	0	0.008	0.102	0	0	679	0.3783
9,960	166.0	6.92	0	0.008	0.102	0	0	679	0.3784
9,972	166.2	6.93	0	0.008	0.102	0	0	679	0.3785
9,984	166.4	6.93	0	0.008	0.102	0	0	680	0.3785
9,996	166.6	6.94	0	0.008	0.102	0	0	680	0.3786
10,008	166.8	6.95	0	0.008	0.102	0	0	680	0.3786
10,020	167.0	6.96	0	0.008	0.102	0	0	680	0.3787
10,032	167.2	6.97	0	0.008	0.102	0	0	680	0.3787
10,044	167.4	6.98	0	0.008	0.102	0	0	680	0.3788
10,056	167.6	6.98	0	0.008	0.102	0	0	680	0.3789
10,068	167.8	6.99	0	0.008	0.102	0	0	680	0.3789
10,080	168.0	7.00	0	0.008	0.102	0	0	680	0.3790

ATTACHMENT 3

Cell 1 Leakage Detection Sump – Peak Conditions

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
0	0.0	0.00	0	3.5	0.0	0	0	1,795	1.00
12	0.2	0.01	0	3.5	42.5	0	0	1,838	1.02
24	0.4	0.02	0	3.5	42.5	100	1200	680	0.38
36	0.6	0.03	0	3.5	42.5	0	0	723	0.40
48	0.8	0.03	0	3.5	42.5	0	0	765	0.43
60	1.0	0.04	0	3.5	42.5	0	0	808	0.45
72	1.2	0.05	0	3.5	42.5	0	0	850	0.47
84	1.4	0.06	0	3.5	42.5	0	0	893	0.50
96	1.6	0.07	0	3.5	42.5	0	0	935	0.52
108	1.8	0.08	0	3.5	42.5	0	0	978	0.54
120	2.0	0.08	0	3.5	42.5	0	0	1,020	0.57
132	2.2	0.09	0	3.5	42.5	0	0	1,063	0.59
144	2.4	0.10	0	3.5	42.5	0	0	1,105	0.62
156	2.6	0.11	0	3.5	42.5	0	0	1,148	0.64
168	2.8	0.12	0	3.5	42.5	0	0	1,190	0.66
180	3.0	0.13	0	3.5	42.5	0	0	1,233	0.69
192	3.2	0.13	0	3.5	42.5	0	0	1,275	0.71
204	3.4	0.14	0	3.5	42.5	0	0	1,318	0.73
216	3.6	0.15	0	3.5	42.5	0	0	1,360	0.76
228	3.8	0.16	0	3.5	42.5	0	0	1,403	0.78
240	4.0	0.17	0	3.5	42.5	0	0	1,445	0.81
252	4.2	0.18	0	3.5	42.5	0	0	1,488	0.83
264	4.4	0.18	0	3.5	42.5	0	0	1,530	0.85
276	4.6	0.19	0	3.5	42.5	0	0	1,573	0.88
288	4.8	0.20	0	3.5	42.5	0	0	1,615	0.90
300	5.0	0.21	0	3.5	42.5	0	0	1,658	0.92
312	5.2	0.22	0	3.5	42.5	0	0	1,700	0.95
324	5.4	0.23	0	3.5	42.5	0	0	1,743	0.97
336	5.6	0.23	0	3.5	42.5	0	0	1,785	0.99
348	5.8	0.24	0	3.5	42.5	0	0	1,828	1.02
360	6.0	0.25	0	3.5	42.5	100	1200	670	0.37
372	6.2	0.26	0	3.5	42.5	0	0	713	0.40
384	6.4	0.27	0	3.5	42.5	0	0	755	0.42
396	6.6	0.28	0	3.5	42.5	0	0	798	0.44
408	6.8	0.28	0	3.5	42.5	0	0	840	0.47
420	7.0	0.29	0	3.5	42.5	0	0	883	0.49
432	7.2	0.30	0	3.5	42.5	0	0	925	0.52
444	7.4	0.31	0	3.5	42.5	0	0	968	0.54
456	7.6	0.32	0	3.5	42.5	0	0	1,010	0.56
468	7.8	0.33	0	3.5	42.5	0	0	1,053	0.59
480	8.0	0.33	0	3.5	42.5	0	0	1,095	0.61
492	8.2	0.34	0	3.5	42.5	0	0	1,138	0.63
504	8.4	0.35	0	3.5	42.5	0	0	1,180	0.66
516	8.6	0.36	0	3.5	42.5	0	0	1,223	0.68
528	8.8	0.37	0	3.5	42.5	0	0	1,265	0.70
540	9.0	0.38	0	3.5	42.5	0	0	1,308	0.73
552	9.2	0.38	0	3.5	42.5	0	0	1,350	0.75
564	9.4	0.39	0	3.5	42.5	0	0	1,393	0.78
576	9.6	0.40	0	3.5	42.5	0	0	1,435	0.80
588	9.8	0.41	0	3.5	42.5	0	0	1,478	0.82
600	10.0	0.42	0	3.5	42.5	0	0	1,520	0.85
612	10.2	0.43	0	3.5	42.5	0	0	1,563	0.87
624	10.4	0.43	0	3.5	42.5	0	0	1,605	0.89

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
636	10.6	0.44	0	3.5	42.5	0	0	1,648	0.92
648	10.8	0.45	0	3.5	42.5	0	0	1,690	0.94
660	11.0	0.46	0	3.5	42.5	0	0	1,733	0.97
672	11.2	0.47	0	3.5	42.5	0	0	1,775	0.99
684	11.4	0.48	0	3.5	42.5	0	0	1,818	1.01
696	11.6	0.48	0	3.5	42.5	100	1200	660	0.37
708	11.8	0.49	0	3.5	42.5	0	0	703	0.39
720	12.0	0.50	0	3.5	42.5	0	0	745	0.42
732	12.2	0.51	0	3.5	42.5	0	0	788	0.44
744	12.4	0.52	0	3.5	42.5	0	0	830	0.46
756	12.6	0.53	0	3.5	42.5	0	0	873	0.49
768	12.8	0.53	0	3.5	42.5	0	0	915	0.51
780	13.0	0.54	0	3.5	42.5	0	0	958	0.53
792	13.2	0.55	0	3.5	42.5	0	0	1,000	0.56
804	13.4	0.56	0	3.5	42.5	0	0	1,043	0.58
816	13.6	0.57	0	3.5	42.5	0	0	1,085	0.60
828	13.8	0.58	0	3.5	42.5	0	0	1,128	0.63
840	14.0	0.58	0	3.5	42.5	0	0	1,170	0.65
852	14.2	0.59	0	3.5	42.5	0	0	1,213	0.68
864	14.4	0.60	0	3.5	42.5	0	0	1,255	0.70
876	14.6	0.61	0	3.5	42.5	0	0	1,298	0.72
888	14.8	0.62	0	3.5	42.5	0	0	1,340	0.75
900	15.0	0.63	0	3.5	42.5	0	0	1,383	0.77
912	15.2	0.63	0	3.5	42.5	0	0	1,425	0.79
924	15.4	0.64	0	3.5	42.5	0	0	1,468	0.82
936	15.6	0.65	0	3.5	42.5	0	0	1,510	0.84
948	15.8	0.66	0	3.5	42.5	0	0	1,553	0.86
960	16.0	0.67	0	3.5	42.5	0	0	1,595	0.89
972	16.2	0.68	0	3.5	42.5	0	0	1,638	0.91
984	16.4	0.68	0	3.5	42.5	0	0	1,680	0.94
996	16.6	0.69	0	3.5	42.5	0	0	1,723	0.96
1,008	16.8	0.70	0	3.5	42.5	0	0	1,765	0.98
1,020	17.0	0.71	0	3.5	42.5	0	0	1,808	1.01
1,032	17.2	0.72	0	3.5	42.5	100	1200	650	0.36
1,044	17.4	0.73	0	3.5	42.5	0	0	693	0.39
1,056	17.6	0.73	0	3.5	42.5	0	0	735	0.41
1,068	17.8	0.74	0	3.5	42.5	0	0	778	0.43
1,080	18.0	0.75	0	3.5	42.5	0	0	820	0.46
1,092	18.2	0.76	0	3.5	42.5	0	0	863	0.48
1,104	18.4	0.77	0	3.5	42.5	0	0	905	0.50
1,116	18.6	0.78	0	3.5	42.5	0	0	948	0.53
1,128	18.8	0.78	0	3.5	42.5	0	0	990	0.55
1,140	19.0	0.79	0	3.5	42.5	0	0	1,033	0.58
1,152	19.2	0.80	0	3.5	42.5	0	0	1,075	0.60
1,164	19.4	0.81	0	3.5	42.5	0	0	1,118	0.62
1,176	19.6	0.82	0	3.5	42.5	0	0	1,160	0.65
1,188	19.8	0.83	0	3.5	42.5	0	0	1,203	0.67
1,200	20.0	0.83	0	3.5	42.5	0	0	1,245	0.69
1,212	20.2	0.84	0	3.5	42.5	0	0	1,288	0.72
1,224	20.4	0.85	0	3.5	42.5	0	0	1,330	0.74
1,236	20.6	0.86	0	3.5	42.5	0	0	1,373	0.76
1,248	20.8	0.87	0	3.5	42.5	0	0	1,415	0.79
1,260	21.0	0.88	0	3.5	42.5	0	0	1,458	0.81

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,272	21.2	0.88	0	3.5	42.5	0	0	1,500	0.84
1,284	21.4	0.89	0	3.5	42.5	0	0	1,543	0.86
1,296	21.6	0.90	0	3.5	42.5	0	0	1,585	0.88
1,308	21.8	0.91	0	3.5	42.5	0	0	1,628	0.91
1,320	22.0	0.92	0	3.5	42.5	0	0	1,670	0.93
1,332	22.2	0.93	0	3.5	42.5	0	0	1,713	0.95
1,344	22.4	0.93	0	3.5	42.5	0	0	1,755	0.98
1,356	22.6	0.94	0	3.5	42.5	0	0	1,798	1.00
1,368	22.8	0.95	0	3.5	42.5	100	1200	640	0.36
1,380	23.0	0.96	0	3.5	42.5	0	0	683	0.38
1,392	23.2	0.97	0	3.5	42.5	0	0	725	0.40
1,404	23.4	0.98	0	3.5	42.5	0	0	768	0.43
1,416	23.6	0.98	0	3.5	42.5	0	0	810	0.45
1,428	23.8	0.99	0	3.5	42.5	0	0	853	0.47
1,440	24.0	1.00	0	3.5	42.5	0	0	895	0.50
1,452	24.2	1.01	0	3.5	42.5	0	0	938	0.52
1,464	24.4	1.02	0	3.5	42.5	0	0	980	0.55
1,476	24.6	1.03	0	3.5	42.5	0	0	1,023	0.57
1,488	24.8	1.03	0	3.5	42.5	0	0	1,065	0.59
1,500	25.0	1.04	0	3.5	42.5	0	0	1,108	0.62
1,512	25.2	1.05	0	3.5	42.5	0	0	1,150	0.64
1,524	25.4	1.06	0	3.5	42.5	0	0	1,193	0.66
1,536	25.6	1.07	0	3.5	42.5	0	0	1,235	0.69
1,548	25.8	1.08	0	3.5	42.5	0	0	1,278	0.71
1,560	26.0	1.08	0	3.5	42.5	0	0	1,320	0.74
1,572	26.2	1.09	0	3.5	42.5	0	0	1,363	0.76
1,584	26.4	1.10	0	3.5	42.5	0	0	1,405	0.78
1,596	26.6	1.11	0	3.5	42.5	0	0	1,448	0.81
1,608	26.8	1.12	0	3.5	42.5	0	0	1,490	0.83
1,620	27.0	1.13	0	3.5	42.5	0	0	1,533	0.85
1,632	27.2	1.13	0	3.5	42.5	0	0	1,575	0.88
1,644	27.4	1.14	0	3.5	42.5	0	0	1,618	0.90
1,656	27.6	1.15	0	3.5	42.5	0	0	1,660	0.92
1,668	27.8	1.16	0	3.5	42.5	0	0	1,703	0.95
1,680	28.0	1.17	0	3.5	42.5	0	0	1,745	0.97
1,692	28.2	1.18	0	3.5	42.5	0	0	1,788	1.00
1,704	28.4	1.18	0	3.5	42.5	0	0	1,830	1.02
1,716	28.6	1.19	0	3.5	42.5	100	1200	673	0.37
1,728	28.8	1.20	0	3.5	42.5	0	0	715	0.40
1,740	29.0	1.21	0	3.5	42.5	0	0	758	0.42
1,752	29.2	1.22	0	3.5	42.5	0	0	800	0.45
1,764	29.4	1.23	0	3.5	42.5	0	0	843	0.47
1,776	29.6	1.23	0	3.5	42.5	0	0	885	0.49
1,788	29.8	1.24	0	3.5	42.5	0	0	928	0.52
1,800	30.0	1.25	0	3.5	42.5	0	0	970	0.54
1,812	30.2	1.26	0	3.5	42.5	0	0	1,013	0.56
1,824	30.4	1.27	0	3.5	42.5	0	0	1,055	0.59
1,836	30.6	1.28	0	3.5	42.5	0	0	1,098	0.61
1,848	30.8	1.28	0	3.5	42.5	0	0	1,140	0.64
1,860	31.0	1.29	0	3.5	42.5	0	0	1,183	0.66
1,872	31.2	1.30	0	3.5	42.5	0	0	1,225	0.68
1,884	31.4	1.31	0	3.5	42.5	0	0	1,268	0.71
1,896	31.6	1.32	0	3.5	42.5	0	0	1,310	0.73

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,908	31.8	1.33	0	3.5	42.5	0	0	1,353	0.75
1,920	32.0	1.33	0	3.5	42.5	0	0	1,395	0.78
1,932	32.2	1.34	0	3.5	42.5	0	0	1,438	0.80
1,944	32.4	1.35	0	3.5	42.5	0	0	1,480	0.82
1,956	32.6	1.36	0	3.5	42.5	0	0	1,523	0.85
1,968	32.8	1.37	0	3.5	42.5	0	0	1,565	0.87
1,980	33.0	1.38	0	3.5	42.5	0	0	1,608	0.90
1,992	33.2	1.38	0	3.5	42.5	0	0	1,650	0.92
2,004	33.4	1.39	0	3.5	42.5	0	0	1,693	0.94
2,016	33.6	1.40	0	3.5	42.5	0	0	1,735	0.97
2,028	33.8	1.41	0	3.5	42.5	0	0	1,778	0.99
2,040	34.0	1.42	0	3.5	42.5	0	0	1,820	1.01
2,052	34.2	1.43	0	3.5	42.5	100	1200	663	0.37
2,064	34.4	1.43	0	3.5	42.5	0	0	705	0.39
2,076	34.6	1.44	0	3.5	42.5	0	0	748	0.42
2,088	34.8	1.45	0	3.5	42.5	0	0	790	0.44
2,100	35.0	1.46	0	3.5	42.5	0	0	833	0.46
2,112	35.2	1.47	0	3.5	42.5	0	0	875	0.49
2,124	35.4	1.48	0	3.5	42.5	0	0	918	0.51
2,136	35.6	1.48	0	3.5	42.5	0	0	960	0.53
2,148	35.8	1.49	0	3.5	42.5	0	0	1,003	0.56
2,160	36.0	1.50	0	3.5	42.5	0	0	1,045	0.58
2,172	36.2	1.51	0	3.5	42.5	0	0	1,088	0.61
2,184	36.4	1.52	0	3.5	42.5	0	0	1,130	0.63
2,196	36.6	1.53	0	3.5	42.5	0	0	1,173	0.65
2,208	36.8	1.53	0	3.5	42.5	0	0	1,215	0.68
2,220	37.0	1.54	0	3.5	42.5	0	0	1,258	0.70
2,232	37.2	1.55	0	3.5	42.5	0	0	1,300	0.72
2,244	37.4	1.56	0	3.5	42.5	0	0	1,343	0.75
2,256	37.6	1.57	0	3.5	42.5	0	0	1,385	0.77
2,268	37.8	1.58	0	3.5	42.5	0	0	1,428	0.80
2,280	38.0	1.58	0	3.5	42.5	0	0	1,470	0.82
2,292	38.2	1.59	0	3.5	42.5	0	0	1,513	0.84
2,304	38.4	1.60	0	3.5	42.5	0	0	1,555	0.87
2,316	38.6	1.61	0	3.5	42.5	0	0	1,598	0.89
2,328	38.8	1.62	0	3.5	42.5	0	0	1,640	0.91
2,340	39.0	1.63	0	3.5	42.5	0	0	1,683	0.94
2,352	39.2	1.63	0	3.5	42.5	0	0	1,725	0.96
2,364	39.4	1.64	0	3.5	42.5	0	0	1,768	0.98
2,376	39.6	1.65	0	3.5	42.5	0	0	1,810	1.01
2,388	39.8	1.66	0	3.5	42.5	100	1200	653	0.36
2,400	40.0	1.67	0	3.5	42.5	0	0	695	0.39
2,412	40.2	1.68	0	3.5	42.5	0	0	738	0.41
2,424	40.4	1.68	0	3.5	42.5	0	0	780	0.43
2,436	40.6	1.69	0	3.5	42.5	0	0	823	0.46
2,448	40.8	1.70	0	3.5	42.5	0	0	865	0.48
2,460	41.0	1.71	0	3.5	42.5	0	0	908	0.51
2,472	41.2	1.72	0	3.5	42.5	0	0	950	0.53
2,484	41.4	1.73	0	3.5	42.5	0	0	993	0.55
2,496	41.6	1.73	0	3.5	42.5	0	0	1,035	0.58
2,508	41.8	1.74	0	3.5	42.5	0	0	1,078	0.60
2,520	42.0	1.75	0	3.5	42.5	0	0	1,120	0.62
2,532	42.2	1.76	0	3.5	42.5	0	0	1,163	0.65

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
2,544	42.4	1.77	0	3.5	42.5	0	0	1,205	0.67
2,556	42.6	1.78	0	3.5	42.5	0	0	1,248	0.70
2,568	42.8	1.78	0	3.5	42.5	0	0	1,290	0.72
2,580	43.0	1.79	0	3.5	42.5	0	0	1,333	0.74
2,592	43.2	1.80	0	3.5	42.5	0	0	1,375	0.77
2,604	43.4	1.81	0	3.5	42.5	0	0	1,418	0.79
2,616	43.6	1.82	0	3.5	42.5	0	0	1,460	0.81
2,628	43.8	1.83	0	3.5	42.5	0	0	1,503	0.84
2,640	44.0	1.83	0	3.5	42.5	0	0	1,545	0.86
2,652	44.2	1.84	0	3.5	42.5	0	0	1,588	0.88
2,664	44.4	1.85	0	3.5	42.5	0	0	1,630	0.91
2,676	44.6	1.86	0	3.5	42.5	0	0	1,673	0.93
2,688	44.8	1.87	0	3.5	42.5	0	0	1,715	0.96
2,700	45.0	1.88	0	3.5	42.5	0	0	1,758	0.98
2,712	45.2	1.88	0	3.5	42.5	0	0	1,800	1.00
2,724	45.4	1.89	0	3.5	42.5	100	1200	643	0.36
2,736	45.6	1.90	0	3.5	42.5	0	0	685	0.38
2,748	45.8	1.91	0	3.5	42.5	0	0	728	0.41
2,760	46.0	1.92	0	3.5	42.5	0	0	770	0.43
2,772	46.2	1.93	0	3.5	42.5	0	0	813	0.45
2,784	46.4	1.93	0	3.5	42.5	0	0	855	0.48
2,796	46.6	1.94	0	3.5	42.5	0	0	898	0.50
2,808	46.8	1.95	0	3.5	42.5	0	0	940	0.52
2,820	47.0	1.96	0	3.5	42.5	0	0	983	0.55
2,832	47.2	1.97	0	3.5	42.5	0	0	1,025	0.57
2,844	47.4	1.98	0	3.5	42.5	0	0	1,068	0.59
2,856	47.6	1.98	0	3.5	42.5	0	0	1,110	0.62
2,868	47.8	1.99	0	3.5	42.5	0	0	1,153	0.64
2,880	48.0	2.00	0	3.5	42.5	0	0	1,195	0.67
2,892	48.2	2.01	0	3.5	42.5	0	0	1,238	0.69
2,904	48.4	2.02	0	3.5	42.5	0	0	1,280	0.71
2,916	48.6	2.03	0	3.5	42.5	0	0	1,323	0.74
2,928	48.8	2.03	0	3.5	42.5	0	0	1,365	0.76
2,940	49.0	2.04	0	3.5	42.5	0	0	1,408	0.78
2,952	49.2	2.05	0	3.5	42.5	0	0	1,450	0.81
2,964	49.4	2.06	0	3.5	42.5	0	0	1,493	0.83
2,976	49.6	2.07	0	3.5	42.5	0	0	1,535	0.86
2,988	49.8	2.08	0	3.5	42.5	0	0	1,578	0.88
3,000	50.0	2.08	0	3.5	42.5	0	0	1,620	0.90
3,012	50.2	2.09	0	3.5	42.5	0	0	1,663	0.93
3,024	50.4	2.10	0	3.5	42.5	0	0	1,705	0.95
3,036	50.6	2.11	0	3.5	42.5	0	0	1,748	0.97
3,048	50.8	2.12	0	3.5	42.5	0	0	1,790	1.00
3,060	51.0	2.13	0	3.5	42.5	0	0	1,833	1.02
3,072	51.2	2.13	0	3.5	42.5	100	1200	675	0.38
3,084	51.4	2.14	0	3.5	42.5	0	0	718	0.40
3,096	51.6	2.15	0	3.5	42.5	0	0	760	0.42
3,108	51.8	2.16	0	3.5	42.5	0	0	803	0.45
3,120	52.0	2.17	0	3.5	42.5	0	0	845	0.47
3,132	52.2	2.18	0	3.5	42.5	0	0	888	0.49
3,144	52.4	2.18	0	3.5	42.5	0	0	930	0.52
3,156	52.6	2.19	0	3.5	42.5	0	0	973	0.54
3,168	52.8	2.20	0	3.5	42.5	0	0	1,015	0.57

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,180	53.0	2.21	0	3.5	42.5	0	0	1,058	0.59
3,192	53.2	2.22	0	3.5	42.5	0	0	1,100	0.61
3,204	53.4	2.23	0	3.5	42.5	0	0	1,143	0.64
3,216	53.6	2.23	0	3.5	42.5	0	0	1,185	0.66
3,228	53.8	2.24	0	3.5	42.5	0	0	1,228	0.68
3,240	54.0	2.25	0	3.5	42.5	0	0	1,270	0.71
3,252	54.2	2.26	0	3.5	42.5	0	0	1,313	0.73
3,264	54.4	2.27	0	3.5	42.5	0	0	1,355	0.75
3,276	54.6	2.28	0	3.5	42.5	0	0	1,398	0.78
3,288	54.8	2.28	0	3.5	42.5	0	0	1,440	0.80
3,300	55.0	2.29	0	3.5	42.5	0	0	1,483	0.83
3,312	55.2	2.30	0	3.5	42.5	0	0	1,525	0.85
3,324	55.4	2.31	0	3.5	42.5	0	0	1,568	0.87
3,336	55.6	2.32	0	3.5	42.5	0	0	1,610	0.90
3,348	55.8	2.33	0	3.5	42.5	0	0	1,653	0.92
3,360	56.0	2.33	0	3.5	42.5	0	0	1,695	0.94
3,372	56.2	2.34	0	3.5	42.5	0	0	1,738	0.97
3,384	56.4	2.35	0	3.5	42.5	0	0	1,780	0.99
3,396	56.6	2.36	0	3.5	42.5	0	0	1,823	1.02
3,408	56.8	2.37	0	3.5	42.5	100	1200	665	0.37
3,420	57.0	2.38	0	3.5	42.5	0	0	708	0.39
3,432	57.2	2.38	0	3.5	42.5	0	0	750	0.42
3,444	57.4	2.39	0	3.5	42.5	0	0	793	0.44
3,456	57.6	2.40	0	3.5	42.5	0	0	835	0.47
3,468	57.8	2.41	0	3.5	42.5	0	0	878	0.49
3,480	58.0	2.42	0	3.5	42.5	0	0	920	0.51
3,492	58.2	2.43	0	3.5	42.5	0	0	963	0.54
3,504	58.4	2.43	0	3.5	42.5	0	0	1,005	0.56
3,516	58.6	2.44	0	3.5	42.5	0	0	1,048	0.58
3,528	58.8	2.45	0	3.5	42.5	0	0	1,090	0.61
3,540	59.0	2.46	0	3.5	42.5	0	0	1,133	0.63
3,552	59.2	2.47	0	3.5	42.5	0	0	1,175	0.65
3,564	59.4	2.48	0	3.5	42.5	0	0	1,218	0.68
3,576	59.6	2.48	0	3.5	42.5	0	0	1,260	0.70
3,588	59.8	2.49	0	3.5	42.5	0	0	1,303	0.73
3,600	60.0	2.50	0	3.5	42.5	0	0	1,345	0.75
3,612	60.2	2.51	0	3.5	42.5	0	0	1,388	0.77
3,624	60.4	2.52	0	3.5	42.5	0	0	1,430	0.80
3,636	60.6	2.53	0	3.5	42.5	0	0	1,473	0.82
3,648	60.8	2.53	0	3.5	42.5	0	0	1,515	0.84
3,660	61.0	2.54	0	3.5	42.5	0	0	1,558	0.87
3,672	61.2	2.55	0	3.5	42.5	0	0	1,600	0.89
3,684	61.4	2.56	0	3.5	42.5	0	0	1,643	0.92
3,696	61.6	2.57	0	3.5	42.5	0	0	1,685	0.94
3,708	61.8	2.58	0	3.5	42.5	0	0	1,728	0.96
3,720	62.0	2.58	0	3.5	42.5	0	0	1,770	0.99
3,732	62.2	2.59	0	3.5	42.5	0	0	1,813	1.01
3,744	62.4	2.60	0	3.5	42.5	100	1200	655	0.36
3,756	62.6	2.61	0	3.5	42.5	0	0	698	0.39
3,768	62.8	2.62	0	3.5	42.5	0	0	740	0.41
3,780	63.0	2.63	0	3.5	42.5	0	0	783	0.44
3,792	63.2	2.63	0	3.5	42.5	0	0	825	0.46
3,804	63.4	2.64	0	3.5	42.5	0	0	868	0.48

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,816	63.6	2.65	0	3.5	42.5	0	0	910	0.51
3,828	63.8	2.66	0	3.5	42.5	0	0	953	0.53
3,840	64.0	2.67	0	3.5	42.5	0	0	995	0.55
3,852	64.2	2.68	0	3.5	42.5	0	0	1,038	0.58
3,864	64.4	2.68	0	3.5	42.5	0	0	1,080	0.60
3,876	64.6	2.69	0	3.5	42.5	0	0	1,123	0.63
3,888	64.8	2.70	0	3.5	42.5	0	0	1,165	0.65
3,900	65.0	2.71	0	3.5	42.5	0	0	1,208	0.67
3,912	65.2	2.72	0	3.5	42.5	0	0	1,250	0.70
3,924	65.4	2.73	0	3.5	42.5	0	0	1,293	0.72
3,936	65.6	2.73	0	3.5	42.5	0	0	1,335	0.74
3,948	65.8	2.74	0	3.5	42.5	0	0	1,378	0.77
3,960	66.0	2.75	0	3.5	42.5	0	0	1,420	0.79
3,972	66.2	2.76	0	3.5	42.5	0	0	1,463	0.81
3,984	66.4	2.77	0	3.5	42.5	0	0	1,505	0.84
3,996	66.6	2.78	0	3.5	42.5	0	0	1,548	0.86
4,008	66.8	2.78	0	3.5	42.5	0	0	1,590	0.89
4,020	67.0	2.79	0	3.5	42.5	0	0	1,633	0.91
4,032	67.2	2.80	0	3.5	42.5	0	0	1,675	0.93
4,044	67.4	2.81	0	3.5	42.5	0	0	1,718	0.96
4,056	67.6	2.82	0	3.5	42.5	0	0	1,760	0.98
4,068	67.8	2.83	0	3.5	42.5	0	0	1,803	1.00
4,080	68.0	2.83	0	3.5	42.5	100	1200	645	0.36
4,092	68.2	2.84	0	3.5	42.5	0	0	688	0.38
4,104	68.4	2.85	0	3.5	42.5	0	0	730	0.41
4,116	68.6	2.86	0	3.5	42.5	0	0	773	0.43
4,128	68.8	2.87	0	3.5	42.5	0	0	815	0.45
4,140	69.0	2.88	0	3.5	42.5	0	0	858	0.48
4,152	69.2	2.88	0	3.5	42.5	0	0	900	0.50
4,164	69.4	2.89	0	3.5	42.5	0	0	943	0.53
4,176	69.6	2.90	0	3.5	42.5	0	0	985	0.55
4,188	69.8	2.91	0	3.5	42.5	0	0	1,028	0.57
4,200	70.0	2.92	0	3.5	42.5	0	0	1,070	0.60
4,212	70.2	2.93	0	3.5	42.5	0	0	1,113	0.62
4,224	70.4	2.93	0	3.5	42.5	0	0	1,155	0.64
4,236	70.6	2.94	0	3.5	42.5	0	0	1,198	0.67
4,248	70.8	2.95	0	3.5	42.5	0	0	1,240	0.69
4,260	71.0	2.96	0	3.5	42.5	0	0	1,283	0.71
4,272	71.2	2.97	0	3.5	42.5	0	0	1,325	0.74
4,284	71.4	2.98	0	3.5	42.5	0	0	1,368	0.76
4,296	71.6	2.98	0	3.5	42.5	0	0	1,410	0.79
4,308	71.8	2.99	0	3.5	42.5	0	0	1,453	0.81
4,320	72.0	3.00	0	3.5	42.5	0	0	1,495	0.83
4,332	72.2	3.01	0	3.5	42.5	0	0	1,538	0.86
4,344	72.4	3.02	0	3.5	42.5	0	0	1,580	0.88
4,356	72.6	3.03	0	3.5	42.5	0	0	1,623	0.90
4,368	72.8	3.03	0	3.5	42.5	0	0	1,665	0.93
4,380	73.0	3.04	0	3.5	42.5	0	0	1,708	0.95
4,392	73.2	3.05	0	3.5	42.5	0	0	1,750	0.97
4,404	73.4	3.06	0	3.5	42.5	0	0	1,793	1.00
4,416	73.6	3.07	0	3.5	42.5	0	0	1,835	1.02
4,428	73.8	3.08	0	3.5	42.5	100	1200	678	0.38
4,440	74.0	3.08	0	3.5	42.5	0	0	720	0.40

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,452	74.2	3.09	0	3.5	42.5	0	0	763	0.42
4,464	74.4	3.10	0	3.5	42.5	0	0	805	0.45
4,476	74.6	3.11	0	3.5	42.5	0	0	848	0.47
4,488	74.8	3.12	0	3.5	42.5	0	0	890	0.50
4,500	75.0	3.13	0	3.5	42.5	0	0	933	0.52
4,512	75.2	3.13	0	3.5	42.5	0	0	975	0.54
4,524	75.4	3.14	0	3.5	42.5	0	0	1,018	0.57
4,536	75.6	3.15	0	3.5	42.5	0	0	1,060	0.59
4,548	75.8	3.16	0	3.5	42.5	0	0	1,103	0.61
4,560	76.0	3.17	0	3.5	42.5	0	0	1,145	0.64
4,572	76.2	3.18	0	3.5	42.5	0	0	1,188	0.66
4,584	76.4	3.18	0	3.5	42.5	0	0	1,230	0.69
4,596	76.6	3.19	0	3.5	42.5	0	0	1,273	0.71
4,608	76.8	3.20	0	3.5	42.5	0	0	1,315	0.73
4,620	77.0	3.21	0	3.5	42.5	0	0	1,358	0.76
4,632	77.2	3.22	0	3.5	42.5	0	0	1,400	0.78
4,644	77.4	3.23	0	3.5	42.5	0	0	1,443	0.80
4,656	77.6	3.23	0	3.5	42.5	0	0	1,485	0.83
4,668	77.8	3.24	0	3.5	42.5	0	0	1,528	0.85
4,680	78.0	3.25	0	3.5	42.5	0	0	1,570	0.87
4,692	78.2	3.26	0	3.5	42.5	0	0	1,613	0.90
4,704	78.4	3.27	0	3.5	42.5	0	0	1,655	0.92
4,716	78.6	3.28	0	3.5	42.5	0	0	1,698	0.95
4,728	78.8	3.28	0	3.5	42.5	0	0	1,740	0.97
4,740	79.0	3.29	0	3.5	42.5	0	0	1,783	0.99
4,752	79.2	3.30	0	3.5	42.5	0	0	1,825	1.02
4,764	79.4	3.31	0	3.5	42.5	100	1200	668	0.37
4,776	79.6	3.32	0	3.5	42.5	0	0	710	0.40
4,788	79.8	3.33	0	3.5	42.5	0	0	753	0.42
4,800	80.0	3.33	0	3.5	42.5	0	0	795	0.44
4,812	80.2	3.34	0	3.5	42.5	0	0	838	0.47
4,824	80.4	3.35	0	3.5	42.5	0	0	880	0.49
4,836	80.6	3.36	0	3.5	42.5	0	0	923	0.51
4,848	80.8	3.37	0	3.5	42.5	0	0	965	0.54
4,860	81.0	3.38	0	3.5	42.5	0	0	1,008	0.56
4,872	81.2	3.38	0	3.5	42.5	0	0	1,050	0.59
4,884	81.4	3.39	0	3.5	42.5	0	0	1,093	0.61
4,896	81.6	3.40	0	3.5	42.5	0	0	1,135	0.63
4,908	81.8	3.41	0	3.5	42.5	0	0	1,178	0.66
4,920	82.0	3.42	0	3.5	42.5	0	0	1,220	0.68
4,932	82.2	3.43	0	3.5	42.5	0	0	1,263	0.70
4,944	82.4	3.43	0	3.5	42.5	0	0	1,305	0.73
4,956	82.6	3.44	0	3.5	42.5	0	0	1,348	0.75
4,968	82.8	3.45	0	3.5	42.5	0	0	1,390	0.77
4,980	83.0	3.46	0	3.5	42.5	0	0	1,433	0.80
4,992	83.2	3.47	0	3.5	42.5	0	0	1,475	0.82
5,004	83.4	3.48	0	3.5	42.5	0	0	1,518	0.85
5,016	83.6	3.48	0	3.5	42.5	0	0	1,560	0.87
5,028	83.8	3.49	0	3.5	42.5	0	0	1,603	0.89
5,040	84.0	3.50	0	3.5	42.5	0	0	1,645	0.92
5,052	84.2	3.51	0	3.5	42.5	0	0	1,688	0.94
5,064	84.4	3.52	0	3.5	42.5	0	0	1,730	0.96
5,076	84.6	3.53	0	3.5	42.5	0	0	1,773	0.99

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,088	84.8	3.53	0	3.5	42.5	0	0	1,815	1.01
5,100	85.0	3.54	0	3.5	42.5	100	1200	658	0.37
5,112	85.2	3.55	0	3.5	42.5	0	0	700	0.39
5,124	85.4	3.56	0	3.5	42.5	0	0	743	0.41
5,136	85.6	3.57	0	3.5	42.5	0	0	785	0.44
5,148	85.8	3.58	0	3.5	42.5	0	0	828	0.46
5,160	86.0	3.58	0	3.5	42.5	0	0	870	0.48
5,172	86.2	3.59	0	3.5	42.5	0	0	913	0.51
5,184	86.4	3.60	0	3.5	42.5	0	0	955	0.53
5,196	86.6	3.61	0	3.5	42.5	0	0	998	0.56
5,208	86.8	3.62	0	3.5	42.5	0	0	1,040	0.58
5,220	87.0	3.63	0	3.5	42.5	0	0	1,083	0.60
5,232	87.2	3.63	0	3.5	42.5	0	0	1,125	0.63
5,244	87.4	3.64	0	3.5	42.5	0	0	1,168	0.65
5,256	87.6	3.65	0	3.5	42.5	0	0	1,210	0.67
5,268	87.8	3.66	0	3.5	42.5	0	0	1,253	0.70
5,280	88.0	3.67	0	3.5	42.5	0	0	1,295	0.72
5,292	88.2	3.68	0	3.5	42.5	0	0	1,338	0.75
5,304	88.4	3.68	0	3.5	42.5	0	0	1,380	0.77
5,316	88.6	3.69	0	3.5	42.5	0	0	1,423	0.79
5,328	88.8	3.70	0	3.5	42.5	0	0	1,465	0.82
5,340	89.0	3.71	0	3.5	42.5	0	0	1,508	0.84
5,352	89.2	3.72	0	3.5	42.5	0	0	1,550	0.86
5,364	89.4	3.73	0	3.5	42.5	0	0	1,593	0.89
5,376	89.6	3.73	0	3.5	42.5	0	0	1,635	0.91
5,388	89.8	3.74	0	3.5	42.5	0	0	1,678	0.93
5,400	90.0	3.75	0	3.5	42.5	0	0	1,720	0.96
5,412	90.2	3.76	0	3.5	42.5	0	0	1,763	0.98
5,424	90.4	3.77	0	3.5	42.5	0	0	1,805	1.01
5,436	90.6	3.78	0	3.5	42.5	100	1200	648	0.36
5,448	90.8	3.78	0	3.5	42.5	0	0	690	0.38
5,460	91.0	3.79	0	3.5	42.5	0	0	733	0.41
5,472	91.2	3.80	0	3.5	42.5	0	0	775	0.43
5,484	91.4	3.81	0	3.5	42.5	0	0	818	0.46
5,496	91.6	3.82	0	3.5	42.5	0	0	860	0.48
5,508	91.8	3.83	0	3.5	42.5	0	0	903	0.50
5,520	92.0	3.83	0	3.5	42.5	0	0	945	0.53
5,532	92.2	3.84	0	3.5	42.5	0	0	988	0.55
5,544	92.4	3.85	0	3.5	42.5	0	0	1,030	0.57
5,556	92.6	3.86	0	3.5	42.5	0	0	1,073	0.60
5,568	92.8	3.87	0	3.5	42.5	0	0	1,115	0.62
5,580	93.0	3.88	0	3.5	42.5	0	0	1,158	0.64
5,592	93.2	3.88	0	3.5	42.5	0	0	1,200	0.67
5,604	93.4	3.89	0	3.5	42.5	0	0	1,243	0.69
5,616	93.6	3.90	0	3.5	42.5	0	0	1,285	0.72
5,628	93.8	3.91	0	3.5	42.5	0	0	1,328	0.74
5,640	94.0	3.92	0	3.5	42.5	0	0	1,370	0.76
5,652	94.2	3.93	0	3.5	42.5	0	0	1,413	0.79
5,664	94.4	3.93	0	3.5	42.5	0	0	1,455	0.81
5,676	94.6	3.94	0	3.5	42.5	0	0	1,498	0.83
5,688	94.8	3.95	0	3.5	42.5	0	0	1,540	0.86
5,700	95.0	3.96	0	3.5	42.5	0	0	1,583	0.88
5,712	95.2	3.97	0	3.5	42.5	0	0	1,625	0.91

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,724	95.4	3.98	0	3.5	42.5	0	0	1,668	0.93
5,736	95.6	3.98	0	3.5	42.5	0	0	1,710	0.95
5,748	95.8	3.99	0	3.5	42.5	0	0	1,753	0.98
5,760	96.0	4.00	0	3.5	42.5	0	0	1,795	1.00
5,772	96.2	4.01	0	3.5	42.5	0	0	1,838	1.02
5,784	96.4	4.02	0	3.5	42.5	100	1200	680	0.38
5,796	96.6	4.03	0	3.5	42.5	0	0	723	0.40
5,808	96.8	4.03	0	3.5	42.5	0	0	765	0.43
5,820	97.0	4.04	0	3.5	42.5	0	0	808	0.45
5,832	97.2	4.05	0	3.5	42.5	0	0	850	0.47
5,844	97.4	4.06	0	3.5	42.5	0	0	893	0.50
5,856	97.6	4.07	0	3.5	42.5	0	0	935	0.52
5,868	97.8	4.08	0	3.5	42.5	0	0	978	0.54
5,880	98.0	4.08	0	3.5	42.5	0	0	1,020	0.57
5,892	98.2	4.09	0	3.5	42.5	0	0	1,063	0.59
5,904	98.4	4.10	0	3.5	42.5	0	0	1,105	0.62
5,916	98.6	4.11	0	3.5	42.5	0	0	1,148	0.64
5,928	98.8	4.12	0	3.5	42.5	0	0	1,190	0.66
5,940	99.0	4.13	0	3.5	42.5	0	0	1,233	0.69
5,952	99.2	4.13	0	3.5	42.5	0	0	1,275	0.71
5,964	99.4	4.14	0	3.5	42.5	0	0	1,318	0.73
5,976	99.6	4.15	0	3.5	42.5	0	0	1,360	0.76
5,988	99.8	4.16	0	3.5	42.5	0	0	1,403	0.78
6,000	100.0	4.17	0	3.5	42.5	0	0	1,445	0.81
6,012	100.2	4.18	0	3.5	42.5	0	0	1,488	0.83
6,024	100.4	4.18	0	3.5	42.5	0	0	1,530	0.85
6,036	100.6	4.19	0	3.5	42.5	0	0	1,573	0.88
6,048	100.8	4.20	0	3.5	42.5	0	0	1,615	0.90
6,060	101.0	4.21	0	3.5	42.5	0	0	1,658	0.92
6,072	101.2	4.22	0	3.5	42.5	0	0	1,700	0.95
6,084	101.4	4.23	0	3.5	42.5	0	0	1,743	0.97
6,096	101.6	4.23	0	3.5	42.5	0	0	1,785	0.99
6,108	101.8	4.24	0	3.5	42.5	0	0	1,828	1.02
6,120	102.0	4.25	0	3.5	42.5	100	1200	670	0.37
6,132	102.2	4.26	0	3.5	42.5	0	0	713	0.40
6,144	102.4	4.27	0	3.5	42.5	0	0	755	0.42
6,156	102.6	4.28	0	3.5	42.5	0	0	798	0.44
6,168	102.8	4.28	0	3.5	42.5	0	0	840	0.47
6,180	103.0	4.29	0	3.5	42.5	0	0	883	0.49
6,192	103.2	4.30	0	3.5	42.5	0	0	925	0.52
6,204	103.4	4.31	0	3.5	42.5	0	0	968	0.54
6,216	103.6	4.32	0	3.5	42.5	0	0	1,010	0.56
6,228	103.8	4.33	0	3.5	42.5	0	0	1,053	0.59
6,240	104.0	4.33	0	3.5	42.5	0	0	1,095	0.61
6,252	104.2	4.34	0	3.5	42.5	0	0	1,138	0.63
6,264	104.4	4.35	0	3.5	42.5	0	0	1,180	0.66
6,276	104.6	4.36	0	3.5	42.5	0	0	1,223	0.68
6,288	104.8	4.37	0	3.5	42.5	0	0	1,265	0.70
6,300	105.0	4.38	0	3.5	42.5	0	0	1,308	0.73
6,312	105.2	4.38	0	3.5	42.5	0	0	1,350	0.75
6,324	105.4	4.39	0	3.5	42.5	0	0	1,393	0.78
6,336	105.6	4.40	0	3.5	42.5	0	0	1,435	0.80
6,348	105.8	4.41	0	3.5	42.5	0	0	1,478	0.82

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,360	106.0	4.42	0	3.5	42.5	0	0	1,520	0.85
6,372	106.2	4.43	0	3.5	42.5	0	0	1,563	0.87
6,384	106.4	4.43	0	3.5	42.5	0	0	1,605	0.89
6,396	106.6	4.44	0	3.5	42.5	0	0	1,648	0.92
6,408	106.8	4.45	0	3.5	42.5	0	0	1,690	0.94
6,420	107.0	4.46	0	3.5	42.5	0	0	1,733	0.97
6,432	107.2	4.47	0	3.5	42.5	0	0	1,775	0.99
6,444	107.4	4.48	0	3.5	42.5	0	0	1,818	1.01
6,456	107.6	4.48	0	3.5	42.5	100	1200	660	0.37
6,468	107.8	4.49	0	3.5	42.5	0	0	703	0.39
6,480	108.0	4.50	0	3.5	42.5	0	0	745	0.42
6,492	108.2	4.51	0	3.5	42.5	0	0	788	0.44
6,504	108.4	4.52	0	3.5	42.5	0	0	830	0.46
6,516	108.6	4.53	0	3.5	42.5	0	0	873	0.49
6,528	108.8	4.53	0	3.5	42.5	0	0	915	0.51
6,540	109.0	4.54	0	3.5	42.5	0	0	958	0.53
6,552	109.2	4.55	0	3.5	42.5	0	0	1,000	0.56
6,564	109.4	4.56	0	3.5	42.5	0	0	1,043	0.58
6,576	109.6	4.57	0	3.5	42.5	0	0	1,085	0.60
6,588	109.8	4.58	0	3.5	42.5	0	0	1,128	0.63
6,600	110.0	4.58	0	3.5	42.5	0	0	1,170	0.65
6,612	110.2	4.59	0	3.5	42.5	0	0	1,213	0.68
6,624	110.4	4.60	0	3.5	42.5	0	0	1,255	0.70
6,636	110.6	4.61	0	3.5	42.5	0	0	1,298	0.72
6,648	110.8	4.62	0	3.5	42.5	0	0	1,340	0.75
6,660	111.0	4.63	0	3.5	42.5	0	0	1,383	0.77
6,672	111.2	4.63	0	3.5	42.5	0	0	1,425	0.79
6,684	111.4	4.64	0	3.5	42.5	0	0	1,468	0.82
6,696	111.6	4.65	0	3.5	42.5	0	0	1,510	0.84
6,708	111.8	4.66	0	3.5	42.5	0	0	1,553	0.86
6,720	112.0	4.67	0	3.5	42.5	0	0	1,595	0.89
6,732	112.2	4.68	0	3.5	42.5	0	0	1,638	0.91
6,744	112.4	4.68	0	3.5	42.5	0	0	1,680	0.94
6,756	112.6	4.69	0	3.5	42.5	0	0	1,723	0.96
6,768	112.8	4.70	0	3.5	42.5	0	0	1,765	0.98
6,780	113.0	4.71	0	3.5	42.5	0	0	1,808	1.01
6,792	113.2	4.72	0	3.5	42.5	100	1200	650	0.36
6,804	113.4	4.73	0	3.5	42.5	0	0	693	0.39
6,816	113.6	4.73	0	3.5	42.5	0	0	735	0.41
6,828	113.8	4.74	0	3.5	42.5	0	0	778	0.43
6,840	114.0	4.75	0	3.5	42.5	0	0	820	0.46
6,852	114.2	4.76	0	3.5	42.5	0	0	863	0.48
6,864	114.4	4.77	0	3.5	42.5	0	0	905	0.50
6,876	114.6	4.78	0	3.5	42.5	0	0	948	0.53
6,888	114.8	4.78	0	3.5	42.5	0	0	990	0.55
6,900	115.0	4.79	0	3.5	42.5	0	0	1,033	0.58
6,912	115.2	4.80	0	3.5	42.5	0	0	1,075	0.60
6,924	115.4	4.81	0	3.5	42.5	0	0	1,118	0.62
6,936	115.6	4.82	0	3.5	42.5	0	0	1,160	0.65
6,948	115.8	4.83	0	3.5	42.5	0	0	1,203	0.67
6,960	116.0	4.83	0	3.5	42.5	0	0	1,245	0.69
6,972	116.2	4.84	0	3.5	42.5	0	0	1,288	0.72
6,984	116.4	4.85	0	3.5	42.5	0	0	1,330	0.74

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,996	116.6	4.86	0	3.5	42.5	0	0	1,373	0.76
7,008	116.8	4.87	0	3.5	42.5	0	0	1,415	0.79
7,020	117.0	4.88	0	3.5	42.5	0	0	1,458	0.81
7,032	117.2	4.88	0	3.5	42.5	0	0	1,500	0.84
7,044	117.4	4.89	0	3.5	42.5	0	0	1,543	0.86
7,056	117.6	4.90	0	3.5	42.5	0	0	1,585	0.88
7,068	117.8	4.91	0	3.5	42.5	0	0	1,628	0.91
7,080	118.0	4.92	0	3.5	42.5	0	0	1,670	0.93
7,092	118.2	4.93	0	3.5	42.5	0	0	1,713	0.95
7,104	118.4	4.93	0	3.5	42.5	0	0	1,755	0.98
7,116	118.6	4.94	0	3.5	42.5	0	0	1,798	1.00
7,128	118.8	4.95	0	3.5	42.5	100	1200	640	0.36
7,140	119.0	4.96	0	3.5	42.5	0	0	683	0.38
7,152	119.2	4.97	0	3.5	42.5	0	0	725	0.40
7,164	119.4	4.98	0	3.5	42.5	0	0	768	0.43
7,176	119.6	4.98	0	3.5	42.5	0	0	810	0.45
7,188	119.8	4.99	0	3.5	42.5	0	0	853	0.47
7,200	120.0	5.00	0	3.5	42.5	0	0	895	0.50
7,212	120.2	5.01	0	3.5	42.5	0	0	938	0.52
7,224	120.4	5.02	0	3.5	42.5	0	0	980	0.55
7,236	120.6	5.03	0	3.5	42.5	0	0	1,023	0.57
7,248	120.8	5.03	0	3.5	42.5	0	0	1,065	0.59
7,260	121.0	5.04	0	3.5	42.5	0	0	1,108	0.62
7,272	121.2	5.05	0	3.5	42.5	0	0	1,150	0.64
7,284	121.4	5.06	0	3.5	42.5	0	0	1,193	0.66
7,296	121.6	5.07	0	3.5	42.5	0	0	1,235	0.69
7,308	121.8	5.08	0	3.5	42.5	0	0	1,278	0.71
7,320	122.0	5.08	0	3.5	42.5	0	0	1,320	0.74
7,332	122.2	5.09	0	3.5	42.5	0	0	1,363	0.76
7,344	122.4	5.10	0	3.5	42.5	0	0	1,405	0.78
7,356	122.6	5.11	0	3.5	42.5	0	0	1,448	0.81
7,368	122.8	5.12	0	3.5	42.5	0	0	1,490	0.83
7,380	123.0	5.13	0	3.5	42.5	0	0	1,533	0.85
7,392	123.2	5.13	0	3.5	42.5	0	0	1,575	0.88
7,404	123.4	5.14	0	3.5	42.5	0	0	1,618	0.90
7,416	123.6	5.15	0	3.5	42.5	0	0	1,660	0.92
7,428	123.8	5.16	0	3.5	42.5	0	0	1,703	0.95
7,440	124.0	5.17	0	3.5	42.5	0	0	1,745	0.97
7,452	124.2	5.18	0	3.5	42.5	0	0	1,788	1.00
7,464	124.4	5.18	0	3.5	42.5	0	0	1,830	1.02
7,476	124.6	5.19	0	3.5	42.5	100	1200	673	0.37
7,488	124.8	5.20	0	3.5	42.5	0	0	715	0.40
7,500	125.0	5.21	0	3.5	42.5	0	0	758	0.42
7,512	125.2	5.22	0	3.5	42.5	0	0	800	0.45
7,524	125.4	5.23	0	3.5	42.5	0	0	843	0.47
7,536	125.6	5.23	0	3.5	42.5	0	0	885	0.49
7,548	125.8	5.24	0	3.5	42.5	0	0	928	0.52
7,560	126.0	5.25	0	3.5	42.5	0	0	970	0.54
7,572	126.2	5.26	0	3.5	42.5	0	0	1,013	0.56
7,584	126.4	5.27	0	3.5	42.5	0	0	1,055	0.59
7,596	126.6	5.28	0	3.5	42.5	0	0	1,098	0.61
7,608	126.8	5.28	0	3.5	42.5	0	0	1,140	0.64
7,620	127.0	5.29	0	3.5	42.5	0	0	1,183	0.66

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,632	127.2	5.30	0	3.5	42.5	0	0	1,225	0.68
7,644	127.4	5.31	0	3.5	42.5	0	0	1,268	0.71
7,656	127.6	5.32	0	3.5	42.5	0	0	1,310	0.73
7,668	127.8	5.33	0	3.5	42.5	0	0	1,353	0.75
7,680	128.0	5.33	0	3.5	42.5	0	0	1,395	0.78
7,692	128.2	5.34	0	3.5	42.5	0	0	1,438	0.80
7,704	128.4	5.35	0	3.5	42.5	0	0	1,480	0.82
7,716	128.6	5.36	0	3.5	42.5	0	0	1,523	0.85
7,728	128.8	5.37	0	3.5	42.5	0	0	1,565	0.87
7,740	129.0	5.38	0	3.5	42.5	0	0	1,608	0.90
7,752	129.2	5.38	0	3.5	42.5	0	0	1,650	0.92
7,764	129.4	5.39	0	3.5	42.5	0	0	1,693	0.94
7,776	129.6	5.40	0	3.5	42.5	0	0	1,735	0.97
7,788	129.8	5.41	0	3.5	42.5	0	0	1,778	0.99
7,800	130.0	5.42	0	3.5	42.5	0	0	1,820	1.01
7,812	130.2	5.43	0	3.5	42.5	100	1200	663	0.37
7,824	130.4	5.43	0	3.5	42.5	0	0	705	0.39
7,836	130.6	5.44	0	3.5	42.5	0	0	748	0.42
7,848	130.8	5.45	0	3.5	42.5	0	0	790	0.44
7,860	131.0	5.46	0	3.5	42.5	0	0	833	0.46
7,872	131.2	5.47	0	3.5	42.5	0	0	875	0.49
7,884	131.4	5.48	0	3.5	42.5	0	0	918	0.51
7,896	131.6	5.48	0	3.5	42.5	0	0	960	0.53
7,908	131.8	5.49	0	3.5	42.5	0	0	1,003	0.56
7,920	132.0	5.50	0	3.5	42.5	0	0	1,045	0.58
7,932	132.2	5.51	0	3.5	42.5	0	0	1,088	0.61
7,944	132.4	5.52	0	3.5	42.5	0	0	1,130	0.63
7,956	132.6	5.53	0	3.5	42.5	0	0	1,173	0.65
7,968	132.8	5.53	0	3.5	42.5	0	0	1,215	0.68
7,980	133.0	5.54	0	3.5	42.5	0	0	1,258	0.70
7,992	133.2	5.55	0	3.5	42.5	0	0	1,300	0.72
8,004	133.4	5.56	0	3.5	42.5	0	0	1,343	0.75
8,016	133.6	5.57	0	3.5	42.5	0	0	1,385	0.77
8,028	133.8	5.58	0	3.5	42.5	0	0	1,428	0.80
8,040	134.0	5.58	0	3.5	42.5	0	0	1,470	0.82
8,052	134.2	5.59	0	3.5	42.5	0	0	1,513	0.84
8,064	134.4	5.60	0	3.5	42.5	0	0	1,555	0.87
8,076	134.6	5.61	0	3.5	42.5	0	0	1,598	0.89
8,088	134.8	5.62	0	3.5	42.5	0	0	1,640	0.91
8,100	135.0	5.63	0	3.5	42.5	0	0	1,683	0.94
8,112	135.2	5.63	0	3.5	42.5	0	0	1,725	0.96
8,124	135.4	5.64	0	3.5	42.5	0	0	1,768	0.98
8,136	135.6	5.65	0	3.5	42.5	0	0	1,810	1.01
8,148	135.8	5.66	0	3.5	42.5	100	1200	653	0.36
8,160	136.0	5.67	0	3.5	42.5	0	0	695	0.39
8,172	136.2	5.68	0	3.5	42.5	0	0	738	0.41
8,184	136.4	5.68	0	3.5	42.5	0	0	780	0.43
8,196	136.6	5.69	0	3.5	42.5	0	0	823	0.46
8,208	136.8	5.70	0	3.5	42.5	0	0	865	0.48
8,220	137.0	5.71	0	3.5	42.5	0	0	908	0.51
8,232	137.2	5.72	0	3.5	42.5	0	0	950	0.53
8,244	137.4	5.73	0	3.5	42.5	0	0	993	0.55
8,256	137.6	5.73	0	3.5	42.5	0	0	1,035	0.58

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,268	137.8	5.74	0	3.5	42.5	0	0	1,078	0.60
8,280	138.0	5.75	0	3.5	42.5	0	0	1,120	0.62
8,292	138.2	5.76	0	3.5	42.5	0	0	1,163	0.65
8,304	138.4	5.77	0	3.5	42.5	0	0	1,205	0.67
8,316	138.6	5.78	0	3.5	42.5	0	0	1,248	0.70
8,328	138.8	5.78	0	3.5	42.5	0	0	1,290	0.72
8,340	139.0	5.79	0	3.5	42.5	0	0	1,333	0.74
8,352	139.2	5.80	0	3.5	42.5	0	0	1,375	0.77
8,364	139.4	5.81	0	3.5	42.5	0	0	1,418	0.79
8,376	139.6	5.82	0	3.5	42.5	0	0	1,460	0.81
8,388	139.8	5.83	0	3.5	42.5	0	0	1,503	0.84
8,400	140.0	5.83	0	3.5	42.5	0	0	1,545	0.86
8,412	140.2	5.84	0	3.5	42.5	0	0	1,588	0.88
8,424	140.4	5.85	0	3.5	42.5	0	0	1,630	0.91
8,436	140.6	5.86	0	3.5	42.5	0	0	1,673	0.93
8,448	140.8	5.87	0	3.5	42.5	0	0	1,715	0.96
8,460	141.0	5.88	0	3.5	42.5	0	0	1,758	0.98
8,472	141.2	5.88	0	3.5	42.5	0	0	1,800	1.00
8,484	141.4	5.89	0	3.5	42.5	100	1200	643	0.36
8,496	141.6	5.90	0	3.5	42.5	0	0	685	0.38
8,508	141.8	5.91	0	3.5	42.5	0	0	728	0.41
8,520	142.0	5.92	0	3.5	42.5	0	0	770	0.43
8,532	142.2	5.93	0	3.5	42.5	0	0	813	0.45
8,544	142.4	5.93	0	3.5	42.5	0	0	855	0.48
8,556	142.6	5.94	0	3.5	42.5	0	0	898	0.50
8,568	142.8	5.95	0	3.5	42.5	0	0	940	0.52
8,580	143.0	5.96	0	3.5	42.5	0	0	983	0.55
8,592	143.2	5.97	0	3.5	42.5	0	0	1,025	0.57
8,604	143.4	5.98	0	3.5	42.5	0	0	1,068	0.59
8,616	143.6	5.98	0	3.5	42.5	0	0	1,110	0.62
8,628	143.8	5.99	0	3.5	42.5	0	0	1,153	0.64
8,640	144.0	6.00	0	3.5	42.5	0	0	1,195	0.67
8,652	144.2	6.01	0	3.5	42.5	0	0	1,238	0.69
8,664	144.4	6.02	0	3.5	42.5	0	0	1,280	0.71
8,676	144.6	6.03	0	3.5	42.5	0	0	1,323	0.74
8,688	144.8	6.03	0	3.5	42.5	0	0	1,365	0.76
8,700	145.0	6.04	0	3.5	42.5	0	0	1,408	0.78
8,712	145.2	6.05	0	3.5	42.5	0	0	1,450	0.81
8,724	145.4	6.06	0	3.5	42.5	0	0	1,493	0.83
8,736	145.6	6.07	0	3.5	42.5	0	0	1,535	0.86
8,748	145.8	6.08	0	3.5	42.5	0	0	1,578	0.88
8,760	146.0	6.08	0	3.5	42.5	0	0	1,620	0.90
8,772	146.2	6.09	0	3.5	42.5	0	0	1,663	0.93
8,784	146.4	6.10	0	3.5	42.5	0	0	1,705	0.95
8,796	146.6	6.11	0	3.5	42.5	0	0	1,748	0.97
8,808	146.8	6.12	0	3.5	42.5	0	0	1,790	1.00
8,820	147.0	6.13	0	3.5	42.5	0	0	1,833	1.02
8,832	147.2	6.13	0	3.5	42.5	100	1200	675	0.38
8,844	147.4	6.14	0	3.5	42.5	0	0	718	0.40
8,856	147.6	6.15	0	3.5	42.5	0	0	760	0.42
8,868	147.8	6.16	0	3.5	42.5	0	0	803	0.45
8,880	148.0	6.17	0	3.5	42.5	0	0	845	0.47
8,892	148.2	6.18	0	3.5	42.5	0	0	888	0.49

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,904	148.4	6.18	0	3.5	42.5	0	0	930	0.52
8,916	148.6	6.19	0	3.5	42.5	0	0	973	0.54
8,928	148.8	6.20	0	3.5	42.5	0	0	1,015	0.57
8,940	149.0	6.21	0	3.5	42.5	0	0	1,058	0.59
8,952	149.2	6.22	0	3.5	42.5	0	0	1,100	0.61
8,964	149.4	6.23	0	3.5	42.5	0	0	1,143	0.64
8,976	149.6	6.23	0	3.5	42.5	0	0	1,185	0.66
8,988	149.8	6.24	0	3.5	42.5	0	0	1,228	0.68
9,000	150.0	6.25	0	3.5	42.5	0	0	1,270	0.71
9,012	150.2	6.26	0	3.5	42.5	0	0	1,313	0.73
9,024	150.4	6.27	0	3.5	42.5	0	0	1,355	0.75
9,036	150.6	6.28	0	3.5	42.5	0	0	1,398	0.78
9,048	150.8	6.28	0	3.5	42.5	0	0	1,440	0.80
9,060	151.0	6.29	0	3.5	42.5	0	0	1,483	0.83
9,072	151.2	6.30	0	3.5	42.5	0	0	1,525	0.85
9,084	151.4	6.31	0	3.5	42.5	0	0	1,568	0.87
9,096	151.6	6.32	0	3.5	42.5	0	0	1,610	0.90
9,108	151.8	6.33	0	3.5	42.5	0	0	1,653	0.92
9,120	152.0	6.33	0	3.5	42.5	0	0	1,695	0.94
9,132	152.2	6.34	0	3.5	42.5	0	0	1,738	0.97
9,144	152.4	6.35	0	3.5	42.5	0	0	1,780	0.99
9,156	152.6	6.36	0	3.5	42.5	0	0	1,823	1.02
9,168	152.8	6.37	0	3.5	42.5	100	1200	665	0.37
9,180	153.0	6.38	0	3.5	42.5	0	0	708	0.39
9,192	153.2	6.38	0	3.5	42.5	0	0	750	0.42
9,204	153.4	6.39	0	3.5	42.5	0	0	793	0.44
9,216	153.6	6.40	0	3.5	42.5	0	0	835	0.47
9,228	153.8	6.41	0	3.5	42.5	0	0	878	0.49
9,240	154.0	6.42	0	3.5	42.5	0	0	920	0.51
9,252	154.2	6.43	0	3.5	42.5	0	0	963	0.54
9,264	154.4	6.43	0	3.5	42.5	0	0	1,005	0.56
9,276	154.6	6.44	0	3.5	42.5	0	0	1,048	0.58
9,288	154.8	6.45	0	3.5	42.5	0	0	1,090	0.61
9,300	155.0	6.46	0	3.5	42.5	0	0	1,133	0.63
9,312	155.2	6.47	0	3.5	42.5	0	0	1,175	0.65
9,324	155.4	6.48	0	3.5	42.5	0	0	1,218	0.68
9,336	155.6	6.48	0	3.5	42.5	0	0	1,260	0.70
9,348	155.8	6.49	0	3.5	42.5	0	0	1,303	0.73
9,360	156.0	6.50	0	3.5	42.5	0	0	1,345	0.75
9,372	156.2	6.51	0	3.5	42.5	0	0	1,388	0.77
9,384	156.4	6.52	0	3.5	42.5	0	0	1,430	0.80
9,396	156.6	6.53	0	3.5	42.5	0	0	1,473	0.82
9,408	156.8	6.53	0	3.5	42.5	0	0	1,515	0.84
9,420	157.0	6.54	0	3.5	42.5	0	0	1,558	0.87
9,432	157.2	6.55	0	3.5	42.5	0	0	1,600	0.89
9,444	157.4	6.56	0	3.5	42.5	0	0	1,643	0.92
9,456	157.6	6.57	0	3.5	42.5	0	0	1,685	0.94
9,468	157.8	6.58	0	3.5	42.5	0	0	1,728	0.96
9,480	158.0	6.58	0	3.5	42.5	0	0	1,770	0.99
9,492	158.2	6.59	0	3.5	42.5	0	0	1,813	1.01
9,504	158.4	6.60	0	3.5	42.5	100	1200	655	0.36
9,516	158.6	6.61	0	3.5	42.5	0	0	698	0.39
9,528	158.8	6.62	0	3.5	42.5	0	0	740	0.41

Attachment 3 - Cell 1 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
9,540	159.0	6.63	0	3.5	42.5	0	0	783	0.44
9,552	159.2	6.63	0	3.5	42.5	0	0	825	0.46
9,564	159.4	6.64	0	3.5	42.5	0	0	868	0.48
9,576	159.6	6.65	0	3.5	42.5	0	0	910	0.51
9,588	159.8	6.66	0	3.5	42.5	0	0	953	0.53
9,600	160.0	6.67	0	3.5	42.5	0	0	995	0.55
9,612	160.2	6.68	0	3.5	42.5	0	0	1,038	0.58
9,624	160.4	6.68	0	3.5	42.5	0	0	1,080	0.60
9,636	160.6	6.69	0	3.5	42.5	0	0	1,123	0.63
9,648	160.8	6.70	0	3.5	42.5	0	0	1,165	0.65
9,660	161.0	6.71	0	3.5	42.5	0	0	1,208	0.67
9,672	161.2	6.72	0	3.5	42.5	0	0	1,250	0.70
9,684	161.4	6.73	0	3.5	42.5	0	0	1,293	0.72
9,696	161.6	6.73	0	3.5	42.5	0	0	1,335	0.74
9,708	161.8	6.74	0	3.5	42.5	0	0	1,378	0.77
9,720	162.0	6.75	0	3.5	42.5	0	0	1,420	0.79
9,732	162.2	6.76	0	3.5	42.5	0	0	1,463	0.81
9,744	162.4	6.77	0	3.5	42.5	0	0	1,505	0.84
9,756	162.6	6.78	0	3.5	42.5	0	0	1,548	0.86
9,768	162.8	6.78	0	3.5	42.5	0	0	1,590	0.89
9,780	163.0	6.79	0	3.5	42.5	0	0	1,633	0.91
9,792	163.2	6.80	0	3.5	42.5	0	0	1,675	0.93
9,804	163.4	6.81	0	3.5	42.5	0	0	1,718	0.96
9,816	163.6	6.82	0	3.5	42.5	0	0	1,760	0.98
9,828	163.8	6.83	0	3.5	42.5	0	0	1,803	1.00
9,840	164.0	6.83	0	3.5	42.5	100	1200	645	0.36
9,852	164.2	6.84	0	3.5	42.5	0	0	688	0.38
9,864	164.4	6.85	0	3.5	42.5	0	0	730	0.41
9,876	164.6	6.86	0	3.5	42.5	0	0	773	0.43
9,888	164.8	6.87	0	3.5	42.5	0	0	815	0.45
9,900	165.0	6.88	0	3.5	42.5	0	0	858	0.48
9,912	165.2	6.88	0	3.5	42.5	0	0	900	0.50
9,924	165.4	6.89	0	3.5	42.5	0	0	943	0.53
9,936	165.6	6.90	0	3.5	42.5	0	0	985	0.55
9,948	165.8	6.91	0	3.5	42.5	0	0	1,028	0.57
9,960	166.0	6.92	0	3.5	42.5	0	0	1,070	0.60
9,972	166.2	6.93	0	3.5	42.5	0	0	1,113	0.62
9,984	166.4	6.93	0	3.5	42.5	0	0	1,155	0.64
9,996	166.6	6.94	0	3.5	42.5	0	0	1,198	0.67
10,008	166.8	6.95	0	3.5	42.5	0	0	1,240	0.69
10,020	167.0	6.96	0	3.5	42.5	0	0	1,283	0.71
10,032	167.2	6.97	0	3.5	42.5	0	0	1,325	0.74
10,044	167.4	6.98	0	3.5	42.5	0	0	1,368	0.76
10,056	167.6	6.98	0	3.5	42.5	0	0	1,410	0.79
10,068	167.8	6.99	0	3.5	42.5	0	0	1,453	0.81
10,080	168.0	7.00	0	3.5	42.5	0	0	1,495	0.83

ATTACHMENT 4

Cell 1 Leachate Collection Sump – Average Conditions

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
0	0.0	0.00	0	4.1	0.0	0	0	0	3,590	1.00
12	0.2	0.01	0	4.1	49.1	0	0	0	3,639	1.01
24	0.4	0.02	0	4.1	49.1	100	0	1,200	2,489	0.69
36	0.6	0.03	0	4.1	49.1	100	0	1,200	1,338	0.37
48	0.8	0.03	0	4.1	49.1	0	0	0	1,387	0.39
60	1.0	0.04	0	4.1	49.1	0	0	0	1,436	0.40
72	1.2	0.05	0	4.1	49.1	0	0	0	1,485	0.41
84	1.4	0.06	0	4.1	49.1	0	0	0	1,534	0.43
96	1.6	0.07	0	4.1	49.1	0	0	0	1,583	0.44
108	1.8	0.08	0	4.1	49.1	0	0	0	1,632	0.45
120	2.0	0.08	0	4.1	49.1	0	0	0	1,681	0.47
132	2.2	0.09	0	4.1	49.1	0	0	0	1,730	0.48
144	2.4	0.10	0	4.1	49.1	0	0	0	1,779	0.50
156	2.6	0.11	0	4.1	49.1	0	0	0	1,829	0.51
168	2.8	0.12	0	4.1	49.1	0	0	0	1,878	0.52
180	3.0	0.13	0	4.1	49.1	0	0	0	1,927	0.54
192	3.2	0.13	0	4.1	49.1	0	0	0	1,976	0.55
204	3.4	0.14	0	4.1	49.1	0	0	0	2,025	0.56
216	3.6	0.15	0	4.1	49.1	0	0	0	2,074	0.58
228	3.8	0.16	0	4.1	49.1	0	0	0	2,123	0.59
240	4.0	0.17	0	4.1	49.1	0	0	0	2,172	0.60
252	4.2	0.18	0	4.1	49.1	0	0	0	2,221	0.62
264	4.4	0.18	0	4.1	49.1	0	0	0	2,270	0.63
276	4.6	0.19	0	4.1	49.1	0	0	0	2,319	0.65
288	4.8	0.20	0	4.1	49.1	0	0	0	2,369	0.66
300	5.0	0.21	0	4.1	49.1	0	0	0	2,418	0.67
312	5.2	0.22	0	4.1	49.1	0	0	0	2,467	0.69
324	5.4	0.23	0	4.1	49.1	0	0	0	2,516	0.70
336	5.6	0.23	0	4.1	49.1	0	0	0	2,565	0.71
348	5.8	0.24	0	4.1	49.1	0	0	0	2,614	0.73
360	6.0	0.25	0	4.1	49.1	0	0	0	2,663	0.74
372	6.2	0.26	0	4.1	49.1	0	0	0	2,712	0.76
384	6.4	0.27	0	4.1	49.1	0	0	0	2,761	0.77
396	6.6	0.28	0	4.1	49.1	0	0	0	2,810	0.78
408	6.8	0.28	0	4.1	49.1	0	0	0	2,859	0.80
420	7.0	0.29	0	4.1	49.1	0	0	0	2,908	0.81
432	7.2	0.30	0	4.1	49.1	0	0	0	2,958	0.82
444	7.4	0.31	0	4.1	49.1	0	0	0	3,007	0.84
456	7.6	0.32	0	4.1	49.1	0	0	0	3,056	0.85
468	7.8	0.33	0	4.1	49.1	0	0	0	3,105	0.86
480	8.0	0.33	0	4.1	49.1	0	0	0	3,154	0.88
492	8.2	0.34	0	4.1	49.1	0	0	0	3,203	0.89
504	8.4	0.35	0	4.1	49.1	0	0	0	3,252	0.91
516	8.6	0.36	0	4.1	49.1	0	0	0	3,301	0.92
528	8.8	0.37	0	4.1	49.1	0	0	0	3,350	0.93
540	9.0	0.38	0	4.1	49.1	0	0	0	3,399	0.95
552	9.2	0.38	0	4.1	49.1	0	0	0	3,448	0.96
564	9.4	0.39	0	4.1	49.1	0	0	0	3,498	0.97
576	9.6	0.40	0	4.1	49.1	0	0	0	3,547	0.99
588	9.8	0.41	0	4.1	49.1	0	0	0	3,596	1.00
600	10.0	0.42	0	4.1	49.1	100	0	1,200	2,445	0.68
612	10.2	0.43	0	4.1	49.1	100	0	1,200	1,294	0.36
624	10.4	0.43	0	4.1	49.1	0	0	0	1,343	0.37
636	10.6	0.44	0	4.1	49.1	0	0	0	1,392	0.39
648	10.8	0.45	0	4.1	49.1	0	0	0	1,441	0.40
660	11.0	0.46	0	4.1	49.1	0	0	0	1,490	0.42
672	11.2	0.47	0	4.1	49.1	0	0	0	1,539	0.43
684	11.4	0.48	0	4.1	49.1	0	0	0	1,588	0.44
696	11.6	0.48	0	4.1	49.1	0	0	0	1,637	0.46
708	11.8	0.49	0	4.1	49.1	0	0	0	1,687	0.47

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
720	12.0	0.50	0	4.1	49.1	0	0	0	1,736	0.48
732	12.2	0.51	0	4.1	49.1	0	0	0	1,785	0.50
744	12.4	0.52	0	4.1	49.1	0	0	0	1,834	0.51
756	12.6	0.53	0	4.1	49.1	0	0	0	1,883	0.52
768	12.8	0.53	0	4.1	49.1	0	0	0	1,932	0.54
780	13.0	0.54	0	4.1	49.1	0	0	0	1,981	0.55
792	13.2	0.55	0	4.1	49.1	0	0	0	2,030	0.57
804	13.4	0.56	0	4.1	49.1	0	0	0	2,079	0.58
816	13.6	0.57	0	4.1	49.1	0	0	0	2,128	0.59
828	13.8	0.58	0	4.1	49.1	0	0	0	2,177	0.61
840	14.0	0.58	0	4.1	49.1	0	0	0	2,227	0.62
852	14.2	0.59	0	4.1	49.1	0	0	0	2,276	0.63
864	14.4	0.60	0	4.1	49.1	0	0	0	2,325	0.65
876	14.6	0.61	0	4.1	49.1	0	0	0	2,374	0.66
888	14.8	0.62	0	4.1	49.1	0	0	0	2,423	0.67
900	15.0	0.63	0	4.1	49.1	0	0	0	2,472	0.69
912	15.2	0.63	0	4.1	49.1	0	0	0	2,521	0.70
924	15.4	0.64	0	4.1	49.1	0	0	0	2,570	0.72
936	15.6	0.65	0	4.1	49.1	0	0	0	2,619	0.73
948	15.8	0.66	0	4.1	49.1	0	0	0	2,668	0.74
960	16.0	0.67	0	4.1	49.1	0	0	0	2,717	0.76
972	16.2	0.68	0	4.1	49.1	0	0	0	2,766	0.77
984	16.4	0.68	0	4.1	49.1	0	0	0	2,816	0.78
996	16.6	0.69	0	4.1	49.1	0	0	0	2,865	0.80
1,008	16.8	0.70	0	4.1	49.1	0	0	0	2,914	0.81
1,020	17.0	0.71	0	4.1	49.1	0	0	0	2,963	0.83
1,032	17.2	0.72	0	4.1	49.1	0	0	0	3,012	0.84
1,044	17.4	0.73	0	4.1	49.1	0	0	0	3,061	0.85
1,056	17.6	0.73	0	4.1	49.1	0	0	0	3,110	0.87
1,068	17.8	0.74	0	4.1	49.1	0	0	0	3,159	0.88
1,080	18.0	0.75	0	4.1	49.1	0	0	0	3,208	0.89
1,092	18.2	0.76	0	4.1	49.1	0	0	0	3,257	0.91
1,104	18.4	0.77	0	4.1	49.1	0	0	0	3,306	0.92
1,116	18.6	0.78	0	4.1	49.1	0	0	0	3,356	0.93
1,128	18.8	0.78	0	4.1	49.1	0	0	0	3,405	0.95
1,140	19.0	0.79	0	4.1	49.1	0	0	0	3,454	0.96
1,152	19.2	0.80	0	4.1	49.1	0	0	0	3,503	0.98
1,164	19.4	0.81	0	4.1	49.1	0	0	0	3,552	0.99
1,176	19.6	0.82	0	4.1	49.1	0	0	0	3,601	1.00
1,188	19.8	0.83	0	4.1	49.1	100	0	1,200	2,450	0.68
1,200	20.0	0.83	0	4.1	49.1	100	0	1,200	1,299	0.36
1,212	20.2	0.84	0	4.1	49.1	0	0	0	1,348	0.38
1,224	20.4	0.85	0	4.1	49.1	0	0	0	1,397	0.39
1,236	20.6	0.86	0	4.1	49.1	0	0	0	1,446	0.40
1,248	20.8	0.87	0	4.1	49.1	0	0	0	1,496	0.42
1,260	21.0	0.88	0	4.1	49.1	0	0	0	1,545	0.43
1,272	21.2	0.88	0	4.1	49.1	0	0	0	1,594	0.44
1,284	21.4	0.89	0	4.1	49.1	0	0	0	1,643	0.46
1,296	21.6	0.90	0	4.1	49.1	0	0	0	1,692	0.47
1,308	21.8	0.91	0	4.1	49.1	0	0	0	1,741	0.48
1,320	22.0	0.92	0	4.1	49.1	0	0	0	1,790	0.50
1,332	22.2	0.93	0	4.1	49.1	0	0	0	1,839	0.51
1,344	22.4	0.93	0	4.1	49.1	0	0	0	1,888	0.53
1,356	22.6	0.94	0	4.1	49.1	0	0	0	1,937	0.54
1,368	22.8	0.95	0	4.1	49.1	0	0	0	1,986	0.55
1,380	23.0	0.96	0	4.1	49.1	0	0	0	2,035	0.57
1,392	23.2	0.97	0	4.1	49.1	0	0	0	2,085	0.58
1,404	23.4	0.98	0	4.1	49.1	0	0	0	2,134	0.59
1,416	23.6	0.98	0	4.1	49.1	0	0	0	2,183	0.61
1,428	23.8	0.99	0	4.1	49.1	0	0	0	2,232	0.62

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,440	24.0	1.00	0	4.1	49.1	0	0	0	2,281	0.64
1,452	24.2	1.01	0	4.1	49.1	0	0	0	2,330	0.65
1,464	24.4	1.02	0	4.1	49.1	0	0	0	2,379	0.66
1,476	24.6	1.03	0	4.1	49.1	0	0	0	2,428	0.68
1,488	24.8	1.03	0	4.1	49.1	0	0	0	2,477	0.69
1,500	25.0	1.04	0	4.1	49.1	0	0	0	2,526	0.70
1,512	25.2	1.05	0	4.1	49.1	0	0	0	2,575	0.72
1,524	25.4	1.06	0	4.1	49.1	0	0	0	2,625	0.73
1,536	25.6	1.07	0	4.1	49.1	0	0	0	2,674	0.74
1,548	25.8	1.08	0	4.1	49.1	0	0	0	2,723	0.76
1,560	26.0	1.08	0	4.1	49.1	0	0	0	2,772	0.77
1,572	26.2	1.09	0	4.1	49.1	0	0	0	2,821	0.79
1,584	26.4	1.10	0	4.1	49.1	0	0	0	2,870	0.80
1,596	26.6	1.11	0	4.1	49.1	0	0	0	2,919	0.81
1,608	26.8	1.12	0	4.1	49.1	0	0	0	2,968	0.83
1,620	27.0	1.13	0	4.1	49.1	0	0	0	3,017	0.84
1,632	27.2	1.13	0	4.1	49.1	0	0	0	3,066	0.85
1,644	27.4	1.14	0	4.1	49.1	0	0	0	3,115	0.87
1,656	27.6	1.15	0	4.1	49.1	0	0	0	3,164	0.88
1,668	27.8	1.16	0	4.1	49.1	0	0	0	3,214	0.90
1,680	28.0	1.17	0	4.1	49.1	0	0	0	3,263	0.91
1,692	28.2	1.18	0	4.1	49.1	0	0	0	3,312	0.92
1,704	28.4	1.18	0	4.1	49.1	0	0	0	3,361	0.94
1,716	28.6	1.19	0	4.1	49.1	0	0	0	3,410	0.95
1,728	28.8	1.20	0	4.1	49.1	0	0	0	3,459	0.96
1,740	29.0	1.21	0	4.1	49.1	0	0	0	3,508	0.98
1,752	29.2	1.22	0	4.1	49.1	0	0	0	3,557	0.99
1,764	29.4	1.23	0	4.1	49.1	0	0	0	3,606	1.00
1,776	29.6	1.23	0	4.1	49.1	100	0	1,200	2,455	0.68
1,788	29.8	1.24	0	4.1	49.1	100	0	1,200	1,304	0.36
1,800	30.0	1.25	0	4.1	49.1	0	0	0	1,354	0.38
1,812	30.2	1.26	0	4.1	49.1	0	0	0	1,403	0.39
1,824	30.4	1.27	0	4.1	49.1	0	0	0	1,452	0.40
1,836	30.6	1.28	0	4.1	49.1	0	0	0	1,501	0.42
1,848	30.8	1.28	0	4.1	49.1	0	0	0	1,550	0.43
1,860	31.0	1.29	0	4.1	49.1	0	0	0	1,599	0.45
1,872	31.2	1.30	0	4.1	49.1	0	0	0	1,648	0.46
1,884	31.4	1.31	0	4.1	49.1	0	0	0	1,697	0.47
1,896	31.6	1.32	0	4.1	49.1	0	0	0	1,746	0.49
1,908	31.8	1.33	0	4.1	49.1	0	0	0	1,795	0.50
1,920	32.0	1.33	0	4.1	49.1	0	0	0	1,844	0.51
1,932	32.2	1.34	0	4.1	49.1	0	0	0	1,893	0.53
1,944	32.4	1.35	0	4.1	49.1	0	0	0	1,943	0.54
1,956	32.6	1.36	0	4.1	49.1	0	0	0	1,992	0.55
1,968	32.8	1.37	0	4.1	49.1	0	0	0	2,041	0.57
1,980	33.0	1.38	0	4.1	49.1	0	0	0	2,090	0.58
1,992	33.2	1.38	0	4.1	49.1	0	0	0	2,139	0.60
2,004	33.4	1.39	0	4.1	49.1	0	0	0	2,188	0.61
2,016	33.6	1.40	0	4.1	49.1	0	0	0	2,237	0.62
2,028	33.8	1.41	0	4.1	49.1	0	0	0	2,286	0.64
2,040	34.0	1.42	0	4.1	49.1	0	0	0	2,335	0.65
2,052	34.2	1.43	0	4.1	49.1	0	0	0	2,384	0.66
2,064	34.4	1.43	0	4.1	49.1	0	0	0	2,433	0.68
2,076	34.6	1.44	0	4.1	49.1	0	0	0	2,483	0.69
2,088	34.8	1.45	0	4.1	49.1	0	0	0	2,532	0.71
2,100	35.0	1.46	0	4.1	49.1	0	0	0	2,581	0.72
2,112	35.2	1.47	0	4.1	49.1	0	0	0	2,630	0.73
2,124	35.4	1.48	0	4.1	49.1	0	0	0	2,679	0.75
2,136	35.6	1.48	0	4.1	49.1	0	0	0	2,728	0.76
2,148	35.8	1.49	0	4.1	49.1	0	0	0	2,777	0.77

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
2,160	36.0	1.50	0	4.1	49.1	0	0	0	2,826	0.79
2,172	36.2	1.51	0	4.1	49.1	0	0	0	2,875	0.80
2,184	36.4	1.52	0	4.1	49.1	0	0	0	2,924	0.81
2,196	36.6	1.53	0	4.1	49.1	0	0	0	2,973	0.83
2,208	36.8	1.53	0	4.1	49.1	0	0	0	3,023	0.84
2,220	37.0	1.54	0	4.1	49.1	0	0	0	3,072	0.86
2,232	37.2	1.55	0	4.1	49.1	0	0	0	3,121	0.87
2,244	37.4	1.56	0	4.1	49.1	0	0	0	3,170	0.88
2,256	37.6	1.57	0	4.1	49.1	0	0	0	3,219	0.90
2,268	37.8	1.58	0	4.1	49.1	0	0	0	3,268	0.91
2,280	38.0	1.58	0	4.1	49.1	0	0	0	3,317	0.92
2,292	38.2	1.59	0	4.1	49.1	0	0	0	3,366	0.94
2,304	38.4	1.60	0	4.1	49.1	0	0	0	3,415	0.95
2,316	38.6	1.61	0	4.1	49.1	0	0	0	3,464	0.96
2,328	38.8	1.62	0	4.1	49.1	0	0	0	3,513	0.98
2,340	39.0	1.63	0	4.1	49.1	0	0	0	3,562	0.99
2,352	39.2	1.63	0	4.1	49.1	0	0	0	3,612	1.01
2,364	39.4	1.64	0	4.1	49.1	100	0	1,200	2,461	0.69
2,376	39.6	1.65	0	4.1	49.1	100	0	1,200	1,310	0.36
2,388	39.8	1.66	0	4.1	49.1	0	0	0	1,359	0.38
2,400	40.0	1.67	0	4.1	49.1	0	0	0	1,408	0.39
2,412	40.2	1.68	0	4.1	49.1	0	0	0	1,457	0.41
2,424	40.4	1.68	0	4.1	49.1	0	0	0	1,506	0.42
2,436	40.6	1.69	0	4.1	49.1	0	0	0	1,555	0.43
2,448	40.8	1.70	0	4.1	49.1	0	0	0	1,604	0.45
2,460	41.0	1.71	0	4.1	49.1	0	0	0	1,653	0.46
2,472	41.2	1.72	0	4.1	49.1	0	0	0	1,702	0.47
2,484	41.4	1.73	0	4.1	49.1	0	0	0	1,752	0.49
2,496	41.6	1.73	0	4.1	49.1	0	0	0	1,801	0.50
2,508	41.8	1.74	0	4.1	49.1	0	0	0	1,850	0.52
2,520	42.0	1.75	0	4.1	49.1	0	0	0	1,899	0.53
2,532	42.2	1.76	0	4.1	49.1	0	0	0	1,948	0.54
2,544	42.4	1.77	0	4.1	49.1	0	0	0	1,997	0.56
2,556	42.6	1.78	0	4.1	49.1	0	0	0	2,046	0.57
2,568	42.8	1.78	0	4.1	49.1	0	0	0	2,095	0.58
2,580	43.0	1.79	0	4.1	49.1	0	0	0	2,144	0.60
2,592	43.2	1.80	0	4.1	49.1	0	0	0	2,193	0.61
2,604	43.4	1.81	0	4.1	49.1	0	0	0	2,242	0.62
2,616	43.6	1.82	0	4.1	49.1	0	0	0	2,291	0.64
2,628	43.8	1.83	0	4.1	49.1	0	0	0	2,341	0.65
2,640	44.0	1.83	0	4.1	49.1	0	0	0	2,390	0.67
2,652	44.2	1.84	0	4.1	49.1	0	0	0	2,439	0.68
2,664	44.4	1.85	0	4.1	49.1	0	0	0	2,488	0.69
2,676	44.6	1.86	0	4.1	49.1	0	0	0	2,537	0.71
2,688	44.8	1.87	0	4.1	49.1	0	0	0	2,586	0.72
2,700	45.0	1.88	0	4.1	49.1	0	0	0	2,635	0.73
2,712	45.2	1.88	0	4.1	49.1	0	0	0	2,684	0.75
2,724	45.4	1.89	0	4.1	49.1	0	0	0	2,733	0.76
2,736	45.6	1.90	0	4.1	49.1	0	0	0	2,782	0.77
2,748	45.8	1.91	0	4.1	49.1	0	0	0	2,831	0.79
2,760	46.0	1.92	0	4.1	49.1	0	0	0	2,881	0.80
2,772	46.2	1.93	0	4.1	49.1	0	0	0	2,930	0.82
2,784	46.4	1.93	0	4.1	49.1	0	0	0	2,979	0.83
2,796	46.6	1.94	0	4.1	49.1	0	0	0	3,028	0.84
2,808	46.8	1.95	0	4.1	49.1	0	0	0	3,077	0.86
2,820	47.0	1.96	0	4.1	49.1	0	0	0	3,126	0.87
2,832	47.2	1.97	0	4.1	49.1	0	0	0	3,175	0.88
2,844	47.4	1.98	0	4.1	49.1	0	0	0	3,224	0.90
2,856	47.6	1.98	0	4.1	49.1	0	0	0	3,273	0.91
2,868	47.8	1.99	0	4.1	49.1	0	0	0	3,322	0.93

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
2,880	48.0	2.00	0	4.1	49.1	0	0	0	3,371	0.94
2,892	48.2	2.01	0	4.1	49.1	0	0	0	3,420	0.95
2,904	48.4	2.02	0	4.1	49.1	0	0	0	3,470	0.97
2,916	48.6	2.03	0	4.1	49.1	0	0	0	3,519	0.98
2,928	48.8	2.03	0	4.1	49.1	0	0	0	3,568	0.99
2,940	49.0	2.04	0	4.1	49.1	0	0	0	3,617	1.01
2,952	49.2	2.05	0	4.1	49.1	100	0	1,200	2,466	0.69
2,964	49.4	2.06	0	4.1	49.1	100	0	1,200	1,315	0.37
2,976	49.6	2.07	0	4.1	49.1	0	0	0	1,364	0.38
2,988	49.8	2.08	0	4.1	49.1	0	0	0	1,413	0.39
3,000	50.0	2.08	0	4.1	49.1	0	0	0	1,462	0.41
3,012	50.2	2.09	0	4.1	49.1	0	0	0	1,511	0.42
3,024	50.4	2.10	0	4.1	49.1	0	0	0	1,560	0.43
3,036	50.6	2.11	0	4.1	49.1	0	0	0	1,610	0.45
3,048	50.8	2.12	0	4.1	49.1	0	0	0	1,659	0.46
3,060	51.0	2.13	0	4.1	49.1	0	0	0	1,708	0.48
3,072	51.2	2.13	0	4.1	49.1	0	0	0	1,757	0.49
3,084	51.4	2.14	0	4.1	49.1	0	0	0	1,806	0.50
3,096	51.6	2.15	0	4.1	49.1	0	0	0	1,855	0.52
3,108	51.8	2.16	0	4.1	49.1	0	0	0	1,904	0.53
3,120	52.0	2.17	0	4.1	49.1	0	0	0	1,953	0.54
3,132	52.2	2.18	0	4.1	49.1	0	0	0	2,002	0.56
3,144	52.4	2.18	0	4.1	49.1	0	0	0	2,051	0.57
3,156	52.6	2.19	0	4.1	49.1	0	0	0	2,100	0.59
3,168	52.8	2.20	0	4.1	49.1	0	0	0	2,150	0.60
3,180	53.0	2.21	0	4.1	49.1	0	0	0	2,199	0.61
3,192	53.2	2.22	0	4.1	49.1	0	0	0	2,248	0.63
3,204	53.4	2.23	0	4.1	49.1	0	0	0	2,297	0.64
3,216	53.6	2.23	0	4.1	49.1	0	0	0	2,346	0.65
3,228	53.8	2.24	0	4.1	49.1	0	0	0	2,395	0.67
3,240	54.0	2.25	0	4.1	49.1	0	0	0	2,444	0.68
3,252	54.2	2.26	0	4.1	49.1	0	0	0	2,493	0.69
3,264	54.4	2.27	0	4.1	49.1	0	0	0	2,542	0.71
3,276	54.6	2.28	0	4.1	49.1	0	0	0	2,591	0.72
3,288	54.8	2.28	0	4.1	49.1	0	0	0	2,640	0.74
3,300	55.0	2.29	0	4.1	49.1	0	0	0	2,689	0.75
3,312	55.2	2.30	0	4.1	49.1	0	0	0	2,739	0.76
3,324	55.4	2.31	0	4.1	49.1	0	0	0	2,788	0.78
3,336	55.6	2.32	0	4.1	49.1	0	0	0	2,837	0.79
3,348	55.8	2.33	0	4.1	49.1	0	0	0	2,886	0.80
3,360	56.0	2.33	0	4.1	49.1	0	0	0	2,935	0.82
3,372	56.2	2.34	0	4.1	49.1	0	0	0	2,984	0.83
3,384	56.4	2.35	0	4.1	49.1	0	0	0	3,033	0.84
3,396	56.6	2.36	0	4.1	49.1	0	0	0	3,082	0.86
3,408	56.8	2.37	0	4.1	49.1	0	0	0	3,131	0.87
3,420	57.0	2.38	0	4.1	49.1	0	0	0	3,180	0.89
3,432	57.2	2.38	0	4.1	49.1	0	0	0	3,229	0.90
3,444	57.4	2.39	0	4.1	49.1	0	0	0	3,279	0.91
3,456	57.6	2.40	0	4.1	49.1	0	0	0	3,328	0.93
3,468	57.8	2.41	0	4.1	49.1	0	0	0	3,377	0.94
3,480	58.0	2.42	0	4.1	49.1	0	0	0	3,426	0.95
3,492	58.2	2.43	0	4.1	49.1	0	0	0	3,475	0.97
3,504	58.4	2.43	0	4.1	49.1	0	0	0	3,524	0.98
3,516	58.6	2.44	0	4.1	49.1	0	0	0	3,573	1.00
3,528	58.8	2.45	0	4.1	49.1	0	0	0	3,622	1.01
3,540	59.0	2.46	0	4.1	49.1	100	0	1,200	2,471	0.69
3,552	59.2	2.47	0	4.1	49.1	100	0	1,200	1,320	0.37
3,564	59.4	2.48	0	4.1	49.1	0	0	0	1,369	0.38
3,576	59.6	2.48	0	4.1	49.1	0	0	0	1,418	0.40
3,588	59.8	2.49	0	4.1	49.1	0	0	0	1,468	0.41

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,600	60.0	2.50	0	4.1	49.1	0	0	0	1,517	0.42
3,612	60.2	2.51	0	4.1	49.1	0	0	0	1,566	0.44
3,624	60.4	2.52	0	4.1	49.1	0	0	0	1,615	0.45
3,636	60.6	2.53	0	4.1	49.1	0	0	0	1,664	0.46
3,648	60.8	2.53	0	4.1	49.1	0	0	0	1,713	0.48
3,660	61.0	2.54	0	4.1	49.1	0	0	0	1,762	0.49
3,672	61.2	2.55	0	4.1	49.1	0	0	0	1,811	0.50
3,684	61.4	2.56	0	4.1	49.1	0	0	0	1,860	0.52
3,696	61.6	2.57	0	4.1	49.1	0	0	0	1,909	0.53
3,708	61.8	2.58	0	4.1	49.1	0	0	0	1,958	0.55
3,720	62.0	2.58	0	4.1	49.1	0	0	0	2,008	0.56
3,732	62.2	2.59	0	4.1	49.1	0	0	0	2,057	0.57
3,744	62.4	2.60	0	4.1	49.1	0	0	0	2,106	0.59
3,756	62.6	2.61	0	4.1	49.1	0	0	0	2,155	0.60
3,768	62.8	2.62	0	4.1	49.1	0	0	0	2,204	0.61
3,780	63.0	2.63	0	4.1	49.1	0	0	0	2,253	0.63
3,792	63.2	2.63	0	4.1	49.1	0	0	0	2,302	0.64
3,804	63.4	2.64	0	4.1	49.1	0	0	0	2,351	0.65
3,816	63.6	2.65	0	4.1	49.1	0	0	0	2,400	0.67
3,828	63.8	2.66	0	4.1	49.1	0	0	0	2,449	0.68
3,840	64.0	2.67	0	4.1	49.1	0	0	0	2,498	0.70
3,852	64.2	2.68	0	4.1	49.1	0	0	0	2,547	0.71
3,864	64.4	2.68	0	4.1	49.1	0	0	0	2,597	0.72
3,876	64.6	2.69	0	4.1	49.1	0	0	0	2,646	0.74
3,888	64.8	2.70	0	4.1	49.1	0	0	0	2,695	0.75
3,900	65.0	2.71	0	4.1	49.1	0	0	0	2,744	0.76
3,912	65.2	2.72	0	4.1	49.1	0	0	0	2,793	0.78
3,924	65.4	2.73	0	4.1	49.1	0	0	0	2,842	0.79
3,936	65.6	2.73	0	4.1	49.1	0	0	0	2,891	0.81
3,948	65.8	2.74	0	4.1	49.1	0	0	0	2,940	0.82
3,960	66.0	2.75	0	4.1	49.1	0	0	0	2,989	0.83
3,972	66.2	2.76	0	4.1	49.1	0	0	0	3,038	0.85
3,984	66.4	2.77	0	4.1	49.1	0	0	0	3,087	0.86
3,996	66.6	2.78	0	4.1	49.1	0	0	0	3,137	0.87
4,008	66.8	2.78	0	4.1	49.1	0	0	0	3,186	0.89
4,020	67.0	2.79	0	4.1	49.1	0	0	0	3,235	0.90
4,032	67.2	2.80	0	4.1	49.1	0	0	0	3,284	0.91
4,044	67.4	2.81	0	4.1	49.1	0	0	0	3,333	0.93
4,056	67.6	2.82	0	4.1	49.1	0	0	0	3,382	0.94
4,068	67.8	2.83	0	4.1	49.1	0	0	0	3,431	0.96
4,080	68.0	2.83	0	4.1	49.1	0	0	0	3,480	0.97
4,092	68.2	2.84	0	4.1	49.1	0	0	0	3,529	0.98
4,104	68.4	2.85	0	4.1	49.1	0	0	0	3,578	1.00
4,116	68.6	2.86	0	4.1	49.1	0	0	0	3,627	1.01
4,128	68.8	2.87	0	4.1	49.1	100	0	1,200	2,477	0.69
4,140	69.0	2.88	0	4.1	49.1	100	0	1,200	1,326	0.37
4,152	69.2	2.88	0	4.1	49.1	0	0	0	1,375	0.38
4,164	69.4	2.89	0	4.1	49.1	0	0	0	1,424	0.40
4,176	69.6	2.90	0	4.1	49.1	0	0	0	1,473	0.41
4,188	69.8	2.91	0	4.1	49.1	0	0	0	1,522	0.42
4,200	70.0	2.92	0	4.1	49.1	0	0	0	1,571	0.44
4,212	70.2	2.93	0	4.1	49.1	0	0	0	1,620	0.45
4,224	70.4	2.93	0	4.1	49.1	0	0	0	1,669	0.46
4,236	70.6	2.94	0	4.1	49.1	0	0	0	1,718	0.48
4,248	70.8	2.95	0	4.1	49.1	0	0	0	1,767	0.49
4,260	71.0	2.96	0	4.1	49.1	0	0	0	1,816	0.51
4,272	71.2	2.97	0	4.1	49.1	0	0	0	1,866	0.52
4,284	71.4	2.98	0	4.1	49.1	0	0	0	1,915	0.53
4,296	71.6	2.98	0	4.1	49.1	0	0	0	1,964	0.55
4,308	71.8	2.99	0	4.1	49.1	0	0	0	2,013	0.56

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,320	72.0	3.00	0	4.1	49.1	0	0	0	2,062	0.57
4,332	72.2	3.01	0	4.1	49.1	0	0	0	2,111	0.59
4,344	72.4	3.02	0	4.1	49.1	0	0	0	2,160	0.60
4,356	72.6	3.03	0	4.1	49.1	0	0	0	2,209	0.62
4,368	72.8	3.03	0	4.1	49.1	0	0	0	2,258	0.63
4,380	73.0	3.04	0	4.1	49.1	0	0	0	2,307	0.64
4,392	73.2	3.05	0	4.1	49.1	0	0	0	2,356	0.66
4,404	73.4	3.06	0	4.1	49.1	0	0	0	2,406	0.67
4,416	73.6	3.07	0	4.1	49.1	0	0	0	2,455	0.68
4,428	73.8	3.08	0	4.1	49.1	0	0	0	2,504	0.70
4,440	74.0	3.08	0	4.1	49.1	0	0	0	2,553	0.71
4,452	74.2	3.09	0	4.1	49.1	0	0	0	2,602	0.72
4,464	74.4	3.10	0	4.1	49.1	0	0	0	2,651	0.74
4,476	74.6	3.11	0	4.1	49.1	0	0	0	2,700	0.75
4,488	74.8	3.12	0	4.1	49.1	0	0	0	2,749	0.77
4,500	75.0	3.13	0	4.1	49.1	0	0	0	2,798	0.78
4,512	75.2	3.13	0	4.1	49.1	0	0	0	2,847	0.79
4,524	75.4	3.14	0	4.1	49.1	0	0	0	2,896	0.81
4,536	75.6	3.15	0	4.1	49.1	0	0	0	2,945	0.82
4,548	75.8	3.16	0	4.1	49.1	0	0	0	2,995	0.83
4,560	76.0	3.17	0	4.1	49.1	0	0	0	3,044	0.85
4,572	76.2	3.18	0	4.1	49.1	0	0	0	3,093	0.86
4,584	76.4	3.18	0	4.1	49.1	0	0	0	3,142	0.88
4,596	76.6	3.19	0	4.1	49.1	0	0	0	3,191	0.89
4,608	76.8	3.20	0	4.1	49.1	0	0	0	3,240	0.90
4,620	77.0	3.21	0	4.1	49.1	0	0	0	3,289	0.92
4,632	77.2	3.22	0	4.1	49.1	0	0	0	3,338	0.93
4,644	77.4	3.23	0	4.1	49.1	0	0	0	3,387	0.94
4,656	77.6	3.23	0	4.1	49.1	0	0	0	3,436	0.96
4,668	77.8	3.24	0	4.1	49.1	0	0	0	3,485	0.97
4,680	78.0	3.25	0	4.1	49.1	0	0	0	3,535	0.98
4,692	78.2	3.26	0	4.1	49.1	0	0	0	3,584	1.00
4,704	78.4	3.27	0	4.1	49.1	0	0	0	3,633	1.01
4,716	78.6	3.28	0	4.1	49.1	100	0	1,200	2,482	0.69
4,728	78.8	3.28	0	4.1	49.1	100	0	1,200	1,331	0.37
4,740	79.0	3.29	0	4.1	49.1	0	0	0	1,380	0.38
4,752	79.2	3.30	0	4.1	49.1	0	0	0	1,429	0.40
4,764	79.4	3.31	0	4.1	49.1	0	0	0	1,478	0.41
4,776	79.6	3.32	0	4.1	49.1	0	0	0	1,527	0.43
4,788	79.8	3.33	0	4.1	49.1	0	0	0	1,576	0.44
4,800	80.0	3.33	0	4.1	49.1	0	0	0	1,625	0.45
4,812	80.2	3.34	0	4.1	49.1	0	0	0	1,674	0.47
4,824	80.4	3.35	0	4.1	49.1	0	0	0	1,724	0.48
4,836	80.6	3.36	0	4.1	49.1	0	0	0	1,773	0.49
4,848	80.8	3.37	0	4.1	49.1	0	0	0	1,822	0.51
4,860	81.0	3.38	0	4.1	49.1	0	0	0	1,871	0.52
4,872	81.2	3.38	0	4.1	49.1	0	0	0	1,920	0.53
4,884	81.4	3.39	0	4.1	49.1	0	0	0	1,969	0.55
4,896	81.6	3.40	0	4.1	49.1	0	0	0	2,018	0.56
4,908	81.8	3.41	0	4.1	49.1	0	0	0	2,067	0.58
4,920	82.0	3.42	0	4.1	49.1	0	0	0	2,116	0.59
4,932	82.2	3.43	0	4.1	49.1	0	0	0	2,165	0.60
4,944	82.4	3.43	0	4.1	49.1	0	0	0	2,214	0.62
4,956	82.6	3.44	0	4.1	49.1	0	0	0	2,264	0.63
4,968	82.8	3.45	0	4.1	49.1	0	0	0	2,313	0.64
4,980	83.0	3.46	0	4.1	49.1	0	0	0	2,362	0.66
4,992	83.2	3.47	0	4.1	49.1	0	0	0	2,411	0.67
5,004	83.4	3.48	0	4.1	49.1	0	0	0	2,460	0.69
5,016	83.6	3.48	0	4.1	49.1	0	0	0	2,509	0.70
5,028	83.8	3.49	0	4.1	49.1	0	0	0	2,558	0.71

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,040	84.0	3.50	0	4.1	49.1	0	0	0	2,607	0.73
5,052	84.2	3.51	0	4.1	49.1	0	0	0	2,656	0.74
5,064	84.4	3.52	0	4.1	49.1	0	0	0	2,705	0.75
5,076	84.6	3.53	0	4.1	49.1	0	0	0	2,754	0.77
5,088	84.8	3.53	0	4.1	49.1	0	0	0	2,804	0.78
5,100	85.0	3.54	0	4.1	49.1	0	0	0	2,853	0.79
5,112	85.2	3.55	0	4.1	49.1	0	0	0	2,902	0.81
5,124	85.4	3.56	0	4.1	49.1	0	0	0	2,951	0.82
5,136	85.6	3.57	0	4.1	49.1	0	0	0	3,000	0.84
5,148	85.8	3.58	0	4.1	49.1	0	0	0	3,049	0.85
5,160	86.0	3.58	0	4.1	49.1	0	0	0	3,098	0.86
5,172	86.2	3.59	0	4.1	49.1	0	0	0	3,147	0.88
5,184	86.4	3.60	0	4.1	49.1	0	0	0	3,196	0.89
5,196	86.6	3.61	0	4.1	49.1	0	0	0	3,245	0.90
5,208	86.8	3.62	0	4.1	49.1	0	0	0	3,294	0.92
5,220	87.0	3.63	0	4.1	49.1	0	0	0	3,343	0.93
5,232	87.2	3.63	0	4.1	49.1	0	0	0	3,393	0.94
5,244	87.4	3.64	0	4.1	49.1	0	0	0	3,442	0.96
5,256	87.6	3.65	0	4.1	49.1	0	0	0	3,491	0.97
5,268	87.8	3.66	0	4.1	49.1	0	0	0	3,540	0.99
5,280	88.0	3.67	0	4.1	49.1	0	0	0	3,589	1.00
5,292	88.2	3.68	0	4.1	49.1	0	0	0	3,638	1.01
5,304	88.4	3.68	0	4.1	49.1	100	0	1,200	2,487	0.69
5,316	88.6	3.69	0	4.1	49.1	100	0	1,200	1,336	0.37
5,328	88.8	3.70	0	4.1	49.1	0	0	0	1,385	0.39
5,340	89.0	3.71	0	4.1	49.1	0	0	0	1,434	0.40
5,352	89.2	3.72	0	4.1	49.1	0	0	0	1,483	0.41
5,364	89.4	3.73	0	4.1	49.1	0	0	0	1,533	0.43
5,376	89.6	3.73	0	4.1	49.1	0	0	0	1,582	0.44
5,388	89.8	3.74	0	4.1	49.1	0	0	0	1,631	0.45
5,400	90.0	3.75	0	4.1	49.1	0	0	0	1,680	0.47
5,412	90.2	3.76	0	4.1	49.1	0	0	0	1,729	0.48
5,424	90.4	3.77	0	4.1	49.1	0	0	0	1,778	0.50
5,436	90.6	3.78	0	4.1	49.1	0	0	0	1,827	0.51
5,448	90.8	3.78	0	4.1	49.1	0	0	0	1,876	0.52
5,460	91.0	3.79	0	4.1	49.1	0	0	0	1,925	0.54
5,472	91.2	3.80	0	4.1	49.1	0	0	0	1,974	0.55
5,484	91.4	3.81	0	4.1	49.1	0	0	0	2,023	0.56
5,496	91.6	3.82	0	4.1	49.1	0	0	0	2,072	0.58
5,508	91.8	3.83	0	4.1	49.1	0	0	0	2,122	0.59
5,520	92.0	3.83	0	4.1	49.1	0	0	0	2,171	0.60
5,532	92.2	3.84	0	4.1	49.1	0	0	0	2,220	0.62
5,544	92.4	3.85	0	4.1	49.1	0	0	0	2,269	0.63
5,556	92.6	3.86	0	4.1	49.1	0	0	0	2,318	0.65
5,568	92.8	3.87	0	4.1	49.1	0	0	0	2,367	0.66
5,580	93.0	3.88	0	4.1	49.1	0	0	0	2,416	0.67
5,592	93.2	3.88	0	4.1	49.1	0	0	0	2,465	0.69
5,604	93.4	3.89	0	4.1	49.1	0	0	0	2,514	0.70
5,616	93.6	3.90	0	4.1	49.1	0	0	0	2,563	0.71
5,628	93.8	3.91	0	4.1	49.1	0	0	0	2,612	0.73
5,640	94.0	3.92	0	4.1	49.1	0	0	0	2,662	0.74
5,652	94.2	3.93	0	4.1	49.1	0	0	0	2,711	0.75
5,664	94.4	3.93	0	4.1	49.1	0	0	0	2,760	0.77
5,676	94.6	3.94	0	4.1	49.1	0	0	0	2,809	0.78
5,688	94.8	3.95	0	4.1	49.1	0	0	0	2,858	0.80
5,700	95.0	3.96	0	4.1	49.1	0	0	0	2,907	0.81
5,712	95.2	3.97	0	4.1	49.1	0	0	0	2,956	0.82
5,724	95.4	3.98	0	4.1	49.1	0	0	0	3,005	0.84
5,736	95.6	3.98	0	4.1	49.1	0	0	0	3,054	0.85
5,748	95.8	3.99	0	4.1	49.1	0	0	0	3,103	0.86

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,760	96.0	4.00	0	4.1	49.1	0	0	0	3,152	0.88
5,772	96.2	4.01	0	4.1	49.1	0	0	0	3,201	0.89
5,784	96.4	4.02	0	4.1	49.1	0	0	0	3,251	0.91
5,796	96.6	4.03	0	4.1	49.1	0	0	0	3,300	0.92
5,808	96.8	4.03	0	4.1	49.1	0	0	0	3,349	0.93
5,820	97.0	4.04	0	4.1	49.1	0	0	0	3,398	0.95
5,832	97.2	4.05	0	4.1	49.1	0	0	0	3,447	0.96
5,844	97.4	4.06	0	4.1	49.1	0	0	0	3,496	0.97
5,856	97.6	4.07	0	4.1	49.1	0	0	0	3,545	0.99
5,868	97.8	4.08	0	4.1	49.1	0	0	0	3,594	1.00
5,880	98.0	4.08	0	4.1	49.1	100	0	1,200	2,443	0.68
5,892	98.2	4.09	0	4.1	49.1	100	0	1,200	1,292	0.36
5,904	98.4	4.10	0	4.1	49.1	0	0	0	1,341	0.37
5,916	98.6	4.11	0	4.1	49.1	0	0	0	1,391	0.39
5,928	98.8	4.12	0	4.1	49.1	0	0	0	1,440	0.40
5,940	99.0	4.13	0	4.1	49.1	0	0	0	1,489	0.41
5,952	99.2	4.13	0	4.1	49.1	0	0	0	1,538	0.43
5,964	99.4	4.14	0	4.1	49.1	0	0	0	1,587	0.44
5,976	99.6	4.15	0	4.1	49.1	0	0	0	1,636	0.46
5,988	99.8	4.16	0	4.1	49.1	0	0	0	1,685	0.47
6,000	100.0	4.17	0	4.1	49.1	0	0	0	1,734	0.48
6,012	100.2	4.18	0	4.1	49.1	0	0	0	1,783	0.50
6,024	100.4	4.18	0	4.1	49.1	0	0	0	1,832	0.51
6,036	100.6	4.19	0	4.1	49.1	0	0	0	1,881	0.52
6,048	100.8	4.20	0	4.1	49.1	0	0	0	1,931	0.54
6,060	101.0	4.21	0	4.1	49.1	0	0	0	1,980	0.55
6,072	101.2	4.22	0	4.1	49.1	0	0	0	2,029	0.57
6,084	101.4	4.23	0	4.1	49.1	0	0	0	2,078	0.58
6,096	101.6	4.23	0	4.1	49.1	0	0	0	2,127	0.59
6,108	101.8	4.24	0	4.1	49.1	0	0	0	2,176	0.61
6,120	102.0	4.25	0	4.1	49.1	0	0	0	2,225	0.62
6,132	102.2	4.26	0	4.1	49.1	0	0	0	2,274	0.63
6,144	102.4	4.27	0	4.1	49.1	0	0	0	2,323	0.65
6,156	102.6	4.28	0	4.1	49.1	0	0	0	2,372	0.66
6,168	102.8	4.28	0	4.1	49.1	0	0	0	2,421	0.67
6,180	103.0	4.29	0	4.1	49.1	0	0	0	2,470	0.69
6,192	103.2	4.30	0	4.1	49.1	0	0	0	2,520	0.70
6,204	103.4	4.31	0	4.1	49.1	0	0	0	2,569	0.72
6,216	103.6	4.32	0	4.1	49.1	0	0	0	2,618	0.73
6,228	103.8	4.33	0	4.1	49.1	0	0	0	2,667	0.74
6,240	104.0	4.33	0	4.1	49.1	0	0	0	2,716	0.76
6,252	104.2	4.34	0	4.1	49.1	0	0	0	2,765	0.77
6,264	104.4	4.35	0	4.1	49.1	0	0	0	2,814	0.78
6,276	104.6	4.36	0	4.1	49.1	0	0	0	2,863	0.80
6,288	104.8	4.37	0	4.1	49.1	0	0	0	2,912	0.81
6,300	105.0	4.38	0	4.1	49.1	0	0	0	2,961	0.82
6,312	105.2	4.38	0	4.1	49.1	0	0	0	3,010	0.84
6,324	105.4	4.39	0	4.1	49.1	0	0	0	3,060	0.85
6,336	105.6	4.40	0	4.1	49.1	0	0	0	3,109	0.87
6,348	105.8	4.41	0	4.1	49.1	0	0	0	3,158	0.88
6,360	106.0	4.42	0	4.1	49.1	0	0	0	3,207	0.89
6,372	106.2	4.43	0	4.1	49.1	0	0	0	3,256	0.91
6,384	106.4	4.43	0	4.1	49.1	0	0	0	3,305	0.92
6,396	106.6	4.44	0	4.1	49.1	0	0	0	3,354	0.93
6,408	106.8	4.45	0	4.1	49.1	0	0	0	3,403	0.95
6,420	107.0	4.46	0	4.1	49.1	0	0	0	3,452	0.96
6,432	107.2	4.47	0	4.1	49.1	0	0	0	3,501	0.98
6,444	107.4	4.48	0	4.1	49.1	0	0	0	3,550	0.99
6,456	107.6	4.48	0	4.1	49.1	0	0	0	3,599	1.00
6,468	107.8	4.49	0	4.1	49.1	100	0	1,200	2,449	0.68

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,480	108.0	4.50	0	4.1	49.1	100	0	1,200	1,298	0.36
6,492	108.2	4.51	0	4.1	49.1	0	0	0	1,347	0.38
6,504	108.4	4.52	0	4.1	49.1	0	0	0	1,396	0.39
6,516	108.6	4.53	0	4.1	49.1	0	0	0	1,445	0.40
6,528	108.8	4.53	0	4.1	49.1	0	0	0	1,494	0.42
6,540	109.0	4.54	0	4.1	49.1	0	0	0	1,543	0.43
6,552	109.2	4.55	0	4.1	49.1	0	0	0	1,592	0.44
6,564	109.4	4.56	0	4.1	49.1	0	0	0	1,641	0.46
6,576	109.6	4.57	0	4.1	49.1	0	0	0	1,690	0.47
6,588	109.8	4.58	0	4.1	49.1	0	0	0	1,739	0.48
6,600	110.0	4.58	0	4.1	49.1	0	0	0	1,789	0.50
6,612	110.2	4.59	0	4.1	49.1	0	0	0	1,838	0.51
6,624	110.4	4.60	0	4.1	49.1	0	0	0	1,887	0.53
6,636	110.6	4.61	0	4.1	49.1	0	0	0	1,936	0.54
6,648	110.8	4.62	0	4.1	49.1	0	0	0	1,985	0.55
6,660	111.0	4.63	0	4.1	49.1	0	0	0	2,034	0.57
6,672	111.2	4.63	0	4.1	49.1	0	0	0	2,083	0.58
6,684	111.4	4.64	0	4.1	49.1	0	0	0	2,132	0.59
6,696	111.6	4.65	0	4.1	49.1	0	0	0	2,181	0.61
6,708	111.8	4.66	0	4.1	49.1	0	0	0	2,230	0.62
6,720	112.0	4.67	0	4.1	49.1	0	0	0	2,279	0.63
6,732	112.2	4.68	0	4.1	49.1	0	0	0	2,328	0.65
6,744	112.4	4.68	0	4.1	49.1	0	0	0	2,378	0.66
6,756	112.6	4.69	0	4.1	49.1	0	0	0	2,427	0.68
6,768	112.8	4.70	0	4.1	49.1	0	0	0	2,476	0.69
6,780	113.0	4.71	0	4.1	49.1	0	0	0	2,525	0.70
6,792	113.2	4.72	0	4.1	49.1	0	0	0	2,574	0.72
6,804	113.4	4.73	0	4.1	49.1	0	0	0	2,623	0.73
6,816	113.6	4.73	0	4.1	49.1	0	0	0	2,672	0.74
6,828	113.8	4.74	0	4.1	49.1	0	0	0	2,721	0.76
6,840	114.0	4.75	0	4.1	49.1	0	0	0	2,770	0.77
6,852	114.2	4.76	0	4.1	49.1	0	0	0	2,819	0.79
6,864	114.4	4.77	0	4.1	49.1	0	0	0	2,868	0.80
6,876	114.6	4.78	0	4.1	49.1	0	0	0	2,918	0.81
6,888	114.8	4.78	0	4.1	49.1	0	0	0	2,967	0.83
6,900	115.0	4.79	0	4.1	49.1	0	0	0	3,016	0.84
6,912	115.2	4.80	0	4.1	49.1	0	0	0	3,065	0.85
6,924	115.4	4.81	0	4.1	49.1	0	0	0	3,114	0.87
6,936	115.6	4.82	0	4.1	49.1	0	0	0	3,163	0.88
6,948	115.8	4.83	0	4.1	49.1	0	0	0	3,212	0.89
6,960	116.0	4.83	0	4.1	49.1	0	0	0	3,261	0.91
6,972	116.2	4.84	0	4.1	49.1	0	0	0	3,310	0.92
6,984	116.4	4.85	0	4.1	49.1	0	0	0	3,359	0.94
6,996	116.6	4.86	0	4.1	49.1	0	0	0	3,408	0.95
7,008	116.8	4.87	0	4.1	49.1	0	0	0	3,458	0.96
7,020	117.0	4.88	0	4.1	49.1	0	0	0	3,507	0.98
7,032	117.2	4.88	0	4.1	49.1	0	0	0	3,556	0.99
7,044	117.4	4.89	0	4.1	49.1	0	0	0	3,605	1.00
7,056	117.6	4.90	0	4.1	49.1	100	0	1,200	2,454	0.68
7,068	117.8	4.91	0	4.1	49.1	100	0	1,200	1,303	0.36
7,080	118.0	4.92	0	4.1	49.1	0	0	0	1,352	0.38
7,092	118.2	4.93	0	4.1	49.1	0	0	0	1,401	0.39
7,104	118.4	4.93	0	4.1	49.1	0	0	0	1,450	0.40
7,116	118.6	4.94	0	4.1	49.1	0	0	0	1,499	0.42
7,128	118.8	4.95	0	4.1	49.1	0	0	0	1,548	0.43
7,140	119.0	4.96	0	4.1	49.1	0	0	0	1,597	0.44
7,152	119.2	4.97	0	4.1	49.1	0	0	0	1,647	0.46
7,164	119.4	4.98	0	4.1	49.1	0	0	0	1,696	0.47
7,176	119.6	4.98	0	4.1	49.1	0	0	0	1,745	0.49
7,188	119.8	4.99	0	4.1	49.1	0	0	0	1,794	0.50

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,200	120.0	5.00	0	4.1	49.1	0	0	0	1,843	0.51
7,212	120.2	5.01	0	4.1	49.1	0	0	0	1,892	0.53
7,224	120.4	5.02	0	4.1	49.1	0	0	0	1,941	0.54
7,236	120.6	5.03	0	4.1	49.1	0	0	0	1,990	0.55
7,248	120.8	5.03	0	4.1	49.1	0	0	0	2,039	0.57
7,260	121.0	5.04	0	4.1	49.1	0	0	0	2,088	0.58
7,272	121.2	5.05	0	4.1	49.1	0	0	0	2,137	0.60
7,284	121.4	5.06	0	4.1	49.1	0	0	0	2,187	0.61
7,296	121.6	5.07	0	4.1	49.1	0	0	0	2,236	0.62
7,308	121.8	5.08	0	4.1	49.1	0	0	0	2,285	0.64
7,320	122.0	5.08	0	4.1	49.1	0	0	0	2,334	0.65
7,332	122.2	5.09	0	4.1	49.1	0	0	0	2,383	0.66
7,344	122.4	5.10	0	4.1	49.1	0	0	0	2,432	0.68
7,356	122.6	5.11	0	4.1	49.1	0	0	0	2,481	0.69
7,368	122.8	5.12	0	4.1	49.1	0	0	0	2,530	0.70
7,380	123.0	5.13	0	4.1	49.1	0	0	0	2,579	0.72
7,392	123.2	5.13	0	4.1	49.1	0	0	0	2,628	0.73
7,404	123.4	5.14	0	4.1	49.1	0	0	0	2,677	0.75
7,416	123.6	5.15	0	4.1	49.1	0	0	0	2,726	0.76
7,428	123.8	5.16	0	4.1	49.1	0	0	0	2,776	0.77
7,440	124.0	5.17	0	4.1	49.1	0	0	0	2,825	0.79
7,452	124.2	5.18	0	4.1	49.1	0	0	0	2,874	0.80
7,464	124.4	5.18	0	4.1	49.1	0	0	0	2,923	0.81
7,476	124.6	5.19	0	4.1	49.1	0	0	0	2,972	0.83
7,488	124.8	5.20	0	4.1	49.1	0	0	0	3,021	0.84
7,500	125.0	5.21	0	4.1	49.1	0	0	0	3,070	0.86
7,512	125.2	5.22	0	4.1	49.1	0	0	0	3,119	0.87
7,524	125.4	5.23	0	4.1	49.1	0	0	0	3,168	0.88
7,536	125.6	5.23	0	4.1	49.1	0	0	0	3,217	0.90
7,548	125.8	5.24	0	4.1	49.1	0	0	0	3,266	0.91
7,560	126.0	5.25	0	4.1	49.1	0	0	0	3,316	0.92
7,572	126.2	5.26	0	4.1	49.1	0	0	0	3,365	0.94
7,584	126.4	5.27	0	4.1	49.1	0	0	0	3,414	0.95
7,596	126.6	5.28	0	4.1	49.1	0	0	0	3,463	0.96
7,608	126.8	5.28	0	4.1	49.1	0	0	0	3,512	0.98
7,620	127.0	5.29	0	4.1	49.1	0	0	0	3,561	0.99
7,632	127.2	5.30	0	4.1	49.1	0	0	0	3,610	1.01
7,644	127.4	5.31	0	4.1	49.1	100	0	1,200	2,459	0.68
7,656	127.6	5.32	0	4.1	49.1	100	0	1,200	1,308	0.36
7,668	127.8	5.33	0	4.1	49.1	0	0	0	1,357	0.38
7,680	128.0	5.33	0	4.1	49.1	0	0	0	1,406	0.39
7,692	128.2	5.34	0	4.1	49.1	0	0	0	1,455	0.41
7,704	128.4	5.35	0	4.1	49.1	0	0	0	1,505	0.42
7,716	128.6	5.36	0	4.1	49.1	0	0	0	1,554	0.43
7,728	128.8	5.37	0	4.1	49.1	0	0	0	1,603	0.45
7,740	129.0	5.38	0	4.1	49.1	0	0	0	1,652	0.46
7,752	129.2	5.38	0	4.1	49.1	0	0	0	1,701	0.47
7,764	129.4	5.39	0	4.1	49.1	0	0	0	1,750	0.49
7,776	129.6	5.40	0	4.1	49.1	0	0	0	1,799	0.50
7,788	129.8	5.41	0	4.1	49.1	0	0	0	1,848	0.51
7,800	130.0	5.42	0	4.1	49.1	0	0	0	1,897	0.53
7,812	130.2	5.43	0	4.1	49.1	0	0	0	1,946	0.54
7,824	130.4	5.43	0	4.1	49.1	0	0	0	1,995	0.56
7,836	130.6	5.44	0	4.1	49.1	0	0	0	2,045	0.57
7,848	130.8	5.45	0	4.1	49.1	0	0	0	2,094	0.58
7,860	131.0	5.46	0	4.1	49.1	0	0	0	2,143	0.60
7,872	131.2	5.47	0	4.1	49.1	0	0	0	2,192	0.61
7,884	131.4	5.48	0	4.1	49.1	0	0	0	2,241	0.62
7,896	131.6	5.48	0	4.1	49.1	0	0	0	2,290	0.64
7,908	131.8	5.49	0	4.1	49.1	0	0	0	2,339	0.65

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,920	132.0	5.50	0	4.1	49.1	0	0	0	2,388	0.67
7,932	132.2	5.51	0	4.1	49.1	0	0	0	2,437	0.68
7,944	132.4	5.52	0	4.1	49.1	0	0	0	2,486	0.69
7,956	132.6	5.53	0	4.1	49.1	0	0	0	2,535	0.71
7,968	132.8	5.53	0	4.1	49.1	0	0	0	2,585	0.72
7,980	133.0	5.54	0	4.1	49.1	0	0	0	2,634	0.73
7,992	133.2	5.55	0	4.1	49.1	0	0	0	2,683	0.75
8,004	133.4	5.56	0	4.1	49.1	0	0	0	2,732	0.76
8,016	133.6	5.57	0	4.1	49.1	0	0	0	2,781	0.77
8,028	133.8	5.58	0	4.1	49.1	0	0	0	2,830	0.79
8,040	134.0	5.58	0	4.1	49.1	0	0	0	2,879	0.80
8,052	134.2	5.59	0	4.1	49.1	0	0	0	2,928	0.82
8,064	134.4	5.60	0	4.1	49.1	0	0	0	2,977	0.83
8,076	134.6	5.61	0	4.1	49.1	0	0	0	3,026	0.84
8,088	134.8	5.62	0	4.1	49.1	0	0	0	3,075	0.86
8,100	135.0	5.63	0	4.1	49.1	0	0	0	3,124	0.87
8,112	135.2	5.63	0	4.1	49.1	0	0	0	3,174	0.88
8,124	135.4	5.64	0	4.1	49.1	0	0	0	3,223	0.90
8,136	135.6	5.65	0	4.1	49.1	0	0	0	3,272	0.91
8,148	135.8	5.66	0	4.1	49.1	0	0	0	3,321	0.92
8,160	136.0	5.67	0	4.1	49.1	0	0	0	3,370	0.94
8,172	136.2	5.68	0	4.1	49.1	0	0	0	3,419	0.95
8,184	136.4	5.68	0	4.1	49.1	0	0	0	3,468	0.97
8,196	136.6	5.69	0	4.1	49.1	0	0	0	3,517	0.98
8,208	136.8	5.70	0	4.1	49.1	0	0	0	3,566	0.99
8,220	137.0	5.71	0	4.1	49.1	0	0	0	3,615	1.01
8,232	137.2	5.72	0	4.1	49.1	100	0	1,200	2,464	0.69
8,244	137.4	5.73	0	4.1	49.1	100	0	1,200	1,314	0.37
8,256	137.6	5.73	0	4.1	49.1	0	0	0	1,363	0.38
8,268	137.8	5.74	0	4.1	49.1	0	0	0	1,412	0.39
8,280	138.0	5.75	0	4.1	49.1	0	0	0	1,461	0.41
8,292	138.2	5.76	0	4.1	49.1	0	0	0	1,510	0.42
8,304	138.4	5.77	0	4.1	49.1	0	0	0	1,559	0.43
8,316	138.6	5.78	0	4.1	49.1	0	0	0	1,608	0.45
8,328	138.8	5.78	0	4.1	49.1	0	0	0	1,657	0.46
8,340	139.0	5.79	0	4.1	49.1	0	0	0	1,706	0.48
8,352	139.2	5.80	0	4.1	49.1	0	0	0	1,755	0.49
8,364	139.4	5.81	0	4.1	49.1	0	0	0	1,804	0.50
8,376	139.6	5.82	0	4.1	49.1	0	0	0	1,853	0.52
8,388	139.8	5.83	0	4.1	49.1	0	0	0	1,903	0.53
8,400	140.0	5.83	0	4.1	49.1	0	0	0	1,952	0.54
8,412	140.2	5.84	0	4.1	49.1	0	0	0	2,001	0.56
8,424	140.4	5.85	0	4.1	49.1	0	0	0	2,050	0.57
8,436	140.6	5.86	0	4.1	49.1	0	0	0	2,099	0.58
8,448	140.8	5.87	0	4.1	49.1	0	0	0	2,148	0.60
8,460	141.0	5.88	0	4.1	49.1	0	0	0	2,197	0.61
8,472	141.2	5.88	0	4.1	49.1	0	0	0	2,246	0.63
8,484	141.4	5.89	0	4.1	49.1	0	0	0	2,295	0.64
8,496	141.6	5.90	0	4.1	49.1	0	0	0	2,344	0.65
8,508	141.8	5.91	0	4.1	49.1	0	0	0	2,393	0.67
8,520	142.0	5.92	0	4.1	49.1	0	0	0	2,443	0.68
8,532	142.2	5.93	0	4.1	49.1	0	0	0	2,492	0.69
8,544	142.4	5.93	0	4.1	49.1	0	0	0	2,541	0.71
8,556	142.6	5.94	0	4.1	49.1	0	0	0	2,590	0.72
8,568	142.8	5.95	0	4.1	49.1	0	0	0	2,639	0.73
8,580	143.0	5.96	0	4.1	49.1	0	0	0	2,688	0.75
8,592	143.2	5.97	0	4.1	49.1	0	0	0	2,737	0.76
8,604	143.4	5.98	0	4.1	49.1	0	0	0	2,786	0.78
8,616	143.6	5.98	0	4.1	49.1	0	0	0	2,835	0.79
8,628	143.8	5.99	0	4.1	49.1	0	0	0	2,884	0.80

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,640	144.0	6.00	0	4.1	49.1	0	0	0	2,933	0.82
8,652	144.2	6.01	0	4.1	49.1	0	0	0	2,982	0.83
8,664	144.4	6.02	0	4.1	49.1	0	0	0	3,032	0.84
8,676	144.6	6.03	0	4.1	49.1	0	0	0	3,081	0.86
8,688	144.8	6.03	0	4.1	49.1	0	0	0	3,130	0.87
8,700	145.0	6.04	0	4.1	49.1	0	0	0	3,179	0.89
8,712	145.2	6.05	0	4.1	49.1	0	0	0	3,228	0.90
8,724	145.4	6.06	0	4.1	49.1	0	0	0	3,277	0.91
8,736	145.6	6.07	0	4.1	49.1	0	0	0	3,326	0.93
8,748	145.8	6.08	0	4.1	49.1	0	0	0	3,375	0.94
8,760	146.0	6.08	0	4.1	49.1	0	0	0	3,424	0.95
8,772	146.2	6.09	0	4.1	49.1	0	0	0	3,473	0.97
8,784	146.4	6.10	0	4.1	49.1	0	0	0	3,522	0.98
8,796	146.6	6.11	0	4.1	49.1	0	0	0	3,572	0.99
8,808	146.8	6.12	0	4.1	49.1	0	0	0	3,621	1.01
8,820	147.0	6.13	0	4.1	49.1	100	0	1,200	2,470	0.69
8,832	147.2	6.13	0	4.1	49.1	100	0	1,200	1,319	0.37
8,844	147.4	6.14	0	4.1	49.1	0	0	0	1,368	0.38
8,856	147.6	6.15	0	4.1	49.1	0	0	0	1,417	0.39
8,868	147.8	6.16	0	4.1	49.1	0	0	0	1,466	0.41
8,880	148.0	6.17	0	4.1	49.1	0	0	0	1,515	0.42
8,892	148.2	6.18	0	4.1	49.1	0	0	0	1,564	0.44
8,904	148.4	6.18	0	4.1	49.1	0	0	0	1,613	0.45
8,916	148.6	6.19	0	4.1	49.1	0	0	0	1,662	0.46
8,928	148.8	6.20	0	4.1	49.1	0	0	0	1,712	0.48
8,940	149.0	6.21	0	4.1	49.1	0	0	0	1,761	0.49
8,952	149.2	6.22	0	4.1	49.1	0	0	0	1,810	0.50
8,964	149.4	6.23	0	4.1	49.1	0	0	0	1,859	0.52
8,976	149.6	6.23	0	4.1	49.1	0	0	0	1,908	0.53
8,988	149.8	6.24	0	4.1	49.1	0	0	0	1,957	0.55
9,000	150.0	6.25	0	4.1	49.1	0	0	0	2,006	0.56
9,012	150.2	6.26	0	4.1	49.1	0	0	0	2,055	0.57
9,024	150.4	6.27	0	4.1	49.1	0	0	0	2,104	0.59
9,036	150.6	6.28	0	4.1	49.1	0	0	0	2,153	0.60
9,048	150.8	6.28	0	4.1	49.1	0	0	0	2,202	0.61
9,060	151.0	6.29	0	4.1	49.1	0	0	0	2,251	0.63
9,072	151.2	6.30	0	4.1	49.1	0	0	0	2,301	0.64
9,084	151.4	6.31	0	4.1	49.1	0	0	0	2,350	0.65
9,096	151.6	6.32	0	4.1	49.1	0	0	0	2,399	0.67
9,108	151.8	6.33	0	4.1	49.1	0	0	0	2,448	0.68
9,120	152.0	6.33	0	4.1	49.1	0	0	0	2,497	0.70
9,132	152.2	6.34	0	4.1	49.1	0	0	0	2,546	0.71
9,144	152.4	6.35	0	4.1	49.1	0	0	0	2,595	0.72
9,156	152.6	6.36	0	4.1	49.1	0	0	0	2,644	0.74
9,168	152.8	6.37	0	4.1	49.1	0	0	0	2,693	0.75
9,180	153.0	6.38	0	4.1	49.1	0	0	0	2,742	0.76
9,192	153.2	6.38	0	4.1	49.1	0	0	0	2,791	0.78
9,204	153.4	6.39	0	4.1	49.1	0	0	0	2,841	0.79
9,216	153.6	6.40	0	4.1	49.1	0	0	0	2,890	0.80
9,228	153.8	6.41	0	4.1	49.1	0	0	0	2,939	0.82
9,240	154.0	6.42	0	4.1	49.1	0	0	0	2,988	0.83
9,252	154.2	6.43	0	4.1	49.1	0	0	0	3,037	0.85
9,264	154.4	6.43	0	4.1	49.1	0	0	0	3,086	0.86
9,276	154.6	6.44	0	4.1	49.1	0	0	0	3,135	0.87
9,288	154.8	6.45	0	4.1	49.1	0	0	0	3,184	0.89
9,300	155.0	6.46	0	4.1	49.1	0	0	0	3,233	0.90
9,312	155.2	6.47	0	4.1	49.1	0	0	0	3,282	0.91
9,324	155.4	6.48	0	4.1	49.1	0	0	0	3,331	0.93
9,336	155.6	6.48	0	4.1	49.1	0	0	0	3,380	0.94
9,348	155.8	6.49	0	4.1	49.1	0	0	0	3,430	0.96

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
9,360	156.0	6.50	0	4.1	49.1	0	0	0	3,479	0.97
9,372	156.2	6.51	0	4.1	49.1	0	0	0	3,528	0.98
9,384	156.4	6.52	0	4.1	49.1	0	0	0	3,577	1.00
9,396	156.6	6.53	0	4.1	49.1	0	0	0	3,626	1.01
9,408	156.8	6.53	0	4.1	49.1	100	0	1,200	2,475	0.69
9,420	157.0	6.54	0	4.1	49.1	100	0	1,200	1,324	0.37
9,432	157.2	6.55	0	4.1	49.1	0	0	0	1,373	0.38
9,444	157.4	6.56	0	4.1	49.1	0	0	0	1,422	0.40
9,456	157.6	6.57	0	4.1	49.1	0	0	0	1,471	0.41
9,468	157.8	6.58	0	4.1	49.1	0	0	0	1,520	0.42
9,480	158.0	6.58	0	4.1	49.1	0	0	0	1,570	0.44
9,492	158.2	6.59	0	4.1	49.1	0	0	0	1,619	0.45
9,504	158.4	6.60	0	4.1	49.1	0	0	0	1,668	0.46
9,516	158.6	6.61	0	4.1	49.1	0	0	0	1,717	0.48
9,528	158.8	6.62	0	4.1	49.1	0	0	0	1,766	0.49
9,540	159.0	6.63	0	4.1	49.1	0	0	0	1,815	0.51
9,552	159.2	6.63	0	4.1	49.1	0	0	0	1,864	0.52
9,564	159.4	6.64	0	4.1	49.1	0	0	0	1,913	0.53
9,576	159.6	6.65	0	4.1	49.1	0	0	0	1,962	0.55
9,588	159.8	6.66	0	4.1	49.1	0	0	0	2,011	0.56
9,600	160.0	6.67	0	4.1	49.1	0	0	0	2,060	0.57
9,612	160.2	6.68	0	4.1	49.1	0	0	0	2,109	0.59
9,624	160.4	6.68	0	4.1	49.1	0	0	0	2,159	0.60
9,636	160.6	6.69	0	4.1	49.1	0	0	0	2,208	0.61
9,648	160.8	6.70	0	4.1	49.1	0	0	0	2,257	0.63
9,660	161.0	6.71	0	4.1	49.1	0	0	0	2,306	0.64
9,672	161.2	6.72	0	4.1	49.1	0	0	0	2,355	0.66
9,684	161.4	6.73	0	4.1	49.1	0	0	0	2,404	0.67
9,696	161.6	6.73	0	4.1	49.1	0	0	0	2,453	0.68
9,708	161.8	6.74	0	4.1	49.1	0	0	0	2,502	0.70
9,720	162.0	6.75	0	4.1	49.1	0	0	0	2,551	0.71
9,732	162.2	6.76	0	4.1	49.1	0	0	0	2,600	0.72
9,744	162.4	6.77	0	4.1	49.1	0	0	0	2,649	0.74
9,756	162.6	6.78	0	4.1	49.1	0	0	0	2,699	0.75
9,768	162.8	6.78	0	4.1	49.1	0	0	0	2,748	0.77
9,780	163.0	6.79	0	4.1	49.1	0	0	0	2,797	0.78
9,792	163.2	6.80	0	4.1	49.1	0	0	0	2,846	0.79
9,804	163.4	6.81	0	4.1	49.1	0	0	0	2,895	0.81
9,816	163.6	6.82	0	4.1	49.1	0	0	0	2,944	0.82
9,828	163.8	6.83	0	4.1	49.1	0	0	0	2,993	0.83
9,840	164.0	6.83	0	4.1	49.1	0	0	0	3,042	0.85
9,852	164.2	6.84	0	4.1	49.1	0	0	0	3,091	0.86
9,864	164.4	6.85	0	4.1	49.1	0	0	0	3,140	0.87
9,876	164.6	6.86	0	4.1	49.1	0	0	0	3,189	0.89
9,888	164.8	6.87	0	4.1	49.1	0	0	0	3,239	0.90
9,900	165.0	6.88	0	4.1	49.1	0	0	0	3,288	0.92
9,912	165.2	6.88	0	4.1	49.1	0	0	0	3,337	0.93
9,924	165.4	6.89	0	4.1	49.1	0	0	0	3,386	0.94
9,936	165.6	6.90	0	4.1	49.1	0	0	0	3,435	0.96
9,948	165.8	6.91	0	4.1	49.1	0	0	0	3,484	0.97
9,960	166.0	6.92	0	4.1	49.1	0	0	0	3,533	0.98
9,972	166.2	6.93	0	4.1	49.1	0	0	0	3,582	1.00
9,984	166.4	6.93	0	4.1	49.1	0	0	0	3,631	1.01
9,996	166.6	6.94	0	4.1	49.1	100	0	1,200	2,480	0.69
10,008	166.8	6.95	0	4.1	49.1	100	0	1,200	1,329	0.37
10,020	167.0	6.96	0	4.1	49.1	0	0	0	1,378	0.38
10,032	167.2	6.97	0	4.1	49.1	0	0	0	1,428	0.40
10,044	167.4	6.98	0	4.1	49.1	0	0	0	1,477	0.41
10,056	167.6	6.98	0	4.1	49.1	0	0	0	1,526	0.42
10,068	167.8	6.99	0	4.1	49.1	0	0	0	1,575	0.44

Attachment 4 - Cell 1 Leachate Collection Sump - Average Conditions										
Time (min)	**Time (hr)**	**Time (day)**	**Stormwater (gpm)**	**Infiltration (gpm)**	**Incremental Volume of Leachate Generated (gal)**	**Low-Flow Pump (gpm)**	**High-Flow Pump (gpm)**	**Volume of Leachate Removed (gal)**	**Volume of Leachate in Sump (gal)**	**Head (ft)**
10,080	168.0	7.00	0	4.1	49.1	0	0	0	1,624	0.45

ATTACHMENT 5

Cell 1 Leachate Collection Sump – Peak Conditions

Attachment 5 - Cell 1 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
0	0.0	0.00	0.0	42.8	0.0	0	0	0	3,590	1.00
12	0.2	0.01	0.0	42.8	513.4	0	0	0	4,104	1.14
24	0.4	0.02	0.0	42.8	513.4	100	0	1,200	3,417	0.95
36	0.6	0.03	0.0	42.8	513.4	100	0	1,200	2,731	0.76
48	0.8	0.03	0.0	42.8	513.4	100	0	1,200	2,044	0.57
60	1.0	0.04	0.0	42.8	513.4	100	0	1,200	1,358	0.38
72	1.2	0.05	0.0	42.8	513.4	0	0	0	1,871	0.52
84	1.4	0.06	0.0	42.8	513.4	0	0	0	2,384	0.66
96	1.6	0.07	0.0	42.8	513.4	0	0	0	2,898	0.81
108	1.8	0.08	0.0	42.8	513.4	0	0	0	3,411	0.95
120	2.0	0.08	0.0	42.8	513.4	0	0	0	3,925	1.09
132	2.2	0.09	0.0	42.8	513.4	100	0	1,200	3,238	0.90
144	2.4	0.10	0.0	42.8	513.4	100	0	1,200	2,552	0.71
156	2.6	0.11	0.0	42.8	513.4	100	0	1,200	1,865	0.52
168	2.8	0.12	0.0	42.8	513.4	100	0	1,200	1,179	0.33
180	3.0	0.13	0.0	42.8	513.4	0	0	0	1,692	0.47
192	3.2	0.13	0.0	42.8	513.4	0	0	0	2,205	0.61
204	3.4	0.14	0.0	42.8	513.4	0	0	0	2,719	0.76
216	3.6	0.15	0.0	42.8	513.4	0	0	0	3,232	0.90
228	3.8	0.16	0.0	42.8	513.4	0	0	0	3,746	1.04
240	4.0	0.17	0.0	42.8	513.4	100	0	1,200	3,059	0.85
252	4.2	0.18	0.0	42.8	513.4	100	0	1,200	2,373	0.66
264	4.4	0.18	0.0	42.8	513.4	100	0	1,200	1,686	0.47
276	4.6	0.19	0.0	42.8	513.4	0	0	0	2,200	0.61
288	4.8	0.20	0.0	42.8	513.4	0	0	0	2,713	0.76
300	5.0	0.21	4.6	42.8	568.4	0	0	0	3,281	0.91
312	5.2	0.22	4.6	42.8	568.4	0	0	0	3,850	1.07
324	5.4	0.23	4.6	42.8	568.4	100	0	1,200	3,218	0.90
336	5.6	0.23	4.6	42.8	568.4	100	0	1,200	2,587	0.72
348	5.8	0.24	4.6	42.8	568.4	100	0	1,200	1,955	0.54
360	6.0	0.25	4.6	42.8	568.4	100	0	1,200	1,323	0.37
372	6.2	0.26	9.2	42.8	623.3	0	0	0	1,947	0.54
384	6.4	0.27	9.2	42.8	623.3	0	0	0	2,570	0.72
396	6.6	0.28	9.2	42.8	623.3	0	0	0	3,193	0.89
408	6.8	0.28	13.7	42.8	678.2	0	0	0	3,871	1.08
420	7.0	0.29	13.7	42.8	678.2	100	0	1,200	3,350	0.93
432	7.2	0.30	13.7	42.8	678.2	100	0	1,200	2,828	0.79
444	7.4	0.31	18.3	42.8	733.2	100	0	1,200	2,361	0.66
456	7.6	0.32	18.3	42.8	733.2	100	0	1,200	1,894	0.53
468	7.8	0.33	18.3	42.8	733.2	100	0	1,200	1,427	0.40
480	8.0	0.33	22.9	42.8	788.1	0	0	0	2,216	0.62
492	8.2	0.34	22.9	42.8	788.1	0	0	0	3,004	0.84
504	8.4	0.35	22.9	42.8	788.1	0	0	0	3,792	1.06
516	8.6	0.36	27.5	42.8	843.0	100	0	1,200	3,435	0.96
528	8.8	0.37	27.5	42.8	843.0	100	0	1,200	3,078	0.86
540	9.0	0.38	32.0	42.8	898.0	100	0	1,200	2,776	0.77
552	9.2	0.38	32.0	42.8	898.0	100	0	1,200	2,474	0.69
564	9.4	0.39	36.6	42.8	952.9	100	0	1,200	2,227	0.62
576	9.6	0.40	36.6	42.8	952.9	100	0	1,200	1,980	0.55
588	9.8	0.41	41.2	42.8	1007.8	100	0	1,200	1,787	0.50
600	10.0	0.42	41.2	42.8	1007.8	0	0	0	2,795	0.78
612	10.2	0.43	45.8	42.8	1062.8	0	0	0	3,858	1.07
624	10.4	0.43	45.8	42.8	1062.8	100	0	1,200	3,721	1.04
636	10.6	0.44	50.4	42.8	1117.7	100	0	1,200	3,639	1.01
648	10.8	0.45	54.9	42.8	1172.6	100	0	1,200	3,611	1.01
660	11.0	0.46	59.5	42.8	1227.6	100	0	1,200	3,639	1.01
672	11.2	0.47	64.1	42.8	1282.5	100	0	1,200	3,721	1.04
684	11.4	0.48	68.7	42.8	1337.4	100	0	1,200	3,859	1.07
696	11.6	0.48	73.2	42.8	1392.4	100	0	1,200	4,051	1.13
708	11.8	0.49	96.1	42.8	1667.0	100	0	1,200	4,518	1.26
720	12.0	0.50	141.9	42.8	2216.4	100	0	1,200	5,534	1.54
732	12.2	0.51	164.8	42.8	2491.0	100	0	1,200	6,826	1.90
744	12.4	0.52	224.3	42.8	3205.2	100	0	1,200	8,831	2.19
756	12.6	0.53	334.2	42.8	4523.6	100	0	1,200	12,154	2.47
768	12.8	0.53	421.2	42.8	5567.3	100	0	1,200	16,522	2.78
780	13.0	0.54	489.8	42.8	6391.3	100	0	1,200	21,713	3.09
792	13.2	0.55	535.6	42.8	6940.6	100	0	1,200	27,453	3.38
804	13.4	0.56	567.6	42.8	7325.1	100	0	1,200	33,579	3.65

Attachment 5 - Cell 1 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
816	13.6	0.57	590.5	42.8	7599.8	100	0	1,200	39,978	3.90
828	13.8	0.58	599.7	42.8	7709.7	100	0	1,200	46,488	4.13
840	14.0	0.58	604.3	42.8	7764.6	100	550	7,800	46,453	4.13
852	14.2	0.59	604.3	42.8	7764.6	100	550	7,800	46,417	4.13
864	14.4	0.60	599.7	42.8	7709.7	100	550	7,800	46,327	4.12
876	14.6	0.61	590.5	42.8	7599.8	100	550	7,800	46,127	4.12
888	14.8	0.62	581.4	42.8	7489.9	100	550	7,800	45,817	4.11
900	15.0	0.63	572.2	42.8	7380.1	100	550	7,800	45,397	4.09
912	15.2	0.63	563.1	42.8	7270.2	100	550	7,800	44,867	4.07
924	15.4	0.64	549.3	42.8	7105.4	100	550	7,800	44,172	4.05
936	15.6	0.65	540.2	42.8	6995.6	100	550	7,800	43,368	4.02
948	15.8	0.66	526.4	42.8	6830.8	100	550	7,800	42,399	3.99
960	16.0	0.67	512.7	42.8	6666.0	100	550	7,800	41,265	3.94
972	16.2	0.68	499.0	42.8	6501.2	100	550	7,800	39,966	3.90
984	16.4	0.68	485.2	42.8	6336.4	100	550	7,800	38,502	3.84
996	16.6	0.69	471.5	42.8	6171.6	100	550	7,800	36,874	3.78
1,008	16.8	0.70	457.8	42.8	6006.8	100	550	7,800	35,081	3.71
1,020	17.0	0.71	444.0	42.8	5842.0	100	550	7,800	33,123	3.63
1,032	17.2	0.72	434.9	42.8	5732.1	100	550	7,800	31,055	3.54
1,044	17.4	0.73	421.2	42.8	5567.3	100	550	7,800	28,822	3.44
1,056	17.6	0.73	412.0	42.8	5457.4	100	550	7,800	26,479	3.33
1,068	17.8	0.74	398.3	42.8	5292.6	100	550	7,800	23,972	3.21
1,080	18.0	0.75	389.1	42.8	5182.8	100	550	7,800	21,355	3.07
1,092	18.2	0.76	380.0	42.8	5072.9	100	550	7,800	18,628	2.91
1,104	18.4	0.77	370.8	42.8	4963.0	100	550	7,800	15,791	2.73
1,116	18.6	0.78	361.6	42.8	4853.2	100	550	7,800	12,844	2.53
1,128	18.8	0.78	352.5	42.8	4743.3	100	550	7,800	9,787	2.28
1,140	19.0	0.79	343.3	42.8	4633.4	100	550	7,800	6,620	1.84
1,152	19.2	0.80	334.2	42.8	4523.6	100	0	1,200	9,944	2.29
1,164	19.4	0.81	329.6	42.8	4468.6	100	0	1,200	13,213	2.55
1,176	19.6	0.82	320.4	42.8	4358.8	100	0	1,200	16,371	2.77
1,188	19.8	0.83	311.3	42.8	4248.9	100	0	1,200	19,420	2.96
1,200	20.0	0.83	306.7	42.8	4194.0	100	0	1,200	22,414	3.12
1,212	20.2	0.84	297.6	42.8	4084.1	100	0	1,200	25,298	3.27
1,224	20.4	0.85	293.0	42.8	4029.2	100	0	1,200	28,128	3.41
1,236	20.6	0.86	283.8	42.8	3919.3	100	0	1,200	30,847	3.53
1,248	20.8	0.87	279.2	42.8	3864.4	100	0	1,200	33,511	3.64
1,260	21.0	0.88	274.7	42.8	3809.4	100	0	1,200	36,121	3.75
1,272	21.2	0.88	265.5	42.8	3699.6	100	0	1,200	38,620	3.85
1,284	21.4	0.89	260.9	42.8	3644.6	100	0	1,200	41,065	3.94
1,296	21.6	0.90	256.4	42.8	3589.7	100	0	1,200	43,455	4.02
1,308	21.8	0.91	251.8	42.8	3534.8	100	550	7,800	39,189	3.87
1,320	22.0	0.92	247.2	42.8	3479.8	100	550	7,800	34,869	3.70
1,332	22.2	0.93	242.6	42.8	3424.9	100	550	7,800	30,494	3.51
1,344	22.4	0.93	238.0	42.8	3370.0	100	550	7,800	26,064	3.31
1,356	22.6	0.94	233.5	42.8	3315.0	100	550	7,800	21,579	3.08
1,368	22.8	0.95	233.5	42.8	3315.0	100	550	7,800	17,094	2.82
1,380	23.0	0.96	228.9	42.8	3260.1	100	550	7,800	12,554	2.50
1,392	23.2	0.97	224.3	42.8	3205.2	100	550	7,800	7,959	2.10
1,404	23.4	0.98	219.7	42.8	3150.2	100	550	7,800	3,310	0.92
1,416	23.6	0.98	219.7	42.8	3150.2	100	0	1,200	5,260	1.46
1,428	23.8	0.99	215.2	42.8	3095.3	100	0	1,200	7,155	1.99
1,440	24.0	1.00	210.6	42.8	3040.4	100	0	1,200	8,995	2.21
1,452	24.2	1.01	201.4	42.8	2930.5	100	0	1,200	10,726	2.36
1,464	24.4	1.02	192.3	42.8	2820.6	100	0	1,200	12,347	2.49
1,476	24.6	1.03	187.7	42.8	2765.7	100	0	1,200	13,912	2.60
1,488	24.8	1.03	178.5	42.8	2655.8	100	0	1,200	15,368	2.71
1,500	25.0	1.04	169.4	42.8	2546.0	100	0	1,200	16,714	2.79
1,512	25.2	1.05	164.8	42.8	2491.0	100	0	1,200	18,005	2.87
1,524	25.4	1.06	164.8	42.8	2491.0	100	0	1,200	19,296	2.95
1,536	25.6	1.07	164.8	42.8	2491.0	100	0	1,200	20,587	3.02
1,548	25.8	1.08	164.8	42.8	2491.0	100	0	1,200	21,878	3.10
1,560	26.0	1.08	164.8	42.8	2491.0	100	0	1,200	23,169	3.16
1,572	26.2	1.09	164.8	42.8	2491.0	100	0	1,200	24,460	3.23
1,584	26.4	1.10	164.8	42.8	2491.0	100	0	1,200	25,751	3.29
1,596	26.6	1.11	160.2	42.8	2436.1	100	0	1,200	26,987	3.35
1,608	26.8	1.12	160.2	42.8	2436.1	100	0	1,200	28,224	3.41
1,620	27.0	1.13	160.2	42.8	2436.1	100	0	1,200	29,460	3.47

Attachment 5 - Cell 1 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,632	27.2	1.13	160.2	42.8	2436.1	100	0	1,200	30,696	3.52
1,644	27.4	1.14	160.2	42.8	2436.1	100	0	1,200	31,932	3.58
1,656	27.6	1.15	160.2	42.8	2436.1	100	0	1,200	33,168	3.63
1,668	27.8	1.16	160.2	42.8	2436.1	100	0	1,200	34,404	3.68
1,680	28.0	1.17	160.2	42.8	2436.1	100	0	1,200	35,640	3.73
1,692	28.2	1.18	160.2	42.8	2436.1	100	0	1,200	36,876	3.78
1,704	28.4	1.18	160.2	42.8	2436.1	100	0	1,200	38,112	3.83
1,716	28.6	1.19	160.2	42.8	2436.1	100	0	1,200	39,348	3.87
1,728	28.8	1.20	160.2	42.8	2436.1	100	0	1,200	40,585	3.92
1,740	29.0	1.21	160.2	42.8	2436.1	100	0	1,200	41,821	3.96
1,752	29.2	1.22	155.6	42.8	2381.2	100	0	1,200	43,002	4.01
1,764	29.4	1.23	155.6	42.8	2381.2	100	550	7,800	37,583	3.81
1,776	29.6	1.23	155.6	42.8	2381.2	100	550	7,800	32,164	3.59
1,788	29.8	1.24	155.6	42.8	2381.2	100	550	7,800	26,745	3.34
1,800	30.0	1.25	155.6	42.8	2381.2	100	550	7,800	21,326	3.07
1,812	30.2	1.26	155.6	42.8	2381.2	100	550	7,800	15,908	2.74
1,824	30.4	1.27	155.6	42.8	2381.2	100	550	7,800	10,489	2.34
1,836	30.6	1.28	155.6	42.8	2381.2	100	550	7,800	5,070	1.41
1,848	30.8	1.28	155.6	42.8	2381.2	100	0	1,200	6,251	1.74
1,860	31.0	1.29	155.6	42.8	2381.2	100	0	1,200	7,432	2.05
1,872	31.2	1.30	155.6	42.8	2381.2	100	0	1,200	8,613	2.17
1,884	31.4	1.31	151.1	42.8	2326.2	100	0	1,200	9,740	2.27
1,896	31.6	1.32	151.1	42.8	2326.2	100	0	1,200	10,866	2.37
1,908	31.8	1.33	151.1	42.8	2326.2	100	0	1,200	11,992	2.46
1,920	32.0	1.33	151.1	42.8	2326.2	100	0	1,200	13,118	2.55
1,932	32.2	1.34	151.1	42.8	2326.2	100	0	1,200	14,245	2.63
1,944	32.4	1.35	151.1	42.8	2326.2	100	0	1,200	15,371	2.71
1,956	32.6	1.36	151.1	42.8	2326.2	100	0	1,200	16,497	2.78
1,968	32.8	1.37	151.1	42.8	2326.2	100	0	1,200	17,623	2.85
1,980	33.0	1.38	151.1	42.8	2326.2	100	0	1,200	18,750	2.92
1,992	33.2	1.38	151.1	42.8	2326.2	100	0	1,200	19,876	2.98
2,004	33.4	1.39	151.1	42.8	2326.2	100	0	1,200	21,002	3.05
2,016	33.6	1.40	151.1	42.8	2326.2	100	0	1,200	22,128	3.11
2,028	33.8	1.41	146.5	42.8	2271.3	100	0	1,200	23,200	3.17
2,040	34.0	1.42	146.5	42.8	2271.3	100	0	1,200	24,271	3.22
2,052	34.2	1.43	146.5	42.8	2271.3	100	0	1,200	25,342	3.27
2,064	34.4	1.43	146.5	42.8	2271.3	100	0	1,200	26,414	3.33
2,076	34.6	1.44	146.5	42.8	2271.3	100	0	1,200	27,485	3.38
2,088	34.8	1.45	146.5	42.8	2271.3	100	0	1,200	28,556	3.43
2,100	35.0	1.46	146.5	42.8	2271.3	100	0	1,200	29,627	3.48
2,112	35.2	1.47	146.5	42.8	2271.3	100	0	1,200	30,699	3.52
2,124	35.4	1.48	146.5	42.8	2271.3	100	0	1,200	31,770	3.57
2,136	35.6	1.48	146.5	42.8	2271.3	100	0	1,200	32,841	3.62
2,148	35.8	1.49	146.5	42.8	2271.3	100	0	1,200	33,913	3.66
2,160	36.0	1.50	146.5	42.8	2271.3	100	0	1,200	34,984	3.70
2,172	36.2	1.51	146.5	42.8	2271.3	100	0	1,200	36,055	3.75
2,184	36.4	1.52	141.9	42.8	2216.4	100	0	1,200	37,072	3.79
2,196	36.6	1.53	141.9	42.8	2216.4	100	0	1,200	38,088	3.83
2,208	36.8	1.53	141.9	42.8	2216.4	100	0	1,200	39,104	3.86
2,220	37.0	1.54	141.9	42.8	2216.4	100	0	1,200	40,121	3.90
2,232	37.2	1.55	141.9	42.8	2216.4	100	0	1,200	41,137	3.94
2,244	37.4	1.56	141.9	42.8	2216.4	100	0	1,200	42,153	3.98
2,256	37.6	1.57	141.9	42.8	2216.4	100	0	1,200	43,170	4.01
2,268	37.8	1.58	141.9	42.8	2216.4	100	550	7,800	37,586	3.81
2,280	38.0	1.58	141.9	42.8	2216.4	100	550	7,800	32,003	3.58
2,292	38.2	1.59	141.9	42.8	2216.4	100	550	7,800	26,419	3.33
2,304	38.4	1.60	141.9	42.8	2216.4	100	550	7,800	20,835	3.04
2,316	38.6	1.61	137.3	42.8	2161.4	100	550	7,800	15,197	2.69
2,328	38.8	1.62	137.3	42.8	2161.4	100	550	7,800	9,558	2.26
2,340	39.0	1.63	137.3	42.8	2161.4	100	550	7,800	3,920	1.09
2,352	39.2	1.63	137.3	42.8	2161.4	100	0	1,200	4,881	1.36
2,364	39.4	1.64	137.3	42.8	2161.4	100	0	1,200	5,842	1.63
2,376	39.6	1.65	137.3	42.8	2161.4	100	0	1,200	6,804	1.90
2,388	39.8	1.66	137.3	42.8	2161.4	100	0	1,200	7,765	2.08
2,400	40.0	1.67	137.3	42.8	2161.4	100	0	1,200	8,727	2.18
2,412	40.2	1.68	137.3	42.8	2161.4	100	0	1,200	9,688	2.27
2,424	40.4	1.68	137.3	42.8	2161.4	100	0	1,200	10,650	2.35
2,436	40.6	1.69	137.3	42.8	2161.4	100	0	1,200	11,611	2.43

Attachment 5 - Cell 1 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
2,448	40.8	1.70	137.3	42.8	2161.4	100	0	1,200	12,573	2.51
2,460	41.0	1.71	137.3	42.8	2161.4	100	0	1,200	13,534	2.58
2,472	41.2	1.72	132.8	42.8	2106.5	100	0	1,200	14,440	2.64
2,484	41.4	1.73	132.8	42.8	2106.5	100	0	1,200	15,347	2.70
2,496	41.6	1.73	132.8	42.8	2106.5	100	0	1,200	16,253	2.76
2,508	41.8	1.74	132.8	42.8	2106.5	100	0	1,200	17,160	2.82
2,520	42.0	1.75	132.8	42.8	2106.5	100	0	1,200	18,066	2.88
2,532	42.2	1.76	132.8	42.8	2106.5	100	0	1,200	18,973	2.93
2,544	42.4	1.77	132.8	42.8	2106.5	100	0	1,200	19,880	2.98
2,556	42.6	1.78	132.8	42.8	2106.5	100	0	1,200	20,786	3.04
2,568	42.8	1.78	132.8	42.8	2106.5	100	0	1,200	21,693	3.09
2,580	43.0	1.79	132.8	42.8	2106.5	100	0	1,200	22,599	3.13
2,592	43.2	1.80	132.8	42.8	2106.5	100	0	1,200	23,506	3.18
2,604	43.4	1.81	132.8	42.8	2106.5	100	0	1,200	24,412	3.23
2,616	43.6	1.82	128.2	42.8	2051.6	100	0	1,200	25,264	3.27
2,628	43.8	1.83	128.2	42.8	2051.6	100	0	1,200	26,115	3.31
2,640	44.0	1.83	128.2	42.8	2051.6	100	0	1,200	26,967	3.35
2,652	44.2	1.84	128.2	42.8	2051.6	100	0	1,200	27,818	3.39
2,664	44.4	1.85	128.2	42.8	2051.6	100	0	1,200	28,670	3.43
2,676	44.6	1.86	128.2	42.8	2051.6	100	0	1,200	29,521	3.47
2,688	44.8	1.87	128.2	42.8	2051.6	100	0	1,200	30,373	3.51
2,700	45.0	1.88	128.2	42.8	2051.6	100	0	1,200	31,225	3.55
2,712	45.2	1.88	128.2	42.8	2051.6	100	0	1,200	32,076	3.58
2,724	45.4	1.89	128.2	42.8	2051.6	100	0	1,200	32,928	3.62
2,736	45.6	1.90	128.2	42.8	2051.6	100	0	1,200	33,779	3.65
2,748	45.8	1.91	128.2	42.8	2051.6	100	0	1,200	34,631	3.69
2,760	46.0	1.92	123.6	42.8	1996.6	100	0	1,200	35,427	3.72
2,772	46.2	1.93	123.6	42.8	1996.6	100	0	1,200	36,224	3.75
2,784	46.4	1.93	123.6	42.8	1996.6	100	0	1,200	37,021	3.78
2,796	46.6	1.94	123.6	42.8	1996.6	100	0	1,200	37,817	3.82
2,808	46.8	1.95	123.6	42.8	1996.6	100	0	1,200	38,614	3.85
2,820	47.0	1.96	123.6	42.8	1996.6	100	0	1,200	39,411	3.88
2,832	47.2	1.97	123.6	42.8	1996.6	100	0	1,200	40,207	3.91
2,844	47.4	1.98	123.6	42.8	1996.6	100	0	1,200	41,004	3.94
2,856	47.6	1.98	123.6	42.8	1996.6	100	0	1,200	41,801	3.96
2,868	47.8	1.99	123.6	42.8	1996.6	100	0	1,200	42,597	3.99
2,880	48.0	2.00	123.6	42.8	1996.6	100	0	1,200	43,394	4.02
2,892	48.2	2.01	123.6	42.8	1996.6	100	550	7,800	37,590	3.81
2,904	48.4	2.02	123.6	42.8	1996.6	100	550	7,800	31,787	3.57
2,916	48.6	2.03	119.0	42.8	1941.7	100	550	7,800	25,929	3.30
2,928	48.8	2.03	119.0	42.8	1941.7	100	550	7,800	20,071	3.00
2,940	49.0	2.04	119.0	42.8	1941.7	100	550	7,800	14,212	2.63
2,952	49.2	2.05	119.0	42.8	1941.7	100	550	7,800	8,354	2.14
2,964	49.4	2.06	119.0	42.8	1941.7	100	550	7,800	2,496	0.70
2,976	49.6	2.07	119.0	42.8	1941.7	100	0	1,200	3,237	0.90
2,988	49.8	2.08	119.0	42.8	1941.7	100	0	1,200	3,979	1.11
3,000	50.0	2.08	119.0	42.8	1941.7	100	0	1,200	4,721	1.31
3,012	50.2	2.09	119.0	42.8	1941.7	100	0	1,200	5,462	1.52
3,024	50.4	2.10	119.0	42.8	1941.7	100	0	1,200	6,204	1.73
3,036	50.6	2.11	119.0	42.8	1941.7	100	0	1,200	6,946	1.93
3,048	50.8	2.12	114.4	42.8	1886.8	100	0	1,200	7,633	2.07
3,060	51.0	2.13	114.4	42.8	1886.8	100	0	1,200	8,319	2.14
3,072	51.2	2.13	114.4	42.8	1886.8	100	0	1,200	9,006	2.21
3,084	51.4	2.14	114.4	42.8	1886.8	100	0	1,200	9,693	2.27
3,096	51.6	2.15	114.4	42.8	1886.8	100	0	1,200	10,380	2.33
3,108	51.8	2.16	114.4	42.8	1886.8	100	0	1,200	11,066	2.39
3,120	52.0	2.17	114.4	42.8	1886.8	100	0	1,200	11,753	2.44
3,132	52.2	2.18	114.4	42.8	1886.8	100	0	1,200	12,440	2.50
3,144	52.4	2.18	114.4	42.8	1886.8	100	0	1,200	13,127	2.55
3,156	52.6	2.19	114.4	42.8	1886.8	100	0	1,200	13,814	2.60
3,168	52.8	2.20	114.4	42.8	1886.8	100	0	1,200	14,500	2.65
3,180	53.0	2.21	114.4	42.8	1886.8	100	0	1,200	15,187	2.69
3,192	53.2	2.22	114.4	42.8	1886.8	100	0	1,200	15,874	2.74
3,204	53.4	2.23	114.4	42.8	1886.8	100	0	1,200	16,561	2.78
3,216	53.6	2.23	109.9	42.8	1831.8	100	0	1,200	17,192	2.82
3,228	53.8	2.24	109.9	42.8	1831.8	100	0	1,200	17,824	2.86
3,240	54.0	2.25	109.9	42.8	1831.8	100	0	1,200	18,456	2.90
3,252	54.2	2.26	109.9	42.8	1831.8	100	0	1,200	19,088	2.94

Attachment 5 - Cell 1 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,264	54.4	2.27	109.9	42.8	1831.8	100	0	1,200	19,720	2.98
3,276	54.6	2.28	109.9	42.8	1831.8	100	0	1,200	20,352	3.01
3,288	54.8	2.28	109.9	42.8	1831.8	100	0	1,200	20,984	3.05
3,300	55.0	2.29	109.9	42.8	1831.8	100	0	1,200	21,615	3.08
3,312	55.2	2.30	109.9	42.8	1831.8	100	0	1,200	22,247	3.12
3,324	55.4	2.31	109.9	42.8	1831.8	100	0	1,200	22,879	3.15
3,336	55.6	2.32	109.9	42.8	1831.8	100	0	1,200	23,511	3.18
3,348	55.8	2.33	109.9	42.8	1831.8	100	0	1,200	24,143	3.21
3,360	56.0	2.33	105.3	42.8	1776.9	100	0	1,200	24,720	3.24
3,372	56.2	2.34	105.3	42.8	1776.9	100	0	1,200	25,297	3.27
3,384	56.4	2.35	105.3	42.8	1776.9	100	0	1,200	25,873	3.30
3,396	56.6	2.36	105.3	42.8	1776.9	100	0	1,200	26,450	3.33
3,408	56.8	2.37	105.3	42.8	1776.9	100	0	1,200	27,027	3.36
3,420	57.0	2.38	105.3	42.8	1776.9	100	0	1,200	27,604	3.38
3,432	57.2	2.38	105.3	42.8	1776.9	100	0	1,200	28,181	3.41
3,444	57.4	2.39	105.3	42.8	1776.9	100	0	1,200	28,758	3.44
3,456	57.6	2.40	105.3	42.8	1776.9	100	0	1,200	29,335	3.46
3,468	57.8	2.41	105.3	42.8	1776.9	100	0	1,200	29,912	3.49
3,480	58.0	2.42	105.3	42.8	1776.9	100	0	1,200	30,489	3.51
3,492	58.2	2.43	105.3	42.8	1776.9	100	0	1,200	31,066	3.54
3,504	58.4	2.43	100.7	42.8	1722.0	100	0	1,200	31,588	3.56
3,516	58.6	2.44	100.7	42.8	1722.0	100	0	1,200	32,110	3.58
3,528	58.8	2.45	100.7	42.8	1722.0	100	0	1,200	32,631	3.61
3,540	59.0	2.46	100.7	42.8	1722.0	100	0	1,200	33,153	3.63
3,552	59.2	2.47	100.7	42.8	1722.0	100	0	1,200	33,675	3.65
3,564	59.4	2.48	100.7	42.8	1722.0	100	0	1,200	34,197	3.67
3,576	59.6	2.48	100.7	42.8	1722.0	100	0	1,200	34,719	3.69
3,588	59.8	2.49	100.7	42.8	1722.0	100	0	1,200	35,241	3.71
3,600	60.0	2.50	100.7	42.8	1722.0	100	0	1,200	35,763	3.73
3,612	60.2	2.51	100.7	42.8	1722.0	100	0	1,200	36,285	3.76
3,624	60.4	2.52	100.7	42.8	1722.0	100	0	1,200	36,807	3.78
3,636	60.6	2.53	100.7	42.8	1722.0	100	0	1,200	37,329	3.80
3,648	60.8	2.53	100.7	42.8	1722.0	100	0	1,200	37,851	3.82
3,660	61.0	2.54	100.7	42.8	1722.0	100	0	1,200	38,373	3.84
3,672	61.2	2.55	96.1	42.8	1667.0	100	0	1,200	38,840	3.85
3,684	61.4	2.56	96.1	42.8	1667.0	100	0	1,200	39,307	3.87
3,696	61.6	2.57	96.1	42.8	1667.0	100	0	1,200	39,774	3.89
3,708	61.8	2.58	96.1	42.8	1667.0	100	0	1,200	40,241	3.91
3,720	62.0	2.58	96.1	42.8	1667.0	100	0	1,200	40,708	3.92
3,732	62.2	2.59	96.1	42.8	1667.0	100	0	1,200	41,175	3.94
3,744	62.4	2.60	96.1	42.8	1667.0	100	0	1,200	41,642	3.96
3,756	62.6	2.61	96.1	42.8	1667.0	100	0	1,200	42,109	3.98
3,768	62.8	2.62	96.1	42.8	1667.0	100	0	1,200	42,576	3.99
3,780	63.0	2.63	96.1	42.8	1667.0	100	0	1,200	43,044	4.01
3,792	63.2	2.63	96.1	42.8	1667.0	100	550	7,800	36,911	3.78
3,804	63.4	2.64	96.1	42.8	1667.0	100	550	7,800	30,778	3.53
3,816	63.6	2.65	91.6	42.8	1612.1	100	550	7,800	24,590	3.24
3,828	63.8	2.66	91.6	42.8	1612.1	100	550	7,800	18,402	2.90
3,840	64.0	2.67	91.6	42.8	1612.1	100	550	7,800	12,214	2.48
3,852	64.2	2.68	91.6	42.8	1612.1	100	550	7,800	6,026	1.68
3,864	64.4	2.68	91.6	42.8	1612.1	100	0	1,200	6,438	1.79
3,876	64.6	2.69	91.6	42.8	1612.1	100	0	1,200	6,850	1.91
3,888	64.8	2.70	91.6	42.8	1612.1	100	0	1,200	7,262	2.03
3,900	65.0	2.71	91.6	42.8	1612.1	100	0	1,200	7,674	2.08
3,912	65.2	2.72	91.6	42.8	1612.1	100	0	1,200	8,087	2.12
3,924	65.4	2.73	91.6	42.8	1612.1	100	0	1,200	8,499	2.16
3,936	65.6	2.73	91.6	42.8	1612.1	100	0	1,200	8,911	2.20
3,948	65.8	2.74	91.6	42.8	1612.1	100	0	1,200	9,323	2.24
3,960	66.0	2.75	91.6	42.8	1612.1	100	0	1,200	9,735	2.27
3,972	66.2	2.76	91.6	42.8	1612.1	100	0	1,200	10,147	2.31
3,984	66.4	2.77	87.0	42.8	1557.2	100	0	1,200	10,504	2.34
3,996	66.6	2.78	87.0	42.8	1557.2	100	0	1,200	10,861	2.37
4,008	66.8	2.78	87.0	42.8	1557.2	100	0	1,200	11,219	2.40
4,020	67.0	2.79	87.0	42.8	1557.2	100	0	1,200	11,576	2.43
4,032	67.2	2.80	87.0	42.8	1557.2	100	0	1,200	11,933	2.46
4,044	67.4	2.81	87.0	42.8	1557.2	100	0	1,200	12,290	2.48
4,056	67.6	2.82	87.0	42.8	1557.2	100	0	1,200	12,647	2.51
4,068	67.8	2.83	87.0	42.8	1557.2	100	0	1,200	13,004	2.54

Attachment 5 - Cell 1 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,080	68.0	2.83	87.0	42.8	1557.2	100	0	1,200	13,362	2.56
4,092	68.2	2.84	87.0	42.8	1557.2	100	0	1,200	13,719	2.59
4,104	68.4	2.85	87.0	42.8	1557.2	100	0	1,200	14,076	2.62
4,116	68.6	2.86	87.0	42.8	1557.2	100	0	1,200	14,433	2.64
4,128	68.8	2.87	82.4	42.8	1502.2	100	0	1,200	14,735	2.66
4,140	69.0	2.88	82.4	42.8	1502.2	100	0	1,200	15,038	2.68
4,152	69.2	2.88	82.4	42.8	1502.2	100	0	1,200	15,340	2.70
4,164	69.4	2.89	82.4	42.8	1502.2	100	0	1,200	15,642	2.72
4,176	69.6	2.90	82.4	42.8	1502.2	100	0	1,200	15,944	2.74
4,188	69.8	2.91	82.4	42.8	1502.2	100	0	1,200	16,247	2.76
4,200	70.0	2.92	82.4	42.8	1502.2	100	0	1,200	16,549	2.78
4,212	70.2	2.93	82.4	42.8	1502.2	100	0	1,200	16,851	2.80
4,224	70.4	2.93	82.4	42.8	1502.2	100	0	1,200	17,153	2.82
4,236	70.6	2.94	82.4	42.8	1502.2	100	0	1,200	17,456	2.84
4,248	70.8	2.95	82.4	42.8	1502.2	100	0	1,200	17,758	2.86
4,260	71.0	2.96	82.4	42.8	1502.2	100	0	1,200	18,060	2.88
4,272	71.2	2.97	82.4	42.8	1502.2	100	0	1,200	18,362	2.90
4,284	71.4	2.98	77.8	42.8	1447.3	100	0	1,200	18,610	2.91
4,296	71.6	2.98	77.8	42.8	1447.3	100	0	1,200	18,857	2.93
4,308	71.8	2.99	77.8	42.8	1447.3	100	0	1,200	19,104	2.94
4,320	72.0	3.00	77.8	42.8	1447.3	100	0	1,200	19,351	2.95
4,332	72.2	3.01	77.8	42.8	1447.3	100	0	1,200	19,599	2.97
4,344	72.4	3.02	77.8	42.8	1447.3	100	0	1,200	19,846	2.98
4,356	72.6	3.03	77.8	42.8	1447.3	100	0	1,200	20,093	3.00
4,368	72.8	3.03	77.8	42.8	1447.3	100	0	1,200	20,341	3.01
4,380	73.0	3.04	77.8	42.8	1447.3	100	0	1,200	20,588	3.02
4,392	73.2	3.05	77.8	42.8	1447.3	100	0	1,200	20,835	3.04
4,404	73.4	3.06	77.8	42.8	1447.3	100	0	1,200	21,083	3.05
4,416	73.6	3.07	77.8	42.8	1447.3	100	0	1,200	21,330	3.07
4,428	73.8	3.08	77.8	42.8	1447.3	100	0	1,200	21,577	3.08
4,440	74.0	3.08	73.2	42.8	1392.4	100	0	1,200	21,770	3.09
4,452	74.2	3.09	73.2	42.8	1392.4	100	0	1,200	21,962	3.10
4,464	74.4	3.10	73.2	42.8	1392.4	100	0	1,200	22,154	3.11
4,476	74.6	3.11	73.2	42.8	1392.4	100	0	1,200	22,347	3.12
4,488	74.8	3.12	73.2	42.8	1392.4	100	0	1,200	22,539	3.13
4,500	75.0	3.13	73.2	42.8	1392.4	100	0	1,200	22,731	3.14
4,512	75.2	3.13	73.2	42.8	1392.4	100	0	1,200	22,924	3.15
4,524	75.4	3.14	73.2	42.8	1392.4	100	0	1,200	23,116	3.16
4,536	75.6	3.15	73.2	42.8	1392.4	100	0	1,200	23,309	3.17
4,548	75.8	3.16	73.2	42.8	1392.4	100	0	1,200	23,501	3.18
4,560	76.0	3.17	73.2	42.8	1392.4	100	0	1,200	23,693	3.19
4,572	76.2	3.18	73.2	42.8	1392.4	100	0	1,200	23,886	3.20
4,584	76.4	3.18	73.2	42.8	1392.4	100	0	1,200	24,078	3.21
4,596	76.6	3.19	68.7	42.8	1337.4	100	0	1,200	24,215	3.22
4,608	76.8	3.20	68.7	42.8	1337.4	100	0	1,200	24,353	3.23
4,620	77.0	3.21	68.7	42.8	1337.4	100	0	1,200	24,490	3.23
4,632	77.2	3.22	68.7	42.8	1337.4	100	0	1,200	24,628	3.24
4,644	77.4	3.23	68.7	42.8	1337.4	100	0	1,200	24,765	3.25
4,656	77.6	3.23	68.7	42.8	1337.4	100	0	1,200	24,903	3.25
4,668	77.8	3.24	68.7	42.8	1337.4	100	0	1,200	25,040	3.26
4,680	78.0	3.25	68.7	42.8	1337.4	100	0	1,200	25,178	3.27
4,692	78.2	3.26	68.7	42.8	1337.4	100	0	1,200	25,315	3.27
4,704	78.4	3.27	68.7	42.8	1337.4	100	0	1,200	25,452	3.28
4,716	78.6	3.28	68.7	42.8	1337.4	100	0	1,200	25,590	3.29
4,728	78.8	3.28	68.7	42.8	1337.4	100	0	1,200	25,727	3.29
4,740	79.0	3.29	68.7	42.8	1337.4	100	0	1,200	25,865	3.30
4,752	79.2	3.30	68.7	42.8	1337.4	100	0	1,200	26,002	3.31
4,764	79.4	3.31	64.1	42.8	1282.5	100	0	1,200	26,085	3.31
4,776	79.6	3.32	64.1	42.8	1282.5	100	0	1,200	26,167	3.32
4,788	79.8	3.33	64.1	42.8	1282.5	100	0	1,200	26,250	3.32
4,800	80.0	3.33	64.1	42.8	1282.5	100	0	1,200	26,332	3.32
4,812	80.2	3.34	64.1	42.8	1282.5	100	0	1,200	26,415	3.33
4,824	80.4	3.35	64.1	42.8	1282.5	100	0	1,200	26,497	3.33
4,836	80.6	3.36	64.1	42.8	1282.5	100	0	1,200	26,580	3.33
4,848	80.8	3.37	64.1	42.8	1282.5	100	0	1,200	26,662	3.34
4,860	81.0	3.38	64.1	42.8	1282.5	100	0	1,200	26,745	3.34
4,872	81.2	3.38	64.1	42.8	1282.5	100	0	1,200	26,827	3.35
4,884	81.4	3.39	64.1	42.8	1282.5	100	0	1,200	26,910	3.35

Attachment 5 - Cell 1 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,896	81.6	3.40	64.1	42.8	1282.5	100	0	1,200	26,992	3.35
4,908	81.8	3.41	64.1	42.8	1282.5	100	0	1,200	27,075	3.36
4,920	82.0	3.42	59.5	42.8	1227.6	100	0	1,200	27,102	3.36
4,932	82.2	3.43	59.5	42.8	1227.6	100	0	1,200	27,130	3.36
4,944	82.4	3.43	59.5	42.8	1227.6	100	0	1,200	27,158	3.36
4,956	82.6	3.44	59.5	42.8	1227.6	100	0	1,200	27,185	3.36
4,968	82.8	3.45	59.5	42.8	1227.6	100	0	1,200	27,213	3.36
4,980	83.0	3.46	59.5	42.8	1227.6	100	0	1,200	27,240	3.37
4,992	83.2	3.47	59.5	42.8	1227.6	100	0	1,200	27,268	3.37
5,004	83.4	3.48	59.5	42.8	1227.6	100	0	1,200	27,295	3.37
5,016	83.6	3.48	59.5	42.8	1227.6	100	0	1,200	27,323	3.37
5,028	83.8	3.49	59.5	42.8	1227.6	100	0	1,200	27,351	3.37
5,040	84.0	3.50	59.5	42.8	1227.6	100	0	1,200	27,378	3.37
5,052	84.2	3.51	59.5	42.8	1227.6	100	0	1,200	27,406	3.37
5,064	84.4	3.52	59.5	42.8	1227.6	100	0	1,200	27,433	3.38
5,076	84.6	3.53	59.5	42.8	1227.6	100	0	1,200	27,461	3.38
5,088	84.8	3.53	54.9	42.8	1172.6	100	0	1,200	27,433	3.38
5,100	85.0	3.54	54.9	42.8	1172.6	100	0	1,200	27,406	3.37
5,112	85.2	3.55	54.9	42.8	1172.6	100	0	1,200	27,379	3.37
5,124	85.4	3.56	54.9	42.8	1172.6	100	0	1,200	27,351	3.37
5,136	85.6	3.57	54.9	42.8	1172.6	100	0	1,200	27,324	3.37
5,148	85.8	3.58	54.9	42.8	1172.6	100	0	1,200	27,297	3.37
5,160	86.0	3.58	54.9	42.8	1172.6	100	0	1,200	27,269	3.37
5,172	86.2	3.59	54.9	42.8	1172.6	100	0	1,200	27,242	3.37
5,184	86.4	3.60	54.9	42.8	1172.6	100	0	1,200	27,215	3.37
5,196	86.6	3.61	54.9	42.8	1172.6	100	0	1,200	27,187	3.36
5,208	86.8	3.62	54.9	42.8	1172.6	100	0	1,200	27,160	3.36
5,220	87.0	3.63	54.9	42.8	1172.6	100	0	1,200	27,132	3.36
5,232	87.2	3.63	54.9	42.8	1172.6	100	0	1,200	27,105	3.36
5,244	87.4	3.64	54.9	42.8	1172.6	100	0	1,200	27,078	3.36
5,256	87.6	3.65	54.9	42.8	1172.6	100	0	1,200	27,050	3.36
5,268	87.8	3.66	50.4	42.8	1117.7	100	0	1,200	26,968	3.35
5,280	88.0	3.67	50.4	42.8	1117.7	100	0	1,200	26,886	3.35
5,292	88.2	3.68	50.4	42.8	1117.7	100	0	1,200	26,804	3.35
5,304	88.4	3.68	50.4	42.8	1117.7	100	0	1,200	26,721	3.34
5,316	88.6	3.69	50.4	42.8	1117.7	100	0	1,200	26,639	3.34
5,328	88.8	3.70	50.4	42.8	1117.7	100	0	1,200	26,557	3.33
5,340	89.0	3.71	50.4	42.8	1117.7	100	0	1,200	26,474	3.33
5,352	89.2	3.72	50.4	42.8	1117.7	100	0	1,200	26,392	3.33
5,364	89.4	3.73	50.4	42.8	1117.7	100	0	1,200	26,310	3.32
5,376	89.6	3.73	50.4	42.8	1117.7	100	0	1,200	26,227	3.32
5,388	89.8	3.74	50.4	42.8	1117.7	100	0	1,200	26,145	3.31
5,400	90.0	3.75	50.4	42.8	1117.7	100	0	1,200	26,063	3.31
5,412	90.2	3.76	50.4	42.8	1117.7	100	0	1,200	25,981	3.31
5,424	90.4	3.77	45.8	42.8	1062.8	100	0	1,200	25,843	3.30
5,436	90.6	3.78	45.8	42.8	1062.8	100	0	1,200	25,706	3.29
5,448	90.8	3.78	45.8	42.8	1062.8	100	0	1,200	25,569	3.29
5,460	91.0	3.79	45.8	42.8	1062.8	100	0	1,200	25,432	3.28
5,472	91.2	3.80	45.8	42.8	1062.8	100	0	1,200	25,294	3.27
5,484	91.4	3.81	45.8	42.8	1062.8	100	0	1,200	25,157	3.27
5,496	91.6	3.82	45.8	42.8	1062.8	100	0	1,200	25,020	3.26
5,508	91.8	3.83	45.8	42.8	1062.8	100	0	1,200	24,883	3.25
5,520	92.0	3.83	45.8	42.8	1062.8	100	0	1,200	24,746	3.25
5,532	92.2	3.84	45.8	42.8	1062.8	100	0	1,200	24,608	3.24
5,544	92.4	3.85	45.8	42.8	1062.8	100	0	1,200	24,471	3.23
5,556	92.6	3.86	45.8	42.8	1062.8	100	0	1,200	24,334	3.22
5,568	92.8	3.87	45.8	42.8	1062.8	100	0	1,200	24,197	3.22
5,580	93.0	3.88	45.8	42.8	1062.8	100	0	1,200	24,059	3.21
5,592	93.2	3.88	45.8	42.8	1062.8	100	0	1,200	23,922	3.20
5,604	93.4	3.89	45.8	42.8	1062.8	100	0	1,200	23,785	3.20
5,616	93.6	3.90	41.2	42.8	1007.8	100	0	1,200	23,593	3.19
5,628	93.8	3.91	41.2	42.8	1007.8	100	0	1,200	23,401	3.18
5,640	94.0	3.92	41.2	42.8	1007.8	100	0	1,200	23,209	3.17
5,652	94.2	3.93	41.2	42.8	1007.8	100	0	1,200	23,016	3.16
5,664	94.4	3.93	41.2	42.8	1007.8	100	0	1,200	22,824	3.15
5,676	94.6	3.94	41.2	42.8	1007.8	100	0	1,200	22,632	3.14
5,688	94.8	3.95	41.2	42.8	1007.8	100	0	1,200	22,440	3.13
5,700	95.0	3.96	41.2	42.8	1007.8	100	0	1,200	22,248	3.12

Attachment 5 - Cell 1 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,712	95.2	3.97	41.2	42.8	1007.8	100	0	1,200	22,056	3.11
5,724	95.4	3.98	41.2	42.8	1007.8	100	0	1,200	21,863	3.10
5,736	95.6	3.98	41.2	42.8	1007.8	100	0	1,200	21,671	3.08
5,748	95.8	3.99	41.2	42.8	1007.8	100	0	1,200	21,479	3.07
5,760	96.0	4.00	36.6	42.8	952.9	100	0	1,200	21,232	3.06
5,772	96.2	4.01	36.6	42.8	952.9	100	0	1,200	20,985	3.05
5,784	96.4	4.02	36.6	42.8	952.9	100	0	1,200	20,738	3.03
5,796	96.6	4.03	36.6	42.8	952.9	100	0	1,200	20,491	3.02
5,808	96.8	4.03	36.6	42.8	952.9	100	0	1,200	20,244	3.01
5,820	97.0	4.04	36.6	42.8	952.9	100	0	1,200	19,997	2.99
5,832	97.2	4.05	36.6	42.8	952.9	100	0	1,200	19,749	2.98
5,844	97.4	4.06	36.6	42.8	952.9	100	0	1,200	19,502	2.96
5,856	97.6	4.07	36.6	42.8	952.9	100	0	1,200	19,255	2.95
5,868	97.8	4.08	36.6	42.8	952.9	100	0	1,200	19,008	2.93
5,880	98.0	4.08	36.6	42.8	952.9	100	0	1,200	18,761	2.92
5,892	98.2	4.09	36.6	42.8	952.9	100	0	1,200	18,514	2.90
5,904	98.4	4.10	36.6	42.8	952.9	100	0	1,200	18,267	2.89
5,916	98.6	4.11	36.6	42.8	952.9	100	0	1,200	18,020	2.87
5,928	98.8	4.12	36.6	42.8	952.9	100	0	1,200	17,773	2.86
5,940	99.0	4.13	36.6	42.8	952.9	100	0	1,200	17,526	2.84
5,952	99.2	4.13	36.6	42.8	952.9	100	0	1,200	17,278	2.83
5,964	99.4	4.14	36.6	42.8	952.9	100	0	1,200	17,031	2.81
5,976	99.6	4.15	32.0	42.8	898.0	100	0	1,200	16,729	2.79
5,988	99.8	4.16	32.0	42.8	898.0	100	0	1,200	16,427	2.78
6,000	100.0	4.17	32.0	42.8	898.0	100	0	1,200	16,125	2.76
6,012	100.2	4.18	32.0	42.8	898.0	100	0	1,200	15,823	2.74
6,024	100.4	4.18	32.0	42.8	898.0	100	0	1,200	15,521	2.72
6,036	100.6	4.19	32.0	42.8	898.0	100	0	1,200	15,219	2.70
6,048	100.8	4.20	32.0	42.8	898.0	100	0	1,200	14,917	2.67
6,060	101.0	4.21	32.0	42.8	898.0	100	0	1,200	14,615	2.65
6,072	101.2	4.22	32.0	42.8	898.0	100	0	1,200	14,313	2.63
6,084	101.4	4.23	32.0	42.8	898.0	100	0	1,200	14,011	2.61
6,096	101.6	4.23	32.0	42.8	898.0	100	0	1,200	13,709	2.59
6,108	101.8	4.24	32.0	42.8	898.0	100	0	1,200	13,407	2.57
6,120	102.0	4.25	32.0	42.8	898.0	100	0	1,200	13,105	2.55
6,132	102.2	4.26	32.0	42.8	898.0	100	0	1,200	12,803	2.52
6,144	102.4	4.27	32.0	42.8	898.0	100	0	1,200	12,501	2.50
6,156	102.6	4.28	27.5	42.8	843.0	100	0	1,200	12,144	2.47
6,168	102.8	4.28	27.5	42.8	843.0	100	0	1,200	11,787	2.44
6,180	103.0	4.29	27.5	42.8	843.0	100	0	1,200	11,430	2.42
6,192	103.2	4.30	27.5	42.8	843.0	100	0	1,200	11,073	2.39
6,204	103.4	4.31	27.5	42.8	843.0	100	0	1,200	10,716	2.36
6,216	103.6	4.32	27.5	42.8	843.0	100	0	1,200	10,359	2.33
6,228	103.8	4.33	27.5	42.8	843.0	100	0	1,200	10,002	2.30
6,240	104.0	4.33	27.5	42.8	843.0	100	0	1,200	9,645	2.26
6,252	104.2	4.34	27.5	42.8	843.0	100	0	1,200	9,288	2.23
6,264	104.4	4.35	27.5	42.8	843.0	100	0	1,200	8,931	2.20
6,276	104.6	4.36	27.5	42.8	843.0	100	0	1,200	8,574	2.17
6,288	104.8	4.37	27.5	42.8	843.0	100	0	1,200	8,218	2.13
6,300	105.0	4.38	27.5	42.8	843.0	100	0	1,200	7,861	2.09
6,312	105.2	4.38	27.5	42.8	843.0	100	0	1,200	7,504	2.06
6,324	105.4	4.39	27.5	42.8	843.0	100	0	1,200	7,147	1.99
6,336	105.6	4.40	27.5	42.8	843.0	100	0	1,200	6,790	1.89
6,348	105.8	4.41	27.5	42.8	843.0	100	0	1,200	6,433	1.79
6,360	106.0	4.42	22.9	42.8	788.1	100	0	1,200	6,021	1.68
6,372	106.2	4.43	22.9	42.8	788.1	100	0	1,200	5,609	1.56
6,384	106.4	4.43	22.9	42.8	788.1	100	0	1,200	5,197	1.45
6,396	106.6	4.44	22.9	42.8	788.1	100	0	1,200	4,785	1.33
6,408	106.8	4.45	22.9	42.8	788.1	100	0	1,200	4,373	1.22
6,420	107.0	4.46	22.9	42.8	788.1	100	0	1,200	3,961	1.10
6,432	107.2	4.47	22.9	42.8	788.1	100	0	1,200	3,549	0.99
6,444	107.4	4.48	22.9	42.8	788.1	100	0	1,200	3,138	0.87
6,456	107.6	4.48	22.9	42.8	788.1	100	0	1,200	2,726	0.76
6,468	107.8	4.49	22.9	42.8	788.1	100	0	1,200	2,314	0.64
6,480	108.0	4.50	22.9	42.8	788.1	100	0	1,200	1,902	0.53
6,492	108.2	4.51	22.9	42.8	788.1	100	0	1,200	1,490	0.41
6,504	108.4	4.52	22.9	42.8	788.1	0	0	0	2,278	0.63
6,516	108.6	4.53	22.9	42.8	788.1	0	0	0	3,066	0.85

Attachment 5 - Cell 1 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,528	108.8	4.53	22.9	42.8	788.1	0	0	0	3,854	1.07
6,540	109.0	4.54	22.9	42.8	788.1	100	0	1,200	3,442	0.96
6,552	109.2	4.55	22.9	42.8	788.1	100	0	1,200	3,031	0.84
6,564	109.4	4.56	22.9	42.8	788.1	100	0	1,200	2,619	0.73
6,576	109.6	4.57	22.9	42.8	788.1	100	0	1,200	2,207	0.61
6,588	109.8	4.58	18.3	42.8	733.2	100	0	1,200	1,740	0.48
6,600	110.0	4.58	18.3	42.8	733.2	0	0	0	2,473	0.69
6,612	110.2	4.59	18.3	42.8	733.2	0	0	0	3,206	0.89
6,624	110.4	4.60	18.3	42.8	733.2	0	0	0	3,939	1.10
6,636	110.6	4.61	18.3	42.8	733.2	100	0	1,200	3,473	0.97
6,648	110.8	4.62	18.3	42.8	733.2	100	0	1,200	3,006	0.84
6,660	111.0	4.63	18.3	42.8	733.2	100	0	1,200	2,539	0.71
6,672	111.2	4.63	18.3	42.8	733.2	100	0	1,200	2,072	0.58
6,684	111.4	4.64	18.3	42.8	733.2	100	0	1,200	1,605	0.45
6,696	111.6	4.65	18.3	42.8	733.2	0	0	0	2,339	0.65
6,708	111.8	4.66	18.3	42.8	733.2	0	0	0	3,072	0.86
6,720	112.0	4.67	18.3	42.8	733.2	0	0	0	3,805	1.06
6,732	112.2	4.68	18.3	42.8	733.2	100	0	1,200	3,338	0.93
6,744	112.4	4.68	18.3	42.8	733.2	100	0	1,200	2,871	0.80
6,756	112.6	4.69	18.3	42.8	733.2	100	0	1,200	2,404	0.67
6,768	112.8	4.70	18.3	42.8	733.2	100	0	1,200	1,938	0.54
6,780	113.0	4.71	18.3	42.8	733.2	100	0	1,200	1,471	0.41
6,792	113.2	4.72	18.3	42.8	733.2	0	0	0	2,204	0.61
6,804	113.4	4.73	18.3	42.8	733.2	0	0	0	2,937	0.82
6,816	113.6	4.73	13.7	42.8	678.2	0	0	0	3,615	1.01
6,828	113.8	4.74	13.7	42.8	678.2	100	0	1,200	3,094	0.86
6,840	114.0	4.75	13.7	42.8	678.2	100	0	1,200	2,572	0.72
6,852	114.2	4.76	13.7	42.8	678.2	100	0	1,200	2,050	0.57
6,864	114.4	4.77	13.7	42.8	678.2	100	0	1,200	1,528	0.43
6,876	114.6	4.78	13.7	42.8	678.2	0	0	0	2,207	0.61
6,888	114.8	4.78	13.7	42.8	678.2	0	0	0	2,885	0.80
6,900	115.0	4.79	13.7	42.8	678.2	0	0	0	3,563	0.99
6,912	115.2	4.80	13.7	42.8	678.2	0	0	0	4,241	1.18
6,924	115.4	4.81	13.7	42.8	678.2	100	0	1,200	3,720	1.04
6,936	115.6	4.82	13.7	42.8	678.2	100	0	1,200	3,198	0.89
6,948	115.8	4.83	13.7	42.8	678.2	100	0	1,200	2,676	0.75
6,960	116.0	4.83	13.7	42.8	678.2	100	0	1,200	2,154	0.60
6,972	116.2	4.84	13.7	42.8	678.2	100	0	1,200	1,632	0.45
6,984	116.4	4.85	13.7	42.8	678.2	0	0	0	2,311	0.64
6,996	116.6	4.86	13.7	42.8	678.2	0	0	0	2,989	0.83
7,008	116.8	4.87	13.7	42.8	678.2	0	0	0	3,667	1.02
7,020	117.0	4.88	13.7	42.8	678.2	100	0	1,200	3,145	0.88
7,032	117.2	4.88	13.7	42.8	678.2	100	0	1,200	2,624	0.73
7,044	117.4	4.89	9.2	42.8	623.3	100	0	1,200	2,047	0.57
7,056	117.6	4.90	9.2	42.8	623.3	100	0	1,200	1,470	0.41
7,068	117.8	4.91	9.2	42.8	623.3	0	0	0	2,094	0.58
7,080	118.0	4.92	9.2	42.8	623.3	0	0	0	2,717	0.76
7,092	118.2	4.93	9.2	42.8	623.3	0	0	0	3,340	0.93
7,104	118.4	4.93	9.2	42.8	623.3	0	0	0	3,964	1.10
7,116	118.6	4.94	9.2	42.8	623.3	100	0	1,200	3,387	0.94
7,128	118.8	4.95	9.2	42.8	623.3	100	0	1,200	2,810	0.78
7,140	119.0	4.96	9.2	42.8	623.3	100	0	1,200	2,233	0.62
7,152	119.2	4.97	9.2	42.8	623.3	100	0	1,200	1,657	0.46
7,164	119.4	4.98	9.2	42.8	623.3	0	0	0	2,280	0.64
7,176	119.6	4.98	9.2	42.8	623.3	0	0	0	2,903	0.81
7,188	119.8	4.99	9.2	42.8	623.3	0	0	0	3,527	0.98
7,200	120.0	5.00	9.2	42.8	623.3	0	0	0	4,150	1.16
7,212	120.2	5.01	0.0	42.8	513.4	100	0	1,200	3,463	0.96
7,224	120.4	5.02	0.0	42.8	513.4	100	0	1,200	2,777	0.77
7,236	120.6	5.03	0.0	42.8	513.4	100	0	1,200	2,090	0.58
7,248	120.8	5.03	0.0	42.8	513.4	100	0	1,200	1,404	0.39
7,260	121.0	5.04	0.0	42.8	513.4	0	0	0	1,917	0.53
7,272	121.2	5.05	0.0	42.8	513.4	0	0	0	2,431	0.68
7,284	121.4	5.06	0.0	42.8	513.4	0	0	0	2,944	0.82
7,296	121.6	5.07	0.0	42.8	513.4	0	0	0	3,458	0.96
7,308	121.8	5.08	0.0	42.8	513.4	0	0	0	3,971	1.11
7,320	122.0	5.08	0.0	42.8	513.4	100	0	1,200	3,284	0.91
7,332	122.2	5.09	0.0	42.8	513.4	100	0	1,200	2,598	0.72

Attachment 5 - Cell 1 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,344	122.4	5.10	0.0	42.8	513.4	100	0	1,200	1,911	0.53
7,356	122.6	5.11	0.0	42.8	513.4	100	0	1,200	1,225	0.34
7,368	122.8	5.12	0.0	42.8	513.4	0	0	0	1,738	0.48
7,380	123.0	5.13	0.0	42.8	513.4	0	0	0	2,252	0.63
7,392	123.2	5.13	0.0	42.8	513.4	0	0	0	2,765	0.77
7,404	123.4	5.14	0.0	42.8	513.4	0	0	0	3,279	0.91
7,416	123.6	5.15	0.0	42.8	513.4	0	0	0	3,792	1.06
7,428	123.8	5.16	0.0	42.8	513.4	100	0	1,200	3,105	0.86
7,440	124.0	5.17	0.0	42.8	513.4	100	0	1,200	2,419	0.67
7,452	124.2	5.18	0.0	42.8	513.4	100	0	1,200	1,732	0.48
7,464	124.4	5.18	0.0	42.8	513.4	0	0	0	2,246	0.63
7,476	124.6	5.19	0.0	42.8	513.4	0	0	0	2,759	0.77
7,488	124.8	5.20	0.0	42.8	513.4	0	0	0	3,273	0.91
7,500	125.0	5.21	0.0	42.8	513.4	0	0	0	3,786	1.05
7,512	125.2	5.22	0.0	42.8	513.4	100	0	1,200	3,100	0.86
7,524	125.4	5.23	0.0	42.8	513.4	100	0	1,200	2,413	0.67
7,536	125.6	5.23	0.0	42.8	513.4	100	0	1,200	1,726	0.48
7,548	125.8	5.24	0.0	42.8	513.4	0	0	0	2,240	0.62
7,560	126.0	5.25	0.0	42.8	513.4	0	0	0	2,753	0.77
7,572	126.2	5.26	0.0	42.8	513.4	0	0	0	3,267	0.91
7,584	126.4	5.27	0.0	42.8	513.4	0	0	0	3,780	1.05
7,596	126.6	5.28	0.0	42.8	513.4	100	0	1,200	3,094	0.86
7,608	126.8	5.28	0.0	42.8	513.4	100	0	1,200	2,407	0.67
7,620	127.0	5.29	0.0	42.8	513.4	100	0	1,200	1,721	0.48
7,632	127.2	5.30	0.0	42.8	513.4	0	0	0	2,234	0.62
7,644	127.4	5.31	0.0	42.8	513.4	0	0	0	2,747	0.77
7,656	127.6	5.32	0.0	42.8	513.4	0	0	0	3,261	0.91
7,668	127.8	5.33	0.0	42.8	513.4	0	0	0	3,774	1.05
7,680	128.0	5.33	0.0	42.8	513.4	100	0	1,200	3,088	0.86
7,692	128.2	5.34	0.0	42.8	513.4	100	0	1,200	2,401	0.67
7,704	128.4	5.35	0.0	42.8	513.4	100	0	1,200	1,715	0.48
7,716	128.6	5.36	0.0	42.8	513.4	0	0	0	2,228	0.62
7,728	128.8	5.37	0.0	42.8	513.4	0	0	0	2,741	0.76
7,740	129.0	5.38	0.0	42.8	513.4	0	0	0	3,255	0.91
7,752	129.2	5.38	0.0	42.8	513.4	0	0	0	3,768	1.05
7,764	129.4	5.39	0.0	42.8	513.4	100	0	1,200	3,082	0.86
7,776	129.6	5.40	0.0	42.8	513.4	100	0	1,200	2,395	0.67
7,788	129.8	5.41	0.0	42.8	513.4	100	0	1,200	1,709	0.48
7,800	130.0	5.42	0.0	42.8	513.4	0	0	0	2,222	0.62
7,812	130.2	5.43	0.0	42.8	513.4	0	0	0	2,736	0.76
7,824	130.4	5.43	0.0	42.8	513.4	0	0	0	3,249	0.90
7,836	130.6	5.44	0.0	42.8	513.4	0	0	0	3,762	1.05
7,848	130.8	5.45	0.0	42.8	513.4	100	0	1,200	3,076	0.86
7,860	131.0	5.46	0.0	42.8	513.4	100	0	1,200	2,389	0.67
7,872	131.2	5.47	0.0	42.8	513.4	100	0	1,200	1,703	0.47
7,884	131.4	5.48	0.0	42.8	513.4	0	0	0	2,216	0.62
7,896	131.6	5.48	0.0	42.8	513.4	0	0	0	2,730	0.76
7,908	131.8	5.49	0.0	42.8	513.4	0	0	0	3,243	0.90
7,920	132.0	5.50	0.0	42.8	513.4	0	0	0	3,757	1.05
7,932	132.2	5.51	0.0	42.8	513.4	100	0	1,200	3,070	0.86
7,944	132.4	5.52	0.0	42.8	513.4	100	0	1,200	2,383	0.66
7,956	132.6	5.53	0.0	42.8	513.4	100	0	1,200	1,697	0.47
7,968	132.8	5.53	0.0	42.8	513.4	0	0	0	2,210	0.62
7,980	133.0	5.54	0.0	42.8	513.4	0	0	0	2,724	0.76
7,992	133.2	5.55	0.0	42.8	513.4	0	0	0	3,237	0.90
8,004	133.4	5.56	0.0	42.8	513.4	0	0	0	3,751	1.04
8,016	133.6	5.57	0.0	42.8	513.4	100	0	1,200	3,064	0.85
8,028	133.8	5.58	0.0	42.8	513.4	100	0	1,200	2,378	0.66
8,040	134.0	5.58	0.0	42.8	513.4	100	0	1,200	1,691	0.47
8,052	134.2	5.59	0.0	42.8	513.4	0	0	0	2,204	0.61
8,064	134.4	5.60	0.0	42.8	513.4	0	0	0	2,718	0.76
8,076	134.6	5.61	0.0	42.8	513.4	0	0	0	3,231	0.90
8,088	134.8	5.62	0.0	42.8	513.4	0	0	0	3,745	1.04
8,100	135.0	5.63	0.0	42.8	513.4	100	0	1,200	3,058	0.85
8,112	135.2	5.63	0.0	42.8	513.4	100	0	1,200	2,372	0.66
8,124	135.4	5.64	0.0	42.8	513.4	100	0	1,200	1,685	0.47
8,136	135.6	5.65	0.0	42.8	513.4	0	0	0	2,199	0.61
8,148	135.8	5.66	0.0	42.8	513.4	0	0	0	2,712	0.76

Attachment 5 - Cell 1 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,160	136.0	5.67	0.0	42.8	513.4	0	0	0	3,225	0.90
8,172	136.2	5.68	0.0	42.8	513.4	0	0	0	3,739	1.04
8,184	136.4	5.68	0.0	42.8	513.4	100	0	1,200	3,052	0.85
8,196	136.6	5.69	0.0	42.8	513.4	100	0	1,200	2,366	0.66
8,208	136.8	5.70	0.0	42.8	513.4	100	0	1,200	1,679	0.47
8,220	137.0	5.71	0.0	42.8	513.4	0	0	0	2,193	0.61
8,232	137.2	5.72	0.0	42.8	513.4	0	0	0	2,706	0.75
8,244	137.4	5.73	0.0	42.8	513.4	0	0	0	3,220	0.90
8,256	137.6	5.73	0.0	42.8	513.4	0	0	0	3,733	1.04
8,268	137.8	5.74	0.0	42.8	513.4	100	0	1,200	3,046	0.85
8,280	138.0	5.75	0.0	42.8	513.4	100	0	1,200	2,360	0.66
8,292	138.2	5.76	0.0	42.8	513.4	100	0	1,200	1,673	0.47
8,304	138.4	5.77	0.0	42.8	513.4	0	0	0	2,187	0.61
8,316	138.6	5.78	0.0	42.8	513.4	0	0	0	2,700	0.75
8,328	138.8	5.78	0.0	42.8	513.4	0	0	0	3,214	0.90
8,340	139.0	5.79	0.0	42.8	513.4	0	0	0	3,727	1.04
8,352	139.2	5.80	0.0	42.8	513.4	100	0	1,200	3,040	0.85
8,364	139.4	5.81	0.0	42.8	513.4	100	0	1,200	2,354	0.66
8,376	139.6	5.82	0.0	42.8	513.4	100	0	1,200	1,667	0.46
8,388	139.8	5.83	0.0	42.8	513.4	0	0	0	2,181	0.61
8,400	140.0	5.83	0.0	42.8	513.4	0	0	0	2,694	0.75
8,412	140.2	5.84	0.0	42.8	513.4	0	0	0	3,208	0.89
8,424	140.4	5.85	0.0	42.8	513.4	0	0	0	3,721	1.04
8,436	140.6	5.86	0.0	42.8	513.4	100	0	1,200	3,035	0.85
8,448	140.8	5.87	0.0	42.8	513.4	100	0	1,200	2,348	0.65
8,460	141.0	5.88	0.0	42.8	513.4	100	0	1,200	1,661	0.46
8,472	141.2	5.88	0.0	42.8	513.4	0	0	0	2,175	0.61
8,484	141.4	5.89	0.0	42.8	513.4	0	0	0	2,688	0.75
8,496	141.6	5.90	0.0	42.8	513.4	0	0	0	3,202	0.89
8,508	141.8	5.91	0.0	42.8	513.4	0	0	0	3,715	1.03
8,520	142.0	5.92	0.0	42.8	513.4	100	0	1,200	3,029	0.84
8,532	142.2	5.93	0.0	42.8	513.4	100	0	1,200	2,342	0.65
8,544	142.4	5.93	0.0	42.8	513.4	100	0	1,200	1,656	0.46
8,556	142.6	5.94	0.0	42.8	513.4	0	0	0	2,169	0.60
8,568	142.8	5.95	0.0	42.8	513.4	0	0	0	2,682	0.75
8,580	143.0	5.96	0.0	42.8	513.4	0	0	0	3,196	0.89
8,592	143.2	5.97	0.0	42.8	513.4	0	0	0	3,709	1.03
8,604	143.4	5.98	0.0	42.8	513.4	100	0	1,200	3,023	0.84
8,616	143.6	5.98	0.0	42.8	513.4	100	0	1,200	2,336	0.65
8,628	143.8	5.99	0.0	42.8	513.4	100	0	1,200	1,650	0.46
8,640	144.0	6.00	0.0	42.8	513.4	0	0	0	2,163	0.60
8,652	144.2	6.01	0.0	42.8	513.4	0	0	0	2,677	0.75
8,664	144.4	6.02	0.0	42.8	513.4	0	0	0	3,190	0.89
8,676	144.6	6.03	0.0	42.8	513.4	0	0	0	3,703	1.03
8,688	144.8	6.03	0.0	42.8	513.4	100	0	1,200	3,017	0.84
8,700	145.0	6.04	0.0	42.8	513.4	100	0	1,200	2,330	0.65
8,712	145.2	6.05	0.0	42.8	513.4	100	0	1,200	1,644	0.46
8,724	145.4	6.06	0.0	42.8	513.4	0	0	0	2,157	0.60
8,736	145.6	6.07	0.0	42.8	513.4	0	0	0	2,671	0.74
8,748	145.8	6.08	0.0	42.8	513.4	0	0	0	3,184	0.89
8,760	146.0	6.08	0.0	42.8	513.4	0	0	0	3,698	1.03
8,772	146.2	6.09	0.0	42.8	513.4	100	0	1,200	3,011	0.84
8,784	146.4	6.10	0.0	42.8	513.4	100	0	1,200	2,324	0.65
8,796	146.6	6.11	0.0	42.8	513.4	100	0	1,200	1,638	0.46
8,808	146.8	6.12	0.0	42.8	513.4	0	0	0	2,151	0.60
8,820	147.0	6.13	0.0	42.8	513.4	0	0	0	2,665	0.74
8,832	147.2	6.13	0.0	42.8	513.4	0	0	0	3,178	0.89
8,844	147.4	6.14	0.0	42.8	513.4	0	0	0	3,692	1.03
8,856	147.6	6.15	0.0	42.8	513.4	100	0	1,200	3,005	0.84
8,868	147.8	6.16	0.0	42.8	513.4	100	0	1,200	2,319	0.65
8,880	148.0	6.17	0.0	42.8	513.4	100	0	1,200	1,632	0.45
8,892	148.2	6.18	0.0	42.8	513.4	0	0	0	2,145	0.60
8,904	148.4	6.18	0.0	42.8	513.4	0	0	0	2,659	0.74
8,916	148.6	6.19	0.0	42.8	513.4	0	0	0	3,172	0.88
8,928	148.8	6.20	0.0	42.8	513.4	0	0	0	3,686	1.03
8,940	149.0	6.21	0.0	42.8	513.4	100	0	1,200	2,999	0.84
8,952	149.2	6.22	0.0	42.8	513.4	100	0	1,200	2,313	0.64
8,964	149.4	6.23	0.0	42.8	513.4	100	0	1,200	1,626	0.45

Attachment 5 - Cell 1 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,976	149.6	6.23	0.0	42.8	513.4	0	0	0	2,140	0.60
8,988	149.8	6.24	0.0	42.8	513.4	0	0	0	2,653	0.74
9,000	150.0	6.25	0.0	42.8	513.4	0	0	0	3,166	0.88
9,012	150.2	6.26	0.0	42.8	513.4	0	0	0	3,680	1.02
9,024	150.4	6.27	0.0	42.8	513.4	100	0	1,200	2,993	0.83
9,036	150.6	6.28	0.0	42.8	513.4	100	0	1,200	2,307	0.64
9,048	150.8	6.28	0.0	42.8	513.4	100	0	1,200	1,620	0.45
9,060	151.0	6.29	0.0	42.8	513.4	0	0	0	2,134	0.59
9,072	151.2	6.30	0.0	42.8	513.4	0	0	0	2,647	0.74
9,084	151.4	6.31	0.0	42.8	513.4	0	0	0	3,160	0.88
9,096	151.6	6.32	0.0	42.8	513.4	0	0	0	3,674	1.02
9,108	151.8	6.33	0.0	42.8	513.4	100	0	1,200	2,987	0.83
9,120	152.0	6.33	0.0	42.8	513.4	100	0	1,200	2,301	0.64
9,132	152.2	6.34	0.0	42.8	513.4	100	0	1,200	1,614	0.45
9,144	152.4	6.35	0.0	42.8	513.4	0	0	0	2,128	0.59
9,156	152.6	6.36	0.0	42.8	513.4	0	0	0	2,641	0.74
9,168	152.8	6.37	0.0	42.8	513.4	0	0	0	3,155	0.88
9,180	153.0	6.38	0.0	42.8	513.4	0	0	0	3,668	1.02
9,192	153.2	6.38	0.0	42.8	513.4	100	0	1,200	2,981	0.83
9,204	153.4	6.39	0.0	42.8	513.4	100	0	1,200	2,295	0.64
9,216	153.6	6.40	0.0	42.8	513.4	100	0	1,200	1,608	0.45
9,228	153.8	6.41	0.0	42.8	513.4	0	0	0	2,122	0.59
9,240	154.0	6.42	0.0	42.8	513.4	0	0	0	2,635	0.73
9,252	154.2	6.43	0.0	42.8	513.4	0	0	0	3,149	0.88
9,264	154.4	6.43	0.0	42.8	513.4	0	0	0	3,662	1.02
9,276	154.6	6.44	0.0	42.8	513.4	100	0	1,200	2,976	0.83
9,288	154.8	6.45	0.0	42.8	513.4	100	0	1,200	2,289	0.64
9,300	155.0	6.46	0.0	42.8	513.4	100	0	1,200	1,602	0.45
9,312	155.2	6.47	0.0	42.8	513.4	0	0	0	2,116	0.59
9,324	155.4	6.48	0.0	42.8	513.4	0	0	0	2,629	0.73
9,336	155.6	6.48	0.0	42.8	513.4	0	0	0	3,143	0.88
9,348	155.8	6.49	0.0	42.8	513.4	0	0	0	3,656	1.02
9,360	156.0	6.50	0.0	42.8	513.4	100	0	1,200	2,970	0.83
9,372	156.2	6.51	0.0	42.8	513.4	100	0	1,200	2,283	0.64
9,384	156.4	6.52	0.0	42.8	513.4	100	0	1,200	1,597	0.44
9,396	156.6	6.53	0.0	42.8	513.4	0	0	0	2,110	0.59
9,408	156.8	6.53	0.0	42.8	513.4	0	0	0	2,623	0.73
9,420	157.0	6.54	0.0	42.8	513.4	0	0	0	3,137	0.87
9,432	157.2	6.55	0.0	42.8	513.4	0	0	0	3,650	1.02
9,444	157.4	6.56	0.0	42.8	513.4	100	0	1,200	2,964	0.83
9,456	157.6	6.57	0.0	42.8	513.4	100	0	1,200	2,277	0.63
9,468	157.8	6.58	0.0	42.8	513.4	100	0	1,200	1,591	0.44
9,480	158.0	6.58	0.0	42.8	513.4	0	0	0	2,104	0.59
9,492	158.2	6.59	0.0	42.8	513.4	0	0	0	2,618	0.73
9,504	158.4	6.60	0.0	42.8	513.4	0	0	0	3,131	0.87
9,516	158.6	6.61	0.0	42.8	513.4	0	0	0	3,644	1.02
9,528	158.8	6.62	0.0	42.8	513.4	100	0	1,200	2,958	0.82
9,540	159.0	6.63	0.0	42.8	513.4	100	0	1,200	2,271	0.63
9,552	159.2	6.63	0.0	42.8	513.4	100	0	1,200	1,585	0.44
9,564	159.4	6.64	0.0	42.8	513.4	0	0	0	2,098	0.58
9,576	159.6	6.65	0.0	42.8	513.4	0	0	0	2,612	0.73
9,588	159.8	6.66	0.0	42.8	513.4	0	0	0	3,125	0.87
9,600	160.0	6.67	0.0	42.8	513.4	0	0	0	3,639	1.01
9,612	160.2	6.68	0.0	42.8	513.4	100	0	1,200	2,952	0.82
9,624	160.4	6.68	0.0	42.8	513.4	100	0	1,200	2,265	0.63
9,636	160.6	6.69	0.0	42.8	513.4	100	0	1,200	1,579	0.44
9,648	160.8	6.70	0.0	42.8	513.4	0	0	0	2,092	0.58
9,660	161.0	6.71	0.0	42.8	513.4	0	0	0	2,606	0.73
9,672	161.2	6.72	0.0	42.8	513.4	0	0	0	3,119	0.87
9,684	161.4	6.73	0.0	42.8	513.4	0	0	0	3,633	1.01
9,696	161.6	6.73	0.0	42.8	513.4	100	0	1,200	2,946	0.82
9,708	161.8	6.74	0.0	42.8	513.4	100	0	1,200	2,259	0.63
9,720	162.0	6.75	0.0	42.8	513.4	100	0	1,200	1,573	0.44
9,732	162.2	6.76	0.0	42.8	513.4	0	0	0	2,086	0.58
9,744	162.4	6.77	0.0	42.8	513.4	0	0	0	2,600	0.72
9,756	162.6	6.78	0.0	42.8	513.4	0	0	0	3,113	0.87
9,768	162.8	6.78	0.0	42.8	513.4	0	0	0	3,627	1.01
9,780	163.0	6.79	0.0	42.8	513.4	100	0	1,200	2,940	0.82

Attachment 5 - Cell 1 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
9,792	163.2	6.80	0.0	42.8	513.4	100	0	1,200	2,254	0.63
9,804	163.4	6.81	0.0	42.8	513.4	100	0	1,200	1,567	0.44
9,816	163.6	6.82	0.0	42.8	513.4	0	0	0	2,080	0.58
9,828	163.8	6.83	0.0	42.8	513.4	0	0	0	2,594	0.72
9,840	164.0	6.83	0.0	42.8	513.4	0	0	0	3,107	0.87
9,852	164.2	6.84	0.0	42.8	513.4	0	0	0	3,621	1.01
9,864	164.4	6.85	0.0	42.8	513.4	100	0	1,200	2,934	0.82
9,876	164.6	6.86	0.0	42.8	513.4	100	0	1,200	2,248	0.63
9,888	164.8	6.87	0.0	42.8	513.4	100	0	1,200	1,561	0.43
9,900	165.0	6.88	0.0	42.8	513.4	0	0	0	2,075	0.58
9,912	165.2	6.88	0.0	42.8	513.4	0	0	0	2,588	0.72
9,924	165.4	6.89	0.0	42.8	513.4	0	0	0	3,101	0.86
9,936	165.6	6.90	0.0	42.8	513.4	0	0	0	3,615	1.01
9,948	165.8	6.91	0.0	42.8	513.4	100	0	1,200	2,928	0.82
9,960	166.0	6.92	0.0	42.8	513.4	100	0	1,200	2,242	0.62
9,972	166.2	6.93	0.0	42.8	513.4	100	0	1,200	1,555	0.43
9,984	166.4	6.93	0.0	42.8	513.4	0	0	0	2,069	0.58
9,996	166.6	6.94	0.0	42.8	513.4	0	0	0	2,582	0.72
10,008	166.8	6.95	0.0	42.8	513.4	0	0	0	3,096	0.86
10,020	167.0	6.96	0.0	42.8	513.4	0	0	0	3,609	1.01
10,032	167.2	6.97	0.0	42.8	513.4	100	0	1,200	2,922	0.81
10,044	167.4	6.98	0.0	42.8	513.4	100	0	1,200	2,236	0.62
10,056	167.6	6.98	0.0	42.8	513.4	100	0	1,200	1,549	0.43
10,068	167.8	6.99	0.0	42.8	513.4	0	0	0	2,063	0.57
10,080	168.0	7.00	0.0	42.8	513.4	0	0	0	2,576	0.72

ATTACHMENT 6

Cell 2 Leakage Detection Sump – Average Conditions

Attachment 6 - Cell 2 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
0	0.0	0.00	0	0.012	0.0	0	0	1,795	1.00
12	0.2	0.01	0	0.012	0.1	0	0	1,795	1.00
24	0.4	0.02	0	0.012	0.1	100	1,200	595	0.33
36	0.6	0.03	0	0.012	0.1	0	0	596	0.33
48	0.8	0.03	0	0.012	0.1	0	0	596	0.33
60	1.0	0.04	0	0.012	0.1	0	0	596	0.33
72	1.2	0.05	0	0.012	0.1	0	0	596	0.33
84	1.4	0.06	0	0.012	0.1	0	0	596	0.33
96	1.6	0.07	0	0.012	0.1	0	0	596	0.33
108	1.8	0.08	0	0.012	0.1	0	0	597	0.33
120	2.0	0.08	0	0.012	0.1	0	0	597	0.33
132	2.2	0.09	0	0.012	0.1	0	0	597	0.33
144	2.4	0.10	0	0.012	0.1	0	0	597	0.33
156	2.6	0.11	0	0.012	0.1	0	0	597	0.33
168	2.8	0.12	0	0.012	0.1	0	0	597	0.33
180	3.0	0.13	0	0.012	0.1	0	0	597	0.33
192	3.2	0.13	0	0.012	0.1	0	0	598	0.33
204	3.4	0.14	0	0.012	0.1	0	0	598	0.33
216	3.6	0.15	0	0.012	0.1	0	0	598	0.33
228	3.8	0.16	0	0.012	0.1	0	0	598	0.33
240	4.0	0.17	0	0.012	0.1	0	0	598	0.33
252	4.2	0.18	0	0.012	0.1	0	0	598	0.33
264	4.4	0.18	0	0.012	0.1	0	0	598	0.33
276	4.6	0.19	0	0.012	0.1	0	0	599	0.33
288	4.8	0.20	0	0.012	0.1	0	0	599	0.33
300	5.0	0.21	0	0.012	0.1	0	0	599	0.33
312	5.2	0.22	0	0.012	0.1	0	0	599	0.33
324	5.4	0.23	0	0.012	0.1	0	0	599	0.33
336	5.6	0.23	0	0.012	0.1	0	0	599	0.33
348	5.8	0.24	0	0.012	0.1	0	0	599	0.33
360	6.0	0.25	0	0.012	0.1	0	0	600	0.33
372	6.2	0.26	0	0.012	0.1	0	0	600	0.33
384	6.4	0.27	0	0.012	0.1	0	0	600	0.33
396	6.6	0.28	0	0.012	0.1	0	0	600	0.33
408	6.8	0.28	0	0.012	0.1	0	0	600	0.33
420	7.0	0.29	0	0.012	0.1	0	0	600	0.33
432	7.2	0.30	0	0.012	0.1	0	0	601	0.33
444	7.4	0.31	0	0.012	0.1	0	0	601	0.33
456	7.6	0.32	0	0.012	0.1	0	0	601	0.33
468	7.8	0.33	0	0.012	0.1	0	0	601	0.33
480	8.0	0.33	0	0.012	0.1	0	0	601	0.33
492	8.2	0.34	0	0.012	0.1	0	0	601	0.33
504	8.4	0.35	0	0.012	0.1	0	0	601	0.33
516	8.6	0.36	0	0.012	0.1	0	0	602	0.34
528	8.8	0.37	0	0.012	0.1	0	0	602	0.34
540	9.0	0.38	0	0.012	0.1	0	0	602	0.34
552	9.2	0.38	0	0.012	0.1	0	0	602	0.34
564	9.4	0.39	0	0.012	0.1	0	0	602	0.34
576	9.6	0.40	0	0.012	0.1	0	0	602	0.34
588	9.8	0.41	0	0.012	0.1	0	0	602	0.34
600	10.0	0.42	0	0.012	0.1	0	0	603	0.34
612	10.2	0.43	0	0.012	0.1	0	0	603	0.34
624	10.4	0.43	0	0.012	0.1	0	0	603	0.34
636	10.6	0.44	0	0.012	0.1	0	0	603	0.34
648	10.8	0.45	0	0.012	0.1	0	0	603	0.34
660	11.0	0.46	0	0.012	0.1	0	0	603	0.34
672	11.2	0.47	0	0.012	0.1	0	0	603	0.34
684	11.4	0.48	0	0.012	0.1	0	0	604	0.34
696	11.6	0.48	0	0.012	0.1	0	0	604	0.34
708	11.8	0.49	0	0.012	0.1	0	0	604	0.34
720	12.0	0.50	0	0.012	0.1	0	0	604	0.34
732	12.2	0.51	0	0.012	0.1	0	0	604	0.34
744	12.4	0.52	0	0.012	0.1	0	0	604	0.34
756	12.6	0.53	0	0.012	0.1	0	0	604	0.34
768	12.8	0.53	0	0.012	0.1	0	0	605	0.34

Attachment 6 - Cell 2 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
780	13.0	0.54	0	0.012	0.1	0	0	605	0.34
792	13.2	0.55	0	0.012	0.1	0	0	605	0.34
804	13.4	0.56	0	0.012	0.1	0	0	605	0.34
816	13.6	0.57	0	0.012	0.1	0	0	605	0.34
828	13.8	0.58	0	0.012	0.1	0	0	605	0.34
840	14.0	0.58	0	0.012	0.1	0	0	606	0.34
852	14.2	0.59	0	0.012	0.1	0	0	606	0.34
864	14.4	0.60	0	0.012	0.1	0	0	606	0.34
876	14.6	0.61	0	0.012	0.1	0	0	606	0.34
888	14.8	0.62	0	0.012	0.1	0	0	606	0.34
900	15.0	0.63	0	0.012	0.1	0	0	606	0.34
912	15.2	0.63	0	0.012	0.1	0	0	606	0.34
924	15.4	0.64	0	0.012	0.1	0	0	607	0.34
936	15.6	0.65	0	0.012	0.1	0	0	607	0.34
948	15.8	0.66	0	0.012	0.1	0	0	607	0.34
960	16.0	0.67	0	0.012	0.1	0	0	607	0.34
972	16.2	0.68	0	0.012	0.1	0	0	607	0.34
984	16.4	0.68	0	0.012	0.1	0	0	607	0.34
996	16.6	0.69	0	0.012	0.1	0	0	607	0.34
1,008	16.8	0.70	0	0.012	0.1	0	0	608	0.34
1,020	17.0	0.71	0	0.012	0.1	0	0	608	0.34
1,032	17.2	0.72	0	0.012	0.1	0	0	608	0.34
1,044	17.4	0.73	0	0.012	0.1	0	0	608	0.34
1,056	17.6	0.73	0	0.012	0.1	0	0	608	0.34
1,068	17.8	0.74	0	0.012	0.1	0	0	608	0.34
1,080	18.0	0.75	0	0.012	0.1	0	0	608	0.34
1,092	18.2	0.76	0	0.012	0.1	0	0	609	0.34
1,104	18.4	0.77	0	0.012	0.1	0	0	609	0.34
1,116	18.6	0.78	0	0.012	0.1	0	0	609	0.34
1,128	18.8	0.78	0	0.012	0.1	0	0	609	0.34
1,140	19.0	0.79	0	0.012	0.1	0	0	609	0.34
1,152	19.2	0.80	0	0.012	0.1	0	0	609	0.34
1,164	19.4	0.81	0	0.012	0.1	0	0	609	0.34
1,176	19.6	0.82	0	0.012	0.1	0	0	610	0.34
1,188	19.8	0.83	0	0.012	0.1	0	0	610	0.34
1,200	20.0	0.83	0	0.012	0.1	0	0	610	0.34
1,212	20.2	0.84	0	0.012	0.1	0	0	610	0.34
1,224	20.4	0.85	0	0.012	0.1	0	0	610	0.34
1,236	20.6	0.86	0	0.012	0.1	0	0	610	0.34
1,248	20.8	0.87	0	0.012	0.1	0	0	611	0.34
1,260	21.0	0.88	0	0.012	0.1	0	0	611	0.34
1,272	21.2	0.88	0	0.012	0.1	0	0	611	0.34
1,284	21.4	0.89	0	0.012	0.1	0	0	611	0.34
1,296	21.6	0.90	0	0.012	0.1	0	0	611	0.34
1,308	21.8	0.91	0	0.012	0.1	0	0	611	0.34
1,320	22.0	0.92	0	0.012	0.1	0	0	611	0.34
1,332	22.2	0.93	0	0.012	0.1	0	0	612	0.34
1,344	22.4	0.93	0	0.012	0.1	0	0	612	0.34
1,356	22.6	0.94	0	0.012	0.1	0	0	612	0.34
1,368	22.8	0.95	0	0.012	0.1	0	0	612	0.34
1,380	23.0	0.96	0	0.012	0.1	0	0	612	0.34
1,392	23.2	0.97	0	0.012	0.1	0	0	612	0.34
1,404	23.4	0.98	0	0.012	0.1	0	0	612	0.34
1,416	23.6	0.98	0	0.012	0.1	0	0	613	0.34
1,428	23.8	0.99	0	0.012	0.1	0	0	613	0.34
1,440	24.0	1.00	0	0.012	0.1	0	0	613	0.34
1,452	24.2	1.01	0	0.012	0.1	0	0	613	0.34
1,464	24.4	1.02	0	0.012	0.1	0	0	613	0.34
1,476	24.6	1.03	0	0.012	0.1	0	0	613	0.34
1,488	24.8	1.03	0	0.012	0.1	0	0	613	0.34
1,500	25.0	1.04	0	0.012	0.1	0	0	614	0.34
1,512	25.2	1.05	0	0.012	0.1	0	0	614	0.34
1,524	25.4	1.06	0	0.012	0.1	0	0	614	0.34
1,536	25.6	1.07	0	0.012	0.1	0	0	614	0.34
1,548	25.8	1.08	0	0.012	0.1	0	0	614	0.34

Attachment 6 - Cell 2 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,560	26.0	1.08	0	0.012	0.1	0	0	614	0.34
1,572	26.2	1.09	0	0.012	0.1	0	0	615	0.34
1,584	26.4	1.10	0	0.012	0.1	0	0	615	0.34
1,596	26.6	1.11	0	0.012	0.1	0	0	615	0.34
1,608	26.8	1.12	0	0.012	0.1	0	0	615	0.34
1,620	27.0	1.13	0	0.012	0.1	0	0	615	0.34
1,632	27.2	1.13	0	0.012	0.1	0	0	615	0.34
1,644	27.4	1.14	0	0.012	0.1	0	0	615	0.34
1,656	27.6	1.15	0	0.012	0.1	0	0	616	0.34
1,668	27.8	1.16	0	0.012	0.1	0	0	616	0.34
1,680	28.0	1.17	0	0.012	0.1	0	0	616	0.34
1,692	28.2	1.18	0	0.012	0.1	0	0	616	0.34
1,704	28.4	1.18	0	0.012	0.1	0	0	616	0.34
1,716	28.6	1.19	0	0.012	0.1	0	0	616	0.34
1,728	28.8	1.20	0	0.012	0.1	0	0	616	0.34
1,740	29.0	1.21	0	0.012	0.1	0	0	617	0.34
1,752	29.2	1.22	0	0.012	0.1	0	0	617	0.34
1,764	29.4	1.23	0	0.012	0.1	0	0	617	0.34
1,776	29.6	1.23	0	0.012	0.1	0	0	617	0.34
1,788	29.8	1.24	0	0.012	0.1	0	0	617	0.34
1,800	30.0	1.25	0	0.012	0.1	0	0	617	0.34
1,812	30.2	1.26	0	0.012	0.1	0	0	617	0.34
1,824	30.4	1.27	0	0.012	0.1	0	0	618	0.34
1,836	30.6	1.28	0	0.012	0.1	0	0	618	0.34
1,848	30.8	1.28	0	0.012	0.1	0	0	618	0.34
1,860	31.0	1.29	0	0.012	0.1	0	0	618	0.34
1,872	31.2	1.30	0	0.012	0.1	0	0	618	0.34
1,884	31.4	1.31	0	0.012	0.1	0	0	618	0.34
1,896	31.6	1.32	0	0.012	0.1	0	0	618	0.34
1,908	31.8	1.33	0	0.012	0.1	0	0	619	0.34
1,920	32.0	1.33	0	0.012	0.1	0	0	619	0.34
1,932	32.2	1.34	0	0.012	0.1	0	0	619	0.34
1,944	32.4	1.35	0	0.012	0.1	0	0	619	0.34
1,956	32.6	1.36	0	0.012	0.1	0	0	619	0.34
1,968	32.8	1.37	0	0.012	0.1	0	0	619	0.35
1,980	33.0	1.38	0	0.012	0.1	0	0	620	0.35
1,992	33.2	1.38	0	0.012	0.1	0	0	620	0.35
2,004	33.4	1.39	0	0.012	0.1	0	0	620	0.35
2,016	33.6	1.40	0	0.012	0.1	0	0	620	0.35
2,028	33.8	1.41	0	0.012	0.1	0	0	620	0.35
2,040	34.0	1.42	0	0.012	0.1	0	0	620	0.35
2,052	34.2	1.43	0	0.012	0.1	0	0	620	0.35
2,064	34.4	1.43	0	0.012	0.1	0	0	621	0.35
2,076	34.6	1.44	0	0.012	0.1	0	0	621	0.35
2,088	34.8	1.45	0	0.012	0.1	0	0	621	0.35
2,100	35.0	1.46	0	0.012	0.1	0	0	621	0.35
2,112	35.2	1.47	0	0.012	0.1	0	0	621	0.35
2,124	35.4	1.48	0	0.012	0.1	0	0	621	0.35
2,136	35.6	1.48	0	0.012	0.1	0	0	621	0.35
2,148	35.8	1.49	0	0.012	0.1	0	0	622	0.35
2,160	36.0	1.50	0	0.012	0.1	0	0	622	0.35
2,172	36.2	1.51	0	0.012	0.1	0	0	622	0.35
2,184	36.4	1.52	0	0.012	0.1	0	0	622	0.35
2,196	36.6	1.53	0	0.012	0.1	0	0	622	0.35
2,208	36.8	1.53	0	0.012	0.1	0	0	622	0.35
2,220	37.0	1.54	0	0.012	0.1	0	0	622	0.35
2,232	37.2	1.55	0	0.012	0.1	0	0	623	0.35
2,244	37.4	1.56	0	0.012	0.1	0	0	623	0.35
2,256	37.6	1.57	0	0.012	0.1	0	0	623	0.35
2,268	37.8	1.58	0	0.012	0.1	0	0	623	0.35
2,280	38.0	1.58	0	0.012	0.1	0	0	623	0.35
2,292	38.2	1.59	0	0.012	0.1	0	0	623	0.35
2,304	38.4	1.60	0	0.012	0.1	0	0	623	0.35
2,316	38.6	1.61	0	0.012	0.1	0	0	624	0.35
2,328	38.8	1.62	0	0.012	0.1	0	0	624	0.35

Attachment 6 - Cell 2 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
2,340	39.0	1.63	0	0.012	0.1	0	0	624	0.35
2,352	39.2	1.63	0	0.012	0.1	0	0	624	0.35
2,364	39.4	1.64	0	0.012	0.1	0	0	624	0.35
2,376	39.6	1.65	0	0.012	0.1	0	0	624	0.35
2,388	39.8	1.66	0	0.012	0.1	0	0	625	0.35
2,400	40.0	1.67	0	0.012	0.1	0	0	625	0.35
2,412	40.2	1.68	0	0.012	0.1	0	0	625	0.35
2,424	40.4	1.68	0	0.012	0.1	0	0	625	0.35
2,436	40.6	1.69	0	0.012	0.1	0	0	625	0.35
2,448	40.8	1.70	0	0.012	0.1	0	0	625	0.35
2,460	41.0	1.71	0	0.012	0.1	0	0	625	0.35
2,472	41.2	1.72	0	0.012	0.1	0	0	626	0.35
2,484	41.4	1.73	0	0.012	0.1	0	0	626	0.35
2,496	41.6	1.73	0	0.012	0.1	0	0	626	0.35
2,508	41.8	1.74	0	0.012	0.1	0	0	626	0.35
2,520	42.0	1.75	0	0.012	0.1	0	0	626	0.35
2,532	42.2	1.76	0	0.012	0.1	0	0	626	0.35
2,544	42.4	1.77	0	0.012	0.1	0	0	626	0.35
2,556	42.6	1.78	0	0.012	0.1	0	0	627	0.35
2,568	42.8	1.78	0	0.012	0.1	0	0	627	0.35
2,580	43.0	1.79	0	0.012	0.1	0	0	627	0.35
2,592	43.2	1.80	0	0.012	0.1	0	0	627	0.35
2,604	43.4	1.81	0	0.012	0.1	0	0	627	0.35
2,616	43.6	1.82	0	0.012	0.1	0	0	627	0.35
2,628	43.8	1.83	0	0.012	0.1	0	0	627	0.35
2,640	44.0	1.83	0	0.012	0.1	0	0	628	0.35
2,652	44.2	1.84	0	0.012	0.1	0	0	628	0.35
2,664	44.4	1.85	0	0.012	0.1	0	0	628	0.35
2,676	44.6	1.86	0	0.012	0.1	0	0	628	0.35
2,688	44.8	1.87	0	0.012	0.1	0	0	628	0.35
2,700	45.0	1.88	0	0.012	0.1	0	0	628	0.35
2,712	45.2	1.88	0	0.012	0.1	0	0	629	0.35
2,724	45.4	1.89	0	0.012	0.1	0	0	629	0.35
2,736	45.6	1.90	0	0.012	0.1	0	0	629	0.35
2,748	45.8	1.91	0	0.012	0.1	0	0	629	0.35
2,760	46.0	1.92	0	0.012	0.1	0	0	629	0.35
2,772	46.2	1.93	0	0.012	0.1	0	0	629	0.35
2,784	46.4	1.93	0	0.012	0.1	0	0	629	0.35
2,796	46.6	1.94	0	0.012	0.1	0	0	630	0.35
2,808	46.8	1.95	0	0.012	0.1	0	0	630	0.35
2,820	47.0	1.96	0	0.012	0.1	0	0	630	0.35
2,832	47.2	1.97	0	0.012	0.1	0	0	630	0.35
2,844	47.4	1.98	0	0.012	0.1	0	0	630	0.35
2,856	47.6	1.98	0	0.012	0.1	0	0	630	0.35
2,868	47.8	1.99	0	0.012	0.1	0	0	630	0.35
2,880	48.0	2.00	0	0.012	0.1	0	0	631	0.35
2,892	48.2	2.01	0	0.012	0.1	0	0	631	0.35
2,904	48.4	2.02	0	0.012	0.1	0	0	631	0.35
2,916	48.6	2.03	0	0.012	0.1	0	0	631	0.35
2,928	48.8	2.03	0	0.012	0.1	0	0	631	0.35
2,940	49.0	2.04	0	0.012	0.1	0	0	631	0.35
2,952	49.2	2.05	0	0.012	0.1	0	0	631	0.35
2,964	49.4	2.06	0	0.012	0.1	0	0	632	0.35
2,976	49.6	2.07	0	0.012	0.1	0	0	632	0.35
2,988	49.8	2.08	0	0.012	0.1	0	0	632	0.35
3,000	50.0	2.08	0	0.012	0.1	0	0	632	0.35
3,012	50.2	2.09	0	0.012	0.1	0	0	632	0.35
3,024	50.4	2.10	0	0.012	0.1	0	0	632	0.35
3,036	50.6	2.11	0	0.012	0.1	0	0	632	0.35
3,048	50.8	2.12	0	0.012	0.1	0	0	633	0.35
3,060	51.0	2.13	0	0.012	0.1	0	0	633	0.35
3,072	51.2	2.13	0	0.012	0.1	0	0	633	0.35
3,084	51.4	2.14	0	0.012	0.1	0	0	633	0.35
3,096	51.6	2.15	0	0.012	0.1	0	0	633	0.35
3,108	51.8	2.16	0	0.012	0.1	0	0	633	0.35

Attachment 6 - Cell 2 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,120	52.0	2.17	0	0.012	0.1	0	0	634	0.35
3,132	52.2	2.18	0	0.012	0.1	0	0	634	0.35
3,144	52.4	2.18	0	0.012	0.1	0	0	634	0.35
3,156	52.6	2.19	0	0.012	0.1	0	0	634	0.35
3,168	52.8	2.20	0	0.012	0.1	0	0	634	0.35
3,180	53.0	2.21	0	0.012	0.1	0	0	634	0.35
3,192	53.2	2.22	0	0.012	0.1	0	0	634	0.35
3,204	53.4	2.23	0	0.012	0.1	0	0	635	0.35
3,216	53.6	2.23	0	0.012	0.1	0	0	635	0.35
3,228	53.8	2.24	0	0.012	0.1	0	0	635	0.35
3,240	54.0	2.25	0	0.012	0.1	0	0	635	0.35
3,252	54.2	2.26	0	0.012	0.1	0	0	635	0.35
3,264	54.4	2.27	0	0.012	0.1	0	0	635	0.35
3,276	54.6	2.28	0	0.012	0.1	0	0	635	0.35
3,288	54.8	2.28	0	0.012	0.1	0	0	636	0.35
3,300	55.0	2.29	0	0.012	0.1	0	0	636	0.35
3,312	55.2	2.30	0	0.012	0.1	0	0	636	0.35
3,324	55.4	2.31	0	0.012	0.1	0	0	636	0.35
3,336	55.6	2.32	0	0.012	0.1	0	0	636	0.35
3,348	55.8	2.33	0	0.012	0.1	0	0	636	0.35
3,360	56.0	2.33	0	0.012	0.1	0	0	636	0.35
3,372	56.2	2.34	0	0.012	0.1	0	0	637	0.35
3,384	56.4	2.35	0	0.012	0.1	0	0	637	0.35
3,396	56.6	2.36	0	0.012	0.1	0	0	637	0.35
3,408	56.8	2.37	0	0.012	0.1	0	0	637	0.35
3,420	57.0	2.38	0	0.012	0.1	0	0	637	0.35
3,432	57.2	2.38	0	0.012	0.1	0	0	637	0.36
3,444	57.4	2.39	0	0.012	0.1	0	0	637	0.36
3,456	57.6	2.40	0	0.012	0.1	0	0	638	0.36
3,468	57.8	2.41	0	0.012	0.1	0	0	638	0.36
3,480	58.0	2.42	0	0.012	0.1	0	0	638	0.36
3,492	58.2	2.43	0	0.012	0.1	0	0	638	0.36
3,504	58.4	2.43	0	0.012	0.1	0	0	638	0.36
3,516	58.6	2.44	0	0.012	0.1	0	0	638	0.36
3,528	58.8	2.45	0	0.012	0.1	0	0	639	0.36
3,540	59.0	2.46	0	0.012	0.1	0	0	639	0.36
3,552	59.2	2.47	0	0.012	0.1	0	0	639	0.36
3,564	59.4	2.48	0	0.012	0.1	0	0	639	0.36
3,576	59.6	2.48	0	0.012	0.1	0	0	639	0.36
3,588	59.8	2.49	0	0.012	0.1	0	0	639	0.36
3,600	60.0	2.50	0	0.012	0.1	0	0	639	0.36
3,612	60.2	2.51	0	0.012	0.1	0	0	640	0.36
3,624	60.4	2.52	0	0.012	0.1	0	0	640	0.36
3,636	60.6	2.53	0	0.012	0.1	0	0	640	0.36
3,648	60.8	2.53	0	0.012	0.1	0	0	640	0.36
3,660	61.0	2.54	0	0.012	0.1	0	0	640	0.36
3,672	61.2	2.55	0	0.012	0.1	0	0	640	0.36
3,684	61.4	2.56	0	0.012	0.1	0	0	640	0.36
3,696	61.6	2.57	0	0.012	0.1	0	0	641	0.36
3,708	61.8	2.58	0	0.012	0.1	0	0	641	0.36
3,720	62.0	2.58	0	0.012	0.1	0	0	641	0.36
3,732	62.2	2.59	0	0.012	0.1	0	0	641	0.36
3,744	62.4	2.60	0	0.012	0.1	0	0	641	0.36
3,756	62.6	2.61	0	0.012	0.1	0	0	641	0.36
3,768	62.8	2.62	0	0.012	0.1	0	0	641	0.36
3,780	63.0	2.63	0	0.012	0.1	0	0	642	0.36
3,792	63.2	2.63	0	0.012	0.1	0	0	642	0.36
3,804	63.4	2.64	0	0.012	0.1	0	0	642	0.36
3,816	63.6	2.65	0	0.012	0.1	0	0	642	0.36
3,828	63.8	2.66	0	0.012	0.1	0	0	642	0.36
3,840	64.0	2.67	0	0.012	0.1	0	0	642	0.36
3,852	64.2	2.68	0	0.012	0.1	0	0	643	0.36
3,864	64.4	2.68	0	0.012	0.1	0	0	643	0.36
3,876	64.6	2.69	0	0.012	0.1	0	0	643	0.36
3,888	64.8	2.70	0	0.012	0.1	0	0	643	0.36

Attachment 6 - Cell 2 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,900	65.0	2.71	0	0.012	0.1	0	0	643	0.36
3,912	65.2	2.72	0	0.012	0.1	0	0	643	0.36
3,924	65.4	2.73	0	0.012	0.1	0	0	643	0.36
3,936	65.6	2.73	0	0.012	0.1	0	0	644	0.36
3,948	65.8	2.74	0	0.012	0.1	0	0	644	0.36
3,960	66.0	2.75	0	0.012	0.1	0	0	644	0.36
3,972	66.2	2.76	0	0.012	0.1	0	0	644	0.36
3,984	66.4	2.77	0	0.012	0.1	0	0	644	0.36
3,996	66.6	2.78	0	0.012	0.1	0	0	644	0.36
4,008	66.8	2.78	0	0.012	0.1	0	0	644	0.36
4,020	67.0	2.79	0	0.012	0.1	0	0	645	0.36
4,032	67.2	2.80	0	0.012	0.1	0	0	645	0.36
4,044	67.4	2.81	0	0.012	0.1	0	0	645	0.36
4,056	67.6	2.82	0	0.012	0.1	0	0	645	0.36
4,068	67.8	2.83	0	0.012	0.1	0	0	645	0.36
4,080	68.0	2.83	0	0.012	0.1	0	0	645	0.36
4,092	68.2	2.84	0	0.012	0.1	0	0	645	0.36
4,104	68.4	2.85	0	0.012	0.1	0	0	646	0.36
4,116	68.6	2.86	0	0.012	0.1	0	0	646	0.36
4,128	68.8	2.87	0	0.012	0.1	0	0	646	0.36
4,140	69.0	2.88	0	0.012	0.1	0	0	646	0.36
4,152	69.2	2.88	0	0.012	0.1	0	0	646	0.36
4,164	69.4	2.89	0	0.012	0.1	0	0	646	0.36
4,176	69.6	2.90	0	0.012	0.1	0	0	646	0.36
4,188	69.8	2.91	0	0.012	0.1	0	0	647	0.36
4,200	70.0	2.92	0	0.012	0.1	0	0	647	0.36
4,212	70.2	2.93	0	0.012	0.1	0	0	647	0.36
4,224	70.4	2.93	0	0.012	0.1	0	0	647	0.36
4,236	70.6	2.94	0	0.012	0.1	0	0	647	0.36
4,248	70.8	2.95	0	0.012	0.1	0	0	647	0.36
4,260	71.0	2.96	0	0.012	0.1	0	0	648	0.36
4,272	71.2	2.97	0	0.012	0.1	0	0	648	0.36
4,284	71.4	2.98	0	0.012	0.1	0	0	648	0.36
4,296	71.6	2.98	0	0.012	0.1	0	0	648	0.36
4,308	71.8	2.99	0	0.012	0.1	0	0	648	0.36
4,320	72.0	3.00	0	0.012	0.1	0	0	648	0.36
4,332	72.2	3.01	0	0.012	0.1	0	0	648	0.36
4,344	72.4	3.02	0	0.012	0.1	0	0	649	0.36
4,356	72.6	3.03	0	0.012	0.1	0	0	649	0.36
4,368	72.8	3.03	0	0.012	0.1	0	0	649	0.36
4,380	73.0	3.04	0	0.012	0.1	0	0	649	0.36
4,392	73.2	3.05	0	0.012	0.1	0	0	649	0.36
4,404	73.4	3.06	0	0.012	0.1	0	0	649	0.36
4,416	73.6	3.07	0	0.012	0.1	0	0	649	0.36
4,428	73.8	3.08	0	0.012	0.1	0	0	650	0.36
4,440	74.0	3.08	0	0.012	0.1	0	0	650	0.36
4,452	74.2	3.09	0	0.012	0.1	0	0	650	0.36
4,464	74.4	3.10	0	0.012	0.1	0	0	650	0.36
4,476	74.6	3.11	0	0.012	0.1	0	0	650	0.36
4,488	74.8	3.12	0	0.012	0.1	0	0	650	0.36
4,500	75.0	3.13	0	0.012	0.1	0	0	650	0.36
4,512	75.2	3.13	0	0.012	0.1	0	0	651	0.36
4,524	75.4	3.14	0	0.012	0.1	0	0	651	0.36
4,536	75.6	3.15	0	0.012	0.1	0	0	651	0.36
4,548	75.8	3.16	0	0.012	0.1	0	0	651	0.36
4,560	76.0	3.17	0	0.012	0.1	0	0	651	0.36
4,572	76.2	3.18	0	0.012	0.1	0	0	651	0.36
4,584	76.4	3.18	0	0.012	0.1	0	0	652	0.36
4,596	76.6	3.19	0	0.012	0.1	0	0	652	0.36
4,608	76.8	3.20	0	0.012	0.1	0	0	652	0.36
4,620	77.0	3.21	0	0.012	0.1	0	0	652	0.36
4,632	77.2	3.22	0	0.012	0.1	0	0	652	0.36
4,644	77.4	3.23	0	0.012	0.1	0	0	652	0.36
4,656	77.6	3.23	0	0.012	0.1	0	0	652	0.36
4,668	77.8	3.24	0	0.012	0.1	0	0	653	0.36

Attachment 6 - Cell 2 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,680	78.0	3.25	0	0.012	0.1	0	0	653	0.36
4,692	78.2	3.26	0	0.012	0.1	0	0	653	0.36
4,704	78.4	3.27	0	0.012	0.1	0	0	653	0.36
4,716	78.6	3.28	0	0.012	0.1	0	0	653	0.36
4,728	78.8	3.28	0	0.012	0.1	0	0	653	0.36
4,740	79.0	3.29	0	0.012	0.1	0	0	653	0.36
4,752	79.2	3.30	0	0.012	0.1	0	0	654	0.36
4,764	79.4	3.31	0	0.012	0.1	0	0	654	0.36
4,776	79.6	3.32	0	0.012	0.1	0	0	654	0.36
4,788	79.8	3.33	0	0.012	0.1	0	0	654	0.36
4,800	80.0	3.33	0	0.012	0.1	0	0	654	0.36
4,812	80.2	3.34	0	0.012	0.1	0	0	654	0.36
4,824	80.4	3.35	0	0.012	0.1	0	0	654	0.36
4,836	80.6	3.36	0	0.012	0.1	0	0	655	0.36
4,848	80.8	3.37	0	0.012	0.1	0	0	655	0.36
4,860	81.0	3.38	0	0.012	0.1	0	0	655	0.36
4,872	81.2	3.38	0	0.012	0.1	0	0	655	0.36
4,884	81.4	3.39	0	0.012	0.1	0	0	655	0.36
4,896	81.6	3.40	0	0.012	0.1	0	0	655	0.37
4,908	81.8	3.41	0	0.012	0.1	0	0	655	0.37
4,920	82.0	3.42	0	0.012	0.1	0	0	656	0.37
4,932	82.2	3.43	0	0.012	0.1	0	0	656	0.37
4,944	82.4	3.43	0	0.012	0.1	0	0	656	0.37
4,956	82.6	3.44	0	0.012	0.1	0	0	656	0.37
4,968	82.8	3.45	0	0.012	0.1	0	0	656	0.37
4,980	83.0	3.46	0	0.012	0.1	0	0	656	0.37
4,992	83.2	3.47	0	0.012	0.1	0	0	657	0.37
5,004	83.4	3.48	0	0.012	0.1	0	0	657	0.37
5,016	83.6	3.48	0	0.012	0.1	0	0	657	0.37
5,028	83.8	3.49	0	0.012	0.1	0	0	657	0.37
5,040	84.0	3.50	0	0.012	0.1	0	0	657	0.37
5,052	84.2	3.51	0	0.012	0.1	0	0	657	0.37
5,064	84.4	3.52	0	0.012	0.1	0	0	657	0.37
5,076	84.6	3.53	0	0.012	0.1	0	0	658	0.37
5,088	84.8	3.53	0	0.012	0.1	0	0	658	0.37
5,100	85.0	3.54	0	0.012	0.1	0	0	658	0.37
5,112	85.2	3.55	0	0.012	0.1	0	0	658	0.37
5,124	85.4	3.56	0	0.012	0.1	0	0	658	0.37
5,136	85.6	3.57	0	0.012	0.1	0	0	658	0.37
5,148	85.8	3.58	0	0.012	0.1	0	0	658	0.37
5,160	86.0	3.58	0	0.012	0.1	0	0	659	0.37
5,172	86.2	3.59	0	0.012	0.1	0	0	659	0.37
5,184	86.4	3.60	0	0.012	0.1	0	0	659	0.37
5,196	86.6	3.61	0	0.012	0.1	0	0	659	0.37
5,208	86.8	3.62	0	0.012	0.1	0	0	659	0.37
5,220	87.0	3.63	0	0.012	0.1	0	0	659	0.37
5,232	87.2	3.63	0	0.012	0.1	0	0	659	0.37
5,244	87.4	3.64	0	0.012	0.1	0	0	660	0.37
5,256	87.6	3.65	0	0.012	0.1	0	0	660	0.37
5,268	87.8	3.66	0	0.012	0.1	0	0	660	0.37
5,280	88.0	3.67	0	0.012	0.1	0	0	660	0.37
5,292	88.2	3.68	0	0.012	0.1	0	0	660	0.37
5,304	88.4	3.68	0	0.012	0.1	0	0	660	0.37
5,316	88.6	3.69	0	0.012	0.1	0	0	660	0.37
5,328	88.8	3.70	0	0.012	0.1	0	0	661	0.37
5,340	89.0	3.71	0	0.012	0.1	0	0	661	0.37
5,352	89.2	3.72	0	0.012	0.1	0	0	661	0.37
5,364	89.4	3.73	0	0.012	0.1	0	0	661	0.37
5,376	89.6	3.73	0	0.012	0.1	0	0	661	0.37
5,388	89.8	3.74	0	0.012	0.1	0	0	661	0.37
5,400	90.0	3.75	0	0.012	0.1	0	0	662	0.37
5,412	90.2	3.76	0	0.012	0.1	0	0	662	0.37
5,424	90.4	3.77	0	0.012	0.1	0	0	662	0.37
5,436	90.6	3.78	0	0.012	0.1	0	0	662	0.37
5,448	90.8	3.78	0	0.012	0.1	0	0	662	0.37

Attachment 6 - Cell 2 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,460	91.0	3.79	0	0.012	0.1	0	0	662	0.37
5,472	91.2	3.80	0	0.012	0.1	0	0	662	0.37
5,484	91.4	3.81	0	0.012	0.1	0	0	663	0.37
5,496	91.6	3.82	0	0.012	0.1	0	0	663	0.37
5,508	91.8	3.83	0	0.012	0.1	0	0	663	0.37
5,520	92.0	3.83	0	0.012	0.1	0	0	663	0.37
5,532	92.2	3.84	0	0.012	0.1	0	0	663	0.37
5,544	92.4	3.85	0	0.012	0.1	0	0	663	0.37
5,556	92.6	3.86	0	0.012	0.1	0	0	663	0.37
5,568	92.8	3.87	0	0.012	0.1	0	0	664	0.37
5,580	93.0	3.88	0	0.012	0.1	0	0	664	0.37
5,592	93.2	3.88	0	0.012	0.1	0	0	664	0.37
5,604	93.4	3.89	0	0.012	0.1	0	0	664	0.37
5,616	93.6	3.90	0	0.012	0.1	0	0	664	0.37
5,628	93.8	3.91	0	0.012	0.1	0	0	664	0.37
5,640	94.0	3.92	0	0.012	0.1	0	0	664	0.37
5,652	94.2	3.93	0	0.012	0.1	0	0	665	0.37
5,664	94.4	3.93	0	0.012	0.1	0	0	665	0.37
5,676	94.6	3.94	0	0.012	0.1	0	0	665	0.37
5,688	94.8	3.95	0	0.012	0.1	0	0	665	0.37
5,700	95.0	3.96	0	0.012	0.1	0	0	665	0.37
5,712	95.2	3.97	0	0.012	0.1	0	0	665	0.37
5,724	95.4	3.98	0	0.012	0.1	0	0	666	0.37
5,736	95.6	3.98	0	0.012	0.1	0	0	666	0.37
5,748	95.8	3.99	0	0.012	0.1	0	0	666	0.37
5,760	96.0	4.00	0	0.012	0.1	0	0	666	0.37
5,772	96.2	4.01	0	0.012	0.1	0	0	666	0.37
5,784	96.4	4.02	0	0.012	0.1	0	0	666	0.37
5,796	96.6	4.03	0	0.012	0.1	0	0	666	0.37
5,808	96.8	4.03	0	0.012	0.1	0	0	667	0.37
5,820	97.0	4.04	0	0.012	0.1	0	0	667	0.37
5,832	97.2	4.05	0	0.012	0.1	0	0	667	0.37
5,844	97.4	4.06	0	0.012	0.1	0	0	667	0.37
5,856	97.6	4.07	0	0.012	0.1	0	0	667	0.37
5,868	97.8	4.08	0	0.012	0.1	0	0	667	0.37
5,880	98.0	4.08	0	0.012	0.1	0	0	667	0.37
5,892	98.2	4.09	0	0.012	0.1	0	0	668	0.37
5,904	98.4	4.10	0	0.012	0.1	0	0	668	0.37
5,916	98.6	4.11	0	0.012	0.1	0	0	668	0.37
5,928	98.8	4.12	0	0.012	0.1	0	0	668	0.37
5,940	99.0	4.13	0	0.012	0.1	0	0	668	0.37
5,952	99.2	4.13	0	0.012	0.1	0	0	668	0.37
5,964	99.4	4.14	0	0.012	0.1	0	0	668	0.37
5,976	99.6	4.15	0	0.012	0.1	0	0	669	0.37
5,988	99.8	4.16	0	0.012	0.1	0	0	669	0.37
6,000	100.0	4.17	0	0.012	0.1	0	0	669	0.37
6,012	100.2	4.18	0	0.012	0.1	0	0	669	0.37
6,024	100.4	4.18	0	0.012	0.1	0	0	669	0.37
6,036	100.6	4.19	0	0.012	0.1	0	0	669	0.37
6,048	100.8	4.20	0	0.012	0.1	0	0	669	0.37
6,060	101.0	4.21	0	0.012	0.1	0	0	670	0.37
6,072	101.2	4.22	0	0.012	0.1	0	0	670	0.37
6,084	101.4	4.23	0	0.012	0.1	0	0	670	0.37
6,096	101.6	4.23	0	0.012	0.1	0	0	670	0.37
6,108	101.8	4.24	0	0.012	0.1	0	0	670	0.37
6,120	102.0	4.25	0	0.012	0.1	0	0	670	0.37
6,132	102.2	4.26	0	0.012	0.1	0	0	671	0.37
6,144	102.4	4.27	0	0.012	0.1	0	0	671	0.37
6,156	102.6	4.28	0	0.012	0.1	0	0	671	0.37
6,168	102.8	4.28	0	0.012	0.1	0	0	671	0.37
6,180	103.0	4.29	0	0.012	0.1	0	0	671	0.37
6,192	103.2	4.30	0	0.012	0.1	0	0	671	0.37
6,204	103.4	4.31	0	0.012	0.1	0	0	671	0.37
6,216	103.6	4.32	0	0.012	0.1	0	0	672	0.37
6,228	103.8	4.33	0	0.012	0.1	0	0	672	0.37

Attachment 6 - Cell 2 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,240	104.0	4.33	0	0.012	0.1	0	0	672	0.37
6,252	104.2	4.34	0	0.012	0.1	0	0	672	0.37
6,264	104.4	4.35	0	0.012	0.1	0	0	672	0.37
6,276	104.6	4.36	0	0.012	0.1	0	0	672	0.37
6,288	104.8	4.37	0	0.012	0.1	0	0	672	0.37
6,300	105.0	4.38	0	0.012	0.1	0	0	673	0.37
6,312	105.2	4.38	0	0.012	0.1	0	0	673	0.37
6,324	105.4	4.39	0	0.012	0.1	0	0	673	0.37
6,336	105.6	4.40	0	0.012	0.1	0	0	673	0.37
6,348	105.8	4.41	0	0.012	0.1	0	0	673	0.37
6,360	106.0	4.42	0	0.012	0.1	0	0	673	0.38
6,372	106.2	4.43	0	0.012	0.1	0	0	673	0.38
6,384	106.4	4.43	0	0.012	0.1	0	0	674	0.38
6,396	106.6	4.44	0	0.012	0.1	0	0	674	0.38
6,408	106.8	4.45	0	0.012	0.1	0	0	674	0.38
6,420	107.0	4.46	0	0.012	0.1	0	0	674	0.38
6,432	107.2	4.47	0	0.012	0.1	0	0	674	0.38
6,444	107.4	4.48	0	0.012	0.1	0	0	674	0.38
6,456	107.6	4.48	0	0.012	0.1	0	0	674	0.38
6,468	107.8	4.49	0	0.012	0.1	0	0	675	0.38
6,480	108.0	4.50	0	0.012	0.1	0	0	675	0.38
6,492	108.2	4.51	0	0.012	0.1	0	0	675	0.38
6,504	108.4	4.52	0	0.012	0.1	0	0	675	0.38
6,516	108.6	4.53	0	0.012	0.1	0	0	675	0.38
6,528	108.8	4.53	0	0.012	0.1	0	0	675	0.38
6,540	109.0	4.54	0	0.012	0.1	0	0	676	0.38
6,552	109.2	4.55	0	0.012	0.1	0	0	676	0.38
6,564	109.4	4.56	0	0.012	0.1	0	0	676	0.38
6,576	109.6	4.57	0	0.012	0.1	0	0	676	0.38
6,588	109.8	4.58	0	0.012	0.1	0	0	676	0.38
6,600	110.0	4.58	0	0.012	0.1	0	0	676	0.38
6,612	110.2	4.59	0	0.012	0.1	0	0	676	0.38
6,624	110.4	4.60	0	0.012	0.1	0	0	677	0.38
6,636	110.6	4.61	0	0.012	0.1	0	0	677	0.38
6,648	110.8	4.62	0	0.012	0.1	0	0	677	0.38
6,660	111.0	4.63	0	0.012	0.1	0	0	677	0.38
6,672	111.2	4.63	0	0.012	0.1	0	0	677	0.38
6,684	111.4	4.64	0	0.012	0.1	0	0	677	0.38
6,696	111.6	4.65	0	0.012	0.1	0	0	677	0.38
6,708	111.8	4.66	0	0.012	0.1	0	0	678	0.38
6,720	112.0	4.67	0	0.012	0.1	0	0	678	0.38
6,732	112.2	4.68	0	0.012	0.1	0	0	678	0.38
6,744	112.4	4.68	0	0.012	0.1	0	0	678	0.38
6,756	112.6	4.69	0	0.012	0.1	0	0	678	0.38
6,768	112.8	4.70	0	0.012	0.1	0	0	678	0.38
6,780	113.0	4.71	0	0.012	0.1	0	0	678	0.38
6,792	113.2	4.72	0	0.012	0.1	0	0	679	0.38
6,804	113.4	4.73	0	0.012	0.1	0	0	679	0.38
6,816	113.6	4.73	0	0.012	0.1	0	0	679	0.38
6,828	113.8	4.74	0	0.012	0.1	0	0	679	0.38
6,840	114.0	4.75	0	0.012	0.1	0	0	679	0.38
6,852	114.2	4.76	0	0.012	0.1	0	0	679	0.38
6,864	114.4	4.77	0	0.012	0.1	0	0	680	0.38
6,876	114.6	4.78	0	0.012	0.1	0	0	680	0.38
6,888	114.8	4.78	0	0.012	0.1	0	0	680	0.38
6,900	115.0	4.79	0	0.012	0.1	0	0	680	0.38
6,912	115.2	4.80	0	0.012	0.1	0	0	680	0.38
6,924	115.4	4.81	0	0.012	0.1	0	0	680	0.38
6,936	115.6	4.82	0	0.012	0.1	0	0	680	0.38
6,948	115.8	4.83	0	0.012	0.1	0	0	681	0.38
6,960	116.0	4.83	0	0.012	0.1	0	0	681	0.38
6,972	116.2	4.84	0	0.012	0.1	0	0	681	0.38
6,984	116.4	4.85	0	0.012	0.1	0	0	681	0.38
6,996	116.6	4.86	0	0.012	0.1	0	0	681	0.38
7,008	116.8	4.87	0	0.012	0.1	0	0	681	0.38

Attachment 6 - Cell 2 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,020	117.0	4.88	0	0.012	0.1	0	0	681	0.38
7,032	117.2	4.88	0	0.012	0.1	0	0	682	0.38
7,044	117.4	4.89	0	0.012	0.1	0	0	682	0.38
7,056	117.6	4.90	0	0.012	0.1	0	0	682	0.38
7,068	117.8	4.91	0	0.012	0.1	0	0	682	0.38
7,080	118.0	4.92	0	0.012	0.1	0	0	682	0.38
7,092	118.2	4.93	0	0.012	0.1	0	0	682	0.38
7,104	118.4	4.93	0	0.012	0.1	0	0	682	0.38
7,116	118.6	4.94	0	0.012	0.1	0	0	683	0.38
7,128	118.8	4.95	0	0.012	0.1	0	0	683	0.38
7,140	119.0	4.96	0	0.012	0.1	0	0	683	0.38
7,152	119.2	4.97	0	0.012	0.1	0	0	683	0.38
7,164	119.4	4.98	0	0.012	0.1	0	0	683	0.38
7,176	119.6	4.98	0	0.012	0.1	0	0	683	0.38
7,188	119.8	4.99	0	0.012	0.1	0	0	683	0.38
7,200	120.0	5.00	0	0.012	0.1	0	0	684	0.38
7,212	120.2	5.01	0	0.012	0.1	0	0	684	0.38
7,224	120.4	5.02	0	0.012	0.1	0	0	684	0.38
7,236	120.6	5.03	0	0.012	0.1	0	0	684	0.38
7,248	120.8	5.03	0	0.012	0.1	0	0	684	0.38
7,260	121.0	5.04	0	0.012	0.1	0	0	684	0.38
7,272	121.2	5.05	0	0.012	0.1	0	0	685	0.38
7,284	121.4	5.06	0	0.012	0.1	0	0	685	0.38
7,296	121.6	5.07	0	0.012	0.1	0	0	685	0.38
7,308	121.8	5.08	0	0.012	0.1	0	0	685	0.38
7,320	122.0	5.08	0	0.012	0.1	0	0	685	0.38
7,332	122.2	5.09	0	0.012	0.1	0	0	685	0.38
7,344	122.4	5.10	0	0.012	0.1	0	0	685	0.38
7,356	122.6	5.11	0	0.012	0.1	0	0	686	0.38
7,368	122.8	5.12	0	0.012	0.1	0	0	686	0.38
7,380	123.0	5.13	0	0.012	0.1	0	0	686	0.38
7,392	123.2	5.13	0	0.012	0.1	0	0	686	0.38
7,404	123.4	5.14	0	0.012	0.1	0	0	686	0.38
7,416	123.6	5.15	0	0.012	0.1	0	0	686	0.38
7,428	123.8	5.16	0	0.012	0.1	0	0	686	0.38
7,440	124.0	5.17	0	0.012	0.1	0	0	687	0.38
7,452	124.2	5.18	0	0.012	0.1	0	0	687	0.38
7,464	124.4	5.18	0	0.012	0.1	0	0	687	0.38
7,476	124.6	5.19	0	0.012	0.1	0	0	687	0.38
7,488	124.8	5.20	0	0.012	0.1	0	0	687	0.38
7,500	125.0	5.21	0	0.012	0.1	0	0	687	0.38
7,512	125.2	5.22	0	0.012	0.1	0	0	687	0.38
7,524	125.4	5.23	0	0.012	0.1	0	0	688	0.38
7,536	125.6	5.23	0	0.012	0.1	0	0	688	0.38
7,548	125.8	5.24	0	0.012	0.1	0	0	688	0.38
7,560	126.0	5.25	0	0.012	0.1	0	0	688	0.38
7,572	126.2	5.26	0	0.012	0.1	0	0	688	0.38
7,584	126.4	5.27	0	0.012	0.1	0	0	688	0.38
7,596	126.6	5.28	0	0.012	0.1	0	0	688	0.38
7,608	126.8	5.28	0	0.012	0.1	0	0	689	0.38
7,620	127.0	5.29	0	0.012	0.1	0	0	689	0.38
7,632	127.2	5.30	0	0.012	0.1	0	0	689	0.38
7,644	127.4	5.31	0	0.012	0.1	0	0	689	0.38
7,656	127.6	5.32	0	0.012	0.1	0	0	689	0.38
7,668	127.8	5.33	0	0.012	0.1	0	0	689	0.38
7,680	128.0	5.33	0	0.012	0.1	0	0	690	0.38
7,692	128.2	5.34	0	0.012	0.1	0	0	690	0.38
7,704	128.4	5.35	0	0.012	0.1	0	0	690	0.38
7,716	128.6	5.36	0	0.012	0.1	0	0	690	0.38
7,728	128.8	5.37	0	0.012	0.1	0	0	690	0.38
7,740	129.0	5.38	0	0.012	0.1	0	0	690	0.38
7,752	129.2	5.38	0	0.012	0.1	0	0	690	0.38
7,764	129.4	5.39	0	0.012	0.1	0	0	691	0.38
7,776	129.6	5.40	0	0.012	0.1	0	0	691	0.38
7,788	129.8	5.41	0	0.012	0.1	0	0	691	0.38

Attachment 6 - Cell 2 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,800	130.0	5.42	0	0.012	0.1	0	0	691	0.38
7,812	130.2	5.43	0	0.012	0.1	0	0	691	0.38
7,824	130.4	5.43	0	0.012	0.1	0	0	691	0.39
7,836	130.6	5.44	0	0.012	0.1	0	0	691	0.39
7,848	130.8	5.45	0	0.012	0.1	0	0	692	0.39
7,860	131.0	5.46	0	0.012	0.1	0	0	692	0.39
7,872	131.2	5.47	0	0.012	0.1	0	0	692	0.39
7,884	131.4	5.48	0	0.012	0.1	0	0	692	0.39
7,896	131.6	5.48	0	0.012	0.1	0	0	692	0.39
7,908	131.8	5.49	0	0.012	0.1	0	0	692	0.39
7,920	132.0	5.50	0	0.012	0.1	0	0	692	0.39
7,932	132.2	5.51	0	0.012	0.1	0	0	693	0.39
7,944	132.4	5.52	0	0.012	0.1	0	0	693	0.39
7,956	132.6	5.53	0	0.012	0.1	0	0	693	0.39
7,968	132.8	5.53	0	0.012	0.1	0	0	693	0.39
7,980	133.0	5.54	0	0.012	0.1	0	0	693	0.39
7,992	133.2	5.55	0	0.012	0.1	0	0	693	0.39
8,004	133.4	5.56	0	0.012	0.1	0	0	694	0.39
8,016	133.6	5.57	0	0.012	0.1	0	0	694	0.39
8,028	133.8	5.58	0	0.012	0.1	0	0	694	0.39
8,040	134.0	5.58	0	0.012	0.1	0	0	694	0.39
8,052	134.2	5.59	0	0.012	0.1	0	0	694	0.39
8,064	134.4	5.60	0	0.012	0.1	0	0	694	0.39
8,076	134.6	5.61	0	0.012	0.1	0	0	694	0.39
8,088	134.8	5.62	0	0.012	0.1	0	0	695	0.39
8,100	135.0	5.63	0	0.012	0.1	0	0	695	0.39
8,112	135.2	5.63	0	0.012	0.1	0	0	695	0.39
8,124	135.4	5.64	0	0.012	0.1	0	0	695	0.39
8,136	135.6	5.65	0	0.012	0.1	0	0	695	0.39
8,148	135.8	5.66	0	0.012	0.1	0	0	695	0.39
8,160	136.0	5.67	0	0.012	0.1	0	0	695	0.39
8,172	136.2	5.68	0	0.012	0.1	0	0	696	0.39
8,184	136.4	5.68	0	0.012	0.1	0	0	696	0.39
8,196	136.6	5.69	0	0.012	0.1	0	0	696	0.39
8,208	136.8	5.70	0	0.012	0.1	0	0	696	0.39
8,220	137.0	5.71	0	0.012	0.1	0	0	696	0.39
8,232	137.2	5.72	0	0.012	0.1	0	0	696	0.39
8,244	137.4	5.73	0	0.012	0.1	0	0	696	0.39
8,256	137.6	5.73	0	0.012	0.1	0	0	697	0.39
8,268	137.8	5.74	0	0.012	0.1	0	0	697	0.39
8,280	138.0	5.75	0	0.012	0.1	0	0	697	0.39
8,292	138.2	5.76	0	0.012	0.1	0	0	697	0.39
8,304	138.4	5.77	0	0.012	0.1	0	0	697	0.39
8,316	138.6	5.78	0	0.012	0.1	0	0	697	0.39
8,328	138.8	5.78	0	0.012	0.1	0	0	697	0.39
8,340	139.0	5.79	0	0.012	0.1	0	0	698	0.39
8,352	139.2	5.80	0	0.012	0.1	0	0	698	0.39
8,364	139.4	5.81	0	0.012	0.1	0	0	698	0.39
8,376	139.6	5.82	0	0.012	0.1	0	0	698	0.39
8,388	139.8	5.83	0	0.012	0.1	0	0	698	0.39
8,400	140.0	5.83	0	0.012	0.1	0	0	698	0.39
8,412	140.2	5.84	0	0.012	0.1	0	0	699	0.39
8,424	140.4	5.85	0	0.012	0.1	0	0	699	0.39
8,436	140.6	5.86	0	0.012	0.1	0	0	699	0.39
8,448	140.8	5.87	0	0.012	0.1	0	0	699	0.39
8,460	141.0	5.88	0	0.012	0.1	0	0	699	0.39
8,472	141.2	5.88	0	0.012	0.1	0	0	699	0.39
8,484	141.4	5.89	0	0.012	0.1	0	0	699	0.39
8,496	141.6	5.90	0	0.012	0.1	0	0	700	0.39
8,508	141.8	5.91	0	0.012	0.1	0	0	700	0.39
8,520	142.0	5.92	0	0.012	0.1	0	0	700	0.39
8,532	142.2	5.93	0	0.012	0.1	0	0	700	0.39
8,544	142.4	5.93	0	0.012	0.1	0	0	700	0.39
8,556	142.6	5.94	0	0.012	0.1	0	0	700	0.39
8,568	142.8	5.95	0	0.012	0.1	0	0	700	0.39

Attachment 6 - Cell 2 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,580	143.0	5.96	0	0.012	0.1	0	0	701	0.39
8,592	143.2	5.97	0	0.012	0.1	0	0	701	0.39
8,604	143.4	5.98	0	0.012	0.1	0	0	701	0.39
8,616	143.6	5.98	0	0.012	0.1	0	0	701	0.39
8,628	143.8	5.99	0	0.012	0.1	0	0	701	0.39
8,640	144.0	6.00	0	0.012	0.1	0	0	701	0.39
8,652	144.2	6.01	0	0.012	0.1	0	0	701	0.39
8,664	144.4	6.02	0	0.012	0.1	0	0	702	0.39
8,676	144.6	6.03	0	0.012	0.1	0	0	702	0.39
8,688	144.8	6.03	0	0.012	0.1	0	0	702	0.39
8,700	145.0	6.04	0	0.012	0.1	0	0	702	0.39
8,712	145.2	6.05	0	0.012	0.1	0	0	702	0.39
8,724	145.4	6.06	0	0.012	0.1	0	0	702	0.39
8,736	145.6	6.07	0	0.012	0.1	0	0	702	0.39
8,748	145.8	6.08	0	0.012	0.1	0	0	703	0.39
8,760	146.0	6.08	0	0.012	0.1	0	0	703	0.39
8,772	146.2	6.09	0	0.012	0.1	0	0	703	0.39
8,784	146.4	6.10	0	0.012	0.1	0	0	703	0.39
8,796	146.6	6.11	0	0.012	0.1	0	0	703	0.39
8,808	146.8	6.12	0	0.012	0.1	0	0	703	0.39
8,820	147.0	6.13	0	0.012	0.1	0	0	704	0.39
8,832	147.2	6.13	0	0.012	0.1	0	0	704	0.39
8,844	147.4	6.14	0	0.012	0.1	0	0	704	0.39
8,856	147.6	6.15	0	0.012	0.1	0	0	704	0.39
8,868	147.8	6.16	0	0.012	0.1	0	0	704	0.39
8,880	148.0	6.17	0	0.012	0.1	0	0	704	0.39
8,892	148.2	6.18	0	0.012	0.1	0	0	704	0.39
8,904	148.4	6.18	0	0.012	0.1	0	0	705	0.39
8,916	148.6	6.19	0	0.012	0.1	0	0	705	0.39
8,928	148.8	6.20	0	0.012	0.1	0	0	705	0.39
8,940	149.0	6.21	0	0.012	0.1	0	0	705	0.39
8,952	149.2	6.22	0	0.012	0.1	0	0	705	0.39
8,964	149.4	6.23	0	0.012	0.1	0	0	705	0.39
8,976	149.6	6.23	0	0.012	0.1	0	0	705	0.39
8,988	149.8	6.24	0	0.012	0.1	0	0	706	0.39
9,000	150.0	6.25	0	0.012	0.1	0	0	706	0.39
9,012	150.2	6.26	0	0.012	0.1	0	0	706	0.39
9,024	150.4	6.27	0	0.012	0.1	0	0	706	0.39
9,036	150.6	6.28	0	0.012	0.1	0	0	706	0.39
9,048	150.8	6.28	0	0.012	0.1	0	0	706	0.39
9,060	151.0	6.29	0	0.012	0.1	0	0	706	0.39
9,072	151.2	6.30	0	0.012	0.1	0	0	707	0.39
9,084	151.4	6.31	0	0.012	0.1	0	0	707	0.39
9,096	151.6	6.32	0	0.012	0.1	0	0	707	0.39
9,108	151.8	6.33	0	0.012	0.1	0	0	707	0.39
9,120	152.0	6.33	0	0.012	0.1	0	0	707	0.39
9,132	152.2	6.34	0	0.012	0.1	0	0	707	0.39
9,144	152.4	6.35	0	0.012	0.1	0	0	708	0.39
9,156	152.6	6.36	0	0.012	0.1	0	0	708	0.39
9,168	152.8	6.37	0	0.012	0.1	0	0	708	0.39
9,180	153.0	6.38	0	0.012	0.1	0	0	708	0.39
9,192	153.2	6.38	0	0.012	0.1	0	0	708	0.39
9,204	153.4	6.39	0	0.012	0.1	0	0	708	0.39
9,216	153.6	6.40	0	0.012	0.1	0	0	708	0.39
9,228	153.8	6.41	0	0.012	0.1	0	0	709	0.39
9,240	154.0	6.42	0	0.012	0.1	0	0	709	0.39
9,252	154.2	6.43	0	0.012	0.1	0	0	709	0.39
9,264	154.4	6.43	0	0.012	0.1	0	0	709	0.39
9,276	154.6	6.44	0	0.012	0.1	0	0	709	0.40
9,288	154.8	6.45	0	0.012	0.1	0	0	709	0.40
9,300	155.0	6.46	0	0.012	0.1	0	0	709	0.40
9,312	155.2	6.47	0	0.012	0.1	0	0	710	0.40
9,324	155.4	6.48	0	0.012	0.1	0	0	710	0.40
9,336	155.6	6.48	0	0.012	0.1	0	0	710	0.40
9,348	155.8	6.49	0	0.012	0.1	0	0	710	0.40

Attachment 6 - Cell 2 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
9,360	156.0	6.50	0	0.012	0.1	0	0	710	0.40
9,372	156.2	6.51	0	0.012	0.1	0	0	710	0.40
9,384	156.4	6.52	0	0.012	0.1	0	0	710	0.40
9,396	156.6	6.53	0	0.012	0.1	0	0	711	0.40
9,408	156.8	6.53	0	0.012	0.1	0	0	711	0.40
9,420	157.0	6.54	0	0.012	0.1	0	0	711	0.40
9,432	157.2	6.55	0	0.012	0.1	0	0	711	0.40
9,444	157.4	6.56	0	0.012	0.1	0	0	711	0.40
9,456	157.6	6.57	0	0.012	0.1	0	0	711	0.40
9,468	157.8	6.58	0	0.012	0.1	0	0	711	0.40
9,480	158.0	6.58	0	0.012	0.1	0	0	712	0.40
9,492	158.2	6.59	0	0.012	0.1	0	0	712	0.40
9,504	158.4	6.60	0	0.012	0.1	0	0	712	0.40
9,516	158.6	6.61	0	0.012	0.1	0	0	712	0.40
9,528	158.8	6.62	0	0.012	0.1	0	0	712	0.40
9,540	159.0	6.63	0	0.012	0.1	0	0	712	0.40
9,552	159.2	6.63	0	0.012	0.1	0	0	713	0.40
9,564	159.4	6.64	0	0.012	0.1	0	0	713	0.40
9,576	159.6	6.65	0	0.012	0.1	0	0	713	0.40
9,588	159.8	6.66	0	0.012	0.1	0	0	713	0.40
9,600	160.0	6.67	0	0.012	0.1	0	0	713	0.40
9,612	160.2	6.68	0	0.012	0.1	0	0	713	0.40
9,624	160.4	6.68	0	0.012	0.1	0	0	713	0.40
9,636	160.6	6.69	0	0.012	0.1	0	0	714	0.40
9,648	160.8	6.70	0	0.012	0.1	0	0	714	0.40
9,660	161.0	6.71	0	0.012	0.1	0	0	714	0.40
9,672	161.2	6.72	0	0.012	0.1	0	0	714	0.40
9,684	161.4	6.73	0	0.012	0.1	0	0	714	0.40
9,696	161.6	6.73	0	0.012	0.1	0	0	714	0.40
9,708	161.8	6.74	0	0.012	0.1	0	0	714	0.40
9,720	162.0	6.75	0	0.012	0.1	0	0	715	0.40
9,732	162.2	6.76	0	0.012	0.1	0	0	715	0.40
9,744	162.4	6.77	0	0.012	0.1	0	0	715	0.40
9,756	162.6	6.78	0	0.012	0.1	0	0	715	0.40
9,768	162.8	6.78	0	0.012	0.1	0	0	715	0.40
9,780	163.0	6.79	0	0.012	0.1	0	0	715	0.40
9,792	163.2	6.80	0	0.012	0.1	0	0	715	0.40
9,804	163.4	6.81	0	0.012	0.1	0	0	716	0.40
9,816	163.6	6.82	0	0.012	0.1	0	0	716	0.40
9,828	163.8	6.83	0	0.012	0.1	0	0	716	0.40
9,840	164.0	6.83	0	0.012	0.1	0	0	716	0.40
9,852	164.2	6.84	0	0.012	0.1	0	0	716	0.40
9,864	164.4	6.85	0	0.012	0.1	0	0	716	0.40
9,876	164.6	6.86	0	0.012	0.1	0	0	716	0.40
9,888	164.8	6.87	0	0.012	0.1	0	0	717	0.40
9,900	165.0	6.88	0	0.012	0.1	0	0	717	0.40
9,912	165.2	6.88	0	0.012	0.1	0	0	717	0.40
9,924	165.4	6.89	0	0.012	0.1	0	0	717	0.40
9,936	165.6	6.90	0	0.012	0.1	0	0	717	0.40
9,948	165.8	6.91	0	0.012	0.1	0	0	717	0.40
9,960	166.0	6.92	0	0.012	0.1	0	0	718	0.40
9,972	166.2	6.93	0	0.012	0.1	0	0	718	0.40
9,984	166.4	6.93	0	0.012	0.1	0	0	718	0.40
9,996	166.6	6.94	0	0.012	0.1	0	0	718	0.40
10,008	166.8	6.95	0	0.012	0.1	0	0	718	0.40
10,020	167.0	6.96	0	0.012	0.1	0	0	718	0.40
10,032	167.2	6.97	0	0.012	0.1	0	0	718	0.40
10,044	167.4	6.98	0	0.012	0.1	0	0	719	0.40
10,056	167.6	6.98	0	0.012	0.1	0	0	719	0.40
10,068	167.8	6.99	0	0.012	0.1	0	0	719	0.40
10,080	168.0	7.00	0	0.012	0.1	0	0	719	0.40

ATTACHMENT 7

Cell 2 Leakage Detection Sump – Peak Conditions

Attachment 7 - Cell 2 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
0	0.0	0.00	0	5.139	0.0	0	0	1,795	1.00
12	0.2	0.01	0	5.139	61.7	0	0	1,857	1.03
24	0.4	0.02	0	5.139	61.7	100	1,200	719	0.40
36	0.6	0.03	0	5.139	61.7	0	0	780	0.43
48	0.8	0.03	0	5.139	61.7	0	0	842	0.47
60	1.0	0.04	0	5.139	61.7	0	0	904	0.50
72	1.2	0.05	0	5.139	61.7	0	0	965	0.54
84	1.4	0.06	0	5.139	61.7	0	0	1,027	0.57
96	1.6	0.07	0	5.139	61.7	0	0	1,089	0.61
108	1.8	0.08	0	5.139	61.7	0	0	1,150	0.64
120	2.0	0.08	0	5.139	61.7	0	0	1,212	0.68
132	2.2	0.09	0	5.139	61.7	0	0	1,274	0.71
144	2.4	0.10	0	5.139	61.7	0	0	1,335	0.74
156	2.6	0.11	0	5.139	61.7	0	0	1,397	0.78
168	2.8	0.12	0	5.139	61.7	0	0	1,459	0.81
180	3.0	0.13	0	5.139	61.7	0	0	1,520	0.85
192	3.2	0.13	0	5.139	61.7	0	0	1,582	0.88
204	3.4	0.14	0	5.139	61.7	0	0	1,644	0.92
216	3.6	0.15	0	5.139	61.7	0	0	1,705	0.95
228	3.8	0.16	0	5.139	61.7	0	0	1,767	0.98
240	4.0	0.17	0	5.139	61.7	0	0	1,829	1.02
252	4.2	0.18	0	5.139	61.7	100	1,200	690	0.38
264	4.4	0.18	0	5.139	61.7	0	0	752	0.42
276	4.6	0.19	0	5.139	61.7	0	0	814	0.45
288	4.8	0.20	0	5.139	61.7	0	0	875	0.49
300	5.0	0.21	0	5.139	61.7	0	0	937	0.52
312	5.2	0.22	0	5.139	61.7	0	0	999	0.56
324	5.4	0.23	0	5.139	61.7	0	0	1,060	0.59
336	5.6	0.23	0	5.139	61.7	0	0	1,122	0.62
348	5.8	0.24	0	5.139	61.7	0	0	1,184	0.66
360	6.0	0.25	0	5.139	61.7	0	0	1,245	0.69
372	6.2	0.26	0	5.139	61.7	0	0	1,307	0.73
384	6.4	0.27	0	5.139	61.7	0	0	1,369	0.76
396	6.6	0.28	0	5.139	61.7	0	0	1,430	0.80
408	6.8	0.28	0	5.139	61.7	0	0	1,492	0.83
420	7.0	0.29	0	5.139	61.7	0	0	1,554	0.87
432	7.2	0.30	0	5.139	61.7	0	0	1,615	0.90
444	7.4	0.31	0	5.139	61.7	0	0	1,677	0.93
456	7.6	0.32	0	5.139	61.7	0	0	1,739	0.97
468	7.8	0.33	0	5.139	61.7	0	0	1,800	1.00
480	8.0	0.33	0	5.139	61.7	100	1,200	662	0.37
492	8.2	0.34	0	5.139	61.7	0	0	724	0.40
504	8.4	0.35	0	5.139	61.7	0	0	785	0.44
516	8.6	0.36	0	5.139	61.7	0	0	847	0.47
528	8.8	0.37	0	5.139	61.7	0	0	909	0.51
540	9.0	0.38	0	5.139	61.7	0	0	970	0.54
552	9.2	0.38	0	5.139	61.7	0	0	1,032	0.57
564	9.4	0.39	0	5.139	61.7	0	0	1,094	0.61
576	9.6	0.40	0	5.139	61.7	0	0	1,155	0.64
588	9.8	0.41	0	5.139	61.7	0	0	1,217	0.68
600	10.0	0.42	0	5.139	61.7	0	0	1,279	0.71
612	10.2	0.43	0	5.139	61.7	0	0	1,340	0.75
624	10.4	0.43	0	5.139	61.7	0	0	1,402	0.78
636	10.6	0.44	0	5.139	61.7	0	0	1,464	0.82
648	10.8	0.45	0	5.139	61.7	0	0	1,525	0.85
660	11.0	0.46	0	5.139	61.7	0	0	1,587	0.88
672	11.2	0.47	0	5.139	61.7	0	0	1,649	0.92
684	11.4	0.48	0	5.139	61.7	0	0	1,710	0.95
696	11.6	0.48	0	5.139	61.7	0	0	1,772	0.99
708	11.8	0.49	0	5.139	61.7	0	0	1,834	1.02
720	12.0	0.50	0	5.139	61.7	100	1,200	695	0.39
732	12.2	0.51	0	5.139	61.7	0	0	757	0.42
744	12.4	0.52	0	5.139	61.7	0	0	819	0.46
756	12.6	0.53	0	5.139	61.7	0	0	880	0.49
768	12.8	0.53	0	5.139	61.7	0	0	942	0.52

Attachment 7 - Cell 2 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
780	13.0	0.54	0	5.139	61.7	0	0	1,004	0.56
792	13.2	0.55	0	5.139	61.7	0	0	1,065	0.59
804	13.4	0.56	0	5.139	61.7	0	0	1,127	0.63
816	13.6	0.57	0	5.139	61.7	0	0	1,189	0.66
828	13.8	0.58	0	5.139	61.7	0	0	1,250	0.70
840	14.0	0.58	0	5.139	61.7	0	0	1,312	0.73
852	14.2	0.59	0	5.139	61.7	0	0	1,374	0.77
864	14.4	0.60	0	5.139	61.7	0	0	1,435	0.80
876	14.6	0.61	0	5.139	61.7	0	0	1,497	0.83
888	14.8	0.62	0	5.139	61.7	0	0	1,559	0.87
900	15.0	0.63	0	5.139	61.7	0	0	1,620	0.90
912	15.2	0.63	0	5.139	61.7	0	0	1,682	0.94
924	15.4	0.64	0	5.139	61.7	0	0	1,744	0.97
936	15.6	0.65	0	5.139	61.7	0	0	1,805	1.01
948	15.8	0.66	0	5.139	61.7	100	1,200	667	0.37
960	16.0	0.67	0	5.139	61.7	0	0	729	0.41
972	16.2	0.68	0	5.139	61.7	0	0	790	0.44
984	16.4	0.68	0	5.139	61.7	0	0	852	0.47
996	16.6	0.69	0	5.139	61.7	0	0	914	0.51
1,008	16.8	0.70	0	5.139	61.7	0	0	975	0.54
1,020	17.0	0.71	0	5.139	61.7	0	0	1,037	0.58
1,032	17.2	0.72	0	5.139	61.7	0	0	1,099	0.61
1,044	17.4	0.73	0	5.139	61.7	0	0	1,160	0.65
1,056	17.6	0.73	0	5.139	61.7	0	0	1,222	0.68
1,068	17.8	0.74	0	5.139	61.7	0	0	1,284	0.71
1,080	18.0	0.75	0	5.139	61.7	0	0	1,345	0.75
1,092	18.2	0.76	0	5.139	61.7	0	0	1,407	0.78
1,104	18.4	0.77	0	5.139	61.7	0	0	1,469	0.82
1,116	18.6	0.78	0	5.139	61.7	0	0	1,530	0.85
1,128	18.8	0.78	0	5.139	61.7	0	0	1,592	0.89
1,140	19.0	0.79	0	5.139	61.7	0	0	1,654	0.92
1,152	19.2	0.80	0	5.139	61.7	0	0	1,715	0.96
1,164	19.4	0.81	0	5.139	61.7	0	0	1,777	0.99
1,176	19.6	0.82	0	5.139	61.7	0	0	1,839	1.02
1,188	19.8	0.83	0	5.139	61.7	100	1,200	700	0.39
1,200	20.0	0.83	0	5.139	61.7	0	0	762	0.42
1,212	20.2	0.84	0	5.139	61.7	0	0	824	0.46
1,224	20.4	0.85	0	5.139	61.7	0	0	885	0.49
1,236	20.6	0.86	0	5.139	61.7	0	0	947	0.53
1,248	20.8	0.87	0	5.139	61.7	0	0	1,009	0.56
1,260	21.0	0.88	0	5.139	61.7	0	0	1,070	0.60
1,272	21.2	0.88	0	5.139	61.7	0	0	1,132	0.63
1,284	21.4	0.89	0	5.139	61.7	0	0	1,194	0.66
1,296	21.6	0.90	0	5.139	61.7	0	0	1,255	0.70
1,308	21.8	0.91	0	5.139	61.7	0	0	1,317	0.73
1,320	22.0	0.92	0	5.139	61.7	0	0	1,379	0.77
1,332	22.2	0.93	0	5.139	61.7	0	0	1,440	0.80
1,344	22.4	0.93	0	5.139	61.7	0	0	1,502	0.84
1,356	22.6	0.94	0	5.139	61.7	0	0	1,564	0.87
1,368	22.8	0.95	0	5.139	61.7	0	0	1,625	0.91
1,380	23.0	0.96	0	5.139	61.7	0	0	1,687	0.94
1,392	23.2	0.97	0	5.139	61.7	0	0	1,749	0.97
1,404	23.4	0.98	0	5.139	61.7	0	0	1,810	1.01
1,416	23.6	0.98	0	5.139	61.7	100	1,200	672	0.37
1,428	23.8	0.99	0	5.139	61.7	0	0	734	0.41
1,440	24.0	1.00	0	5.139	61.7	0	0	795	0.44
1,452	24.2	1.01	0	5.139	61.7	0	0	857	0.48
1,464	24.4	1.02	0	5.139	61.7	0	0	919	0.51
1,476	24.6	1.03	0	5.139	61.7	0	0	980	0.55
1,488	24.8	1.03	0	5.139	61.7	0	0	1,042	0.58
1,500	25.0	1.04	0	5.139	61.7	0	0	1,104	0.61
1,512	25.2	1.05	0	5.139	61.7	0	0	1,165	0.65
1,524	25.4	1.06	0	5.139	61.7	0	0	1,227	0.68
1,536	25.6	1.07	0	5.139	61.7	0	0	1,289	0.72
1,548	25.8	1.08	0	5.139	61.7	0	0	1,350	0.75

Attachment 7 - Cell 2 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,560	26.0	1.08	0	5.139	61.7	0	0	1,412	0.79
1,572	26.2	1.09	0	5.139	61.7	0	0	1,474	0.82
1,584	26.4	1.10	0	5.139	61.7	0	0	1,535	0.86
1,596	26.6	1.11	0	5.139	61.7	0	0	1,597	0.89
1,608	26.8	1.12	0	5.139	61.7	0	0	1,659	0.92
1,620	27.0	1.13	0	5.139	61.7	0	0	1,720	0.96
1,632	27.2	1.13	0	5.139	61.7	0	0	1,782	0.99
1,644	27.4	1.14	0	5.139	61.7	0	0	1,844	1.03
1,656	27.6	1.15	0	5.139	61.7	100	1,200	705	0.39
1,668	27.8	1.16	0	5.139	61.7	0	0	767	0.43
1,680	28.0	1.17	0	5.139	61.7	0	0	829	0.46
1,692	28.2	1.18	0	5.139	61.7	0	0	890	0.50
1,704	28.4	1.18	0	5.139	61.7	0	0	952	0.53
1,716	28.6	1.19	0	5.139	61.7	0	0	1,014	0.56
1,728	28.8	1.20	0	5.139	61.7	0	0	1,075	0.60
1,740	29.0	1.21	0	5.139	61.7	0	0	1,137	0.63
1,752	29.2	1.22	0	5.139	61.7	0	0	1,199	0.67
1,764	29.4	1.23	0	5.139	61.7	0	0	1,260	0.70
1,776	29.6	1.23	0	5.139	61.7	0	0	1,322	0.74
1,788	29.8	1.24	0	5.139	61.7	0	0	1,384	0.77
1,800	30.0	1.25	0	5.139	61.7	0	0	1,445	0.81
1,812	30.2	1.26	0	5.139	61.7	0	0	1,507	0.84
1,824	30.4	1.27	0	5.139	61.7	0	0	1,569	0.87
1,836	30.6	1.28	0	5.139	61.7	0	0	1,630	0.91
1,848	30.8	1.28	0	5.139	61.7	0	0	1,692	0.94
1,860	31.0	1.29	0	5.139	61.7	0	0	1,754	0.98
1,872	31.2	1.30	0	5.139	61.7	0	0	1,815	1.01
1,884	31.4	1.31	0	5.139	61.7	100	1,200	677	0.38
1,896	31.6	1.32	0	5.139	61.7	0	0	739	0.41
1,908	31.8	1.33	0	5.139	61.7	0	0	800	0.45
1,920	32.0	1.33	0	5.139	61.7	0	0	862	0.48
1,932	32.2	1.34	0	5.139	61.7	0	0	924	0.51
1,944	32.4	1.35	0	5.139	61.7	0	0	985	0.55
1,956	32.6	1.36	0	5.139	61.7	0	0	1,047	0.58
1,968	32.8	1.37	0	5.139	61.7	0	0	1,109	0.62
1,980	33.0	1.38	0	5.139	61.7	0	0	1,170	0.65
1,992	33.2	1.38	0	5.139	61.7	0	0	1,232	0.69
2,004	33.4	1.39	0	5.139	61.7	0	0	1,294	0.72
2,016	33.6	1.40	0	5.139	61.7	0	0	1,355	0.75
2,028	33.8	1.41	0	5.139	61.7	0	0	1,417	0.79
2,040	34.0	1.42	0	5.139	61.7	0	0	1,479	0.82
2,052	34.2	1.43	0	5.139	61.7	0	0	1,540	0.86
2,064	34.4	1.43	0	5.139	61.7	0	0	1,602	0.89
2,076	34.6	1.44	0	5.139	61.7	0	0	1,664	0.93
2,088	34.8	1.45	0	5.139	61.7	0	0	1,725	0.96
2,100	35.0	1.46	0	5.139	61.7	0	0	1,787	1.00
2,112	35.2	1.47	0	5.139	61.7	0	0	1,849	1.03
2,124	35.4	1.48	0	5.139	61.7	100	1,200	710	0.40
2,136	35.6	1.48	0	5.139	61.7	0	0	772	0.43
2,148	35.8	1.49	0	5.139	61.7	0	0	834	0.46
2,160	36.0	1.50	0	5.139	61.7	0	0	895	0.50
2,172	36.2	1.51	0	5.139	61.7	0	0	957	0.53
2,184	36.4	1.52	0	5.139	61.7	0	0	1,019	0.57
2,196	36.6	1.53	0	5.139	61.7	0	0	1,080	0.60
2,208	36.8	1.53	0	5.139	61.7	0	0	1,142	0.64
2,220	37.0	1.54	0	5.139	61.7	0	0	1,204	0.67
2,232	37.2	1.55	0	5.139	61.7	0	0	1,265	0.70
2,244	37.4	1.56	0	5.139	61.7	0	0	1,327	0.74
2,256	37.6	1.57	0	5.139	61.7	0	0	1,389	0.77
2,268	37.8	1.58	0	5.139	61.7	0	0	1,450	0.81
2,280	38.0	1.58	0	5.139	61.7	0	0	1,512	0.84
2,292	38.2	1.59	0	5.139	61.7	0	0	1,574	0.88
2,304	38.4	1.60	0	5.139	61.7	0	0	1,635	0.91
2,316	38.6	1.61	0	5.139	61.7	0	0	1,697	0.95
2,328	38.8	1.62	0	5.139	61.7	0	0	1,759	0.98

Attachment 7 - Cell 2 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
2,340	39.0	1.63	0	5.139	61.7	0	0	1,820	1.01
2,352	39.2	1.63	0	5.139	61.7	100	1,200	682	0.38
2,364	39.4	1.64	0	5.139	61.7	0	0	744	0.41
2,376	39.6	1.65	0	5.139	61.7	0	0	805	0.45
2,388	39.8	1.66	0	5.139	61.7	0	0	867	0.48
2,400	40.0	1.67	0	5.139	61.7	0	0	929	0.52
2,412	40.2	1.68	0	5.139	61.7	0	0	990	0.55
2,424	40.4	1.68	0	5.139	61.7	0	0	1,052	0.59
2,436	40.6	1.69	0	5.139	61.7	0	0	1,114	0.62
2,448	40.8	1.70	0	5.139	61.7	0	0	1,175	0.65
2,460	41.0	1.71	0	5.139	61.7	0	0	1,237	0.69
2,472	41.2	1.72	0	5.139	61.7	0	0	1,299	0.72
2,484	41.4	1.73	0	5.139	61.7	0	0	1,360	0.76
2,496	41.6	1.73	0	5.139	61.7	0	0	1,422	0.79
2,508	41.8	1.74	0	5.139	61.7	0	0	1,484	0.83
2,520	42.0	1.75	0	5.139	61.7	0	0	1,545	0.86
2,532	42.2	1.76	0	5.139	61.7	0	0	1,607	0.90
2,544	42.4	1.77	0	5.139	61.7	0	0	1,669	0.93
2,556	42.6	1.78	0	5.139	61.7	0	0	1,730	0.96
2,568	42.8	1.78	0	5.139	61.7	0	0	1,792	1.00
2,580	43.0	1.79	0	5.139	61.7	0	0	1,854	1.03
2,592	43.2	1.80	0	5.139	61.7	100	1,200	715	0.40
2,604	43.4	1.81	0	5.139	61.7	0	0	777	0.43
2,616	43.6	1.82	0	5.139	61.7	0	0	839	0.47
2,628	43.8	1.83	0	5.139	61.7	0	0	900	0.50
2,640	44.0	1.83	0	5.139	61.7	0	0	962	0.54
2,652	44.2	1.84	0	5.139	61.7	0	0	1,024	0.57
2,664	44.4	1.85	0	5.139	61.7	0	0	1,085	0.60
2,676	44.6	1.86	0	5.139	61.7	0	0	1,147	0.64
2,688	44.8	1.87	0	5.139	61.7	0	0	1,209	0.67
2,700	45.0	1.88	0	5.139	61.7	0	0	1,270	0.71
2,712	45.2	1.88	0	5.139	61.7	0	0	1,332	0.74
2,724	45.4	1.89	0	5.139	61.7	0	0	1,394	0.78
2,736	45.6	1.90	0	5.139	61.7	0	0	1,455	0.81
2,748	45.8	1.91	0	5.139	61.7	0	0	1,517	0.84
2,760	46.0	1.92	0	5.139	61.7	0	0	1,579	0.88
2,772	46.2	1.93	0	5.139	61.7	0	0	1,640	0.91
2,784	46.4	1.93	0	5.139	61.7	0	0	1,702	0.95
2,796	46.6	1.94	0	5.139	61.7	0	0	1,764	0.98
2,808	46.8	1.95	0	5.139	61.7	0	0	1,825	1.02
2,820	47.0	1.96	0	5.139	61.7	100	1,200	687	0.38
2,832	47.2	1.97	0	5.139	61.7	0	0	749	0.42
2,844	47.4	1.98	0	5.139	61.7	0	0	810	0.45
2,856	47.6	1.98	0	5.139	61.7	0	0	872	0.49
2,868	47.8	1.99	0	5.139	61.7	0	0	934	0.52
2,880	48.0	2.00	0	5.139	61.7	0	0	995	0.55
2,892	48.2	2.01	0	5.139	61.7	0	0	1,057	0.59
2,904	48.4	2.02	0	5.139	61.7	0	0	1,119	0.62
2,916	48.6	2.03	0	5.139	61.7	0	0	1,180	0.66
2,928	48.8	2.03	0	5.139	61.7	0	0	1,242	0.69
2,940	49.0	2.04	0	5.139	61.7	0	0	1,304	0.73
2,952	49.2	2.05	0	5.139	61.7	0	0	1,365	0.76
2,964	49.4	2.06	0	5.139	61.7	0	0	1,427	0.79
2,976	49.6	2.07	0	5.139	61.7	0	0	1,489	0.83
2,988	49.8	2.08	0	5.139	61.7	0	0	1,550	0.86
3,000	50.0	2.08	0	5.139	61.7	0	0	1,612	0.90
3,012	50.2	2.09	0	5.139	61.7	0	0	1,674	0.93
3,024	50.4	2.10	0	5.139	61.7	0	0	1,735	0.97
3,036	50.6	2.11	0	5.139	61.7	0	0	1,797	1.00
3,048	50.8	2.12	0	5.139	61.7	100	1,200	659	0.37
3,060	51.0	2.13	0	5.139	61.7	0	0	720	0.40
3,072	51.2	2.13	0	5.139	61.7	0	0	782	0.44
3,084	51.4	2.14	0	5.139	61.7	0	0	844	0.47
3,096	51.6	2.15	0	5.139	61.7	0	0	905	0.50
3,108	51.8	2.16	0	5.139	61.7	0	0	967	0.54

Attachment 7 - Cell 2 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,120	52.0	2.17	0	5.139	61.7	0	0	1,029	0.57
3,132	52.2	2.18	0	5.139	61.7	0	0	1,090	0.61
3,144	52.4	2.18	0	5.139	61.7	0	0	1,152	0.64
3,156	52.6	2.19	0	5.139	61.7	0	0	1,214	0.68
3,168	52.8	2.20	0	5.139	61.7	0	0	1,275	0.71
3,180	53.0	2.21	0	5.139	61.7	0	0	1,337	0.74
3,192	53.2	2.22	0	5.139	61.7	0	0	1,399	0.78
3,204	53.4	2.23	0	5.139	61.7	0	0	1,460	0.81
3,216	53.6	2.23	0	5.139	61.7	0	0	1,522	0.85
3,228	53.8	2.24	0	5.139	61.7	0	0	1,584	0.88
3,240	54.0	2.25	0	5.139	61.7	0	0	1,645	0.92
3,252	54.2	2.26	0	5.139	61.7	0	0	1,707	0.95
3,264	54.4	2.27	0	5.139	61.7	0	0	1,769	0.99
3,276	54.6	2.28	0	5.139	61.7	0	0	1,830	1.02
3,288	54.8	2.28	0	5.139	61.7	100	1,200	692	0.39
3,300	55.0	2.29	0	5.139	61.7	0	0	754	0.42
3,312	55.2	2.30	0	5.139	61.7	0	0	815	0.45
3,324	55.4	2.31	0	5.139	61.7	0	0	877	0.49
3,336	55.6	2.32	0	5.139	61.7	0	0	939	0.52
3,348	55.8	2.33	0	5.139	61.7	0	0	1,000	0.56
3,360	56.0	2.33	0	5.139	61.7	0	0	1,062	0.59
3,372	56.2	2.34	0	5.139	61.7	0	0	1,124	0.63
3,384	56.4	2.35	0	5.139	61.7	0	0	1,185	0.66
3,396	56.6	2.36	0	5.139	61.7	0	0	1,247	0.69
3,408	56.8	2.37	0	5.139	61.7	0	0	1,309	0.73
3,420	57.0	2.38	0	5.139	61.7	0	0	1,370	0.76
3,432	57.2	2.38	0	5.139	61.7	0	0	1,432	0.80
3,444	57.4	2.39	0	5.139	61.7	0	0	1,494	0.83
3,456	57.6	2.40	0	5.139	61.7	0	0	1,555	0.87
3,468	57.8	2.41	0	5.139	61.7	0	0	1,617	0.90
3,480	58.0	2.42	0	5.139	61.7	0	0	1,679	0.94
3,492	58.2	2.43	0	5.139	61.7	0	0	1,740	0.97
3,504	58.4	2.43	0	5.139	61.7	0	0	1,802	1.00
3,516	58.6	2.44	0	5.139	61.7	100	1,200	664	0.37
3,528	58.8	2.45	0	5.139	61.7	0	0	725	0.40
3,540	59.0	2.46	0	5.139	61.7	0	0	787	0.44
3,552	59.2	2.47	0	5.139	61.7	0	0	849	0.47
3,564	59.4	2.48	0	5.139	61.7	0	0	910	0.51
3,576	59.6	2.48	0	5.139	61.7	0	0	972	0.54
3,588	59.8	2.49	0	5.139	61.7	0	0	1,034	0.58
3,600	60.0	2.50	0	5.139	61.7	0	0	1,095	0.61
3,612	60.2	2.51	0	5.139	61.7	0	0	1,157	0.64
3,624	60.4	2.52	0	5.139	61.7	0	0	1,219	0.68
3,636	60.6	2.53	0	5.139	61.7	0	0	1,280	0.71
3,648	60.8	2.53	0	5.139	61.7	0	0	1,342	0.75
3,660	61.0	2.54	0	5.139	61.7	0	0	1,404	0.78
3,672	61.2	2.55	0	5.139	61.7	0	0	1,465	0.82
3,684	61.4	2.56	0	5.139	61.7	0	0	1,527	0.85
3,696	61.6	2.57	0	5.139	61.7	0	0	1,589	0.88
3,708	61.8	2.58	0	5.139	61.7	0	0	1,650	0.92
3,720	62.0	2.58	0	5.139	61.7	0	0	1,712	0.95
3,732	62.2	2.59	0	5.139	61.7	0	0	1,774	0.99
3,744	62.4	2.60	0	5.139	61.7	0	0	1,835	1.02
3,756	62.6	2.61	0	5.139	61.7	100	1,200	697	0.39
3,768	62.8	2.62	0	5.139	61.7	0	0	759	0.42
3,780	63.0	2.63	0	5.139	61.7	0	0	820	0.46
3,792	63.2	2.63	0	5.139	61.7	0	0	882	0.49
3,804	63.4	2.64	0	5.139	61.7	0	0	944	0.53
3,816	63.6	2.65	0	5.139	61.7	0	0	1,005	0.56
3,828	63.8	2.66	0	5.139	61.7	0	0	1,067	0.59
3,840	64.0	2.67	0	5.139	61.7	0	0	1,129	0.63
3,852	64.2	2.68	0	5.139	61.7	0	0	1,190	0.66
3,864	64.4	2.68	0	5.139	61.7	0	0	1,252	0.70
3,876	64.6	2.69	0	5.139	61.7	0	0	1,314	0.73
3,888	64.8	2.70	0	5.139	61.7	0	0	1,375	0.77

Attachment 7 - Cell 2 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,900	65.0	2.71	0	5.139	61.7	0	0	1,437	0.80
3,912	65.2	2.72	0	5.139	61.7	0	0	1,499	0.83
3,924	65.4	2.73	0	5.139	61.7	0	0	1,560	0.87
3,936	65.6	2.73	0	5.139	61.7	0	0	1,622	0.90
3,948	65.8	2.74	0	5.139	61.7	0	0	1,684	0.94
3,960	66.0	2.75	0	5.139	61.7	0	0	1,745	0.97
3,972	66.2	2.76	0	5.139	61.7	0	0	1,807	1.01
3,984	66.4	2.77	0	5.139	61.7	100	1,200	669	0.37
3,996	66.6	2.78	0	5.139	61.7	0	0	730	0.41
4,008	66.8	2.78	0	5.139	61.7	0	0	792	0.44
4,020	67.0	2.79	0	5.139	61.7	0	0	854	0.48
4,032	67.2	2.80	0	5.139	61.7	0	0	915	0.51
4,044	67.4	2.81	0	5.139	61.7	0	0	977	0.54
4,056	67.6	2.82	0	5.139	61.7	0	0	1,039	0.58
4,068	67.8	2.83	0	5.139	61.7	0	0	1,100	0.61
4,080	68.0	2.83	0	5.139	61.7	0	0	1,162	0.65
4,092	68.2	2.84	0	5.139	61.7	0	0	1,224	0.68
4,104	68.4	2.85	0	5.139	61.7	0	0	1,285	0.72
4,116	68.6	2.86	0	5.139	61.7	0	0	1,347	0.75
4,128	68.8	2.87	0	5.139	61.7	0	0	1,409	0.78
4,140	69.0	2.88	0	5.139	61.7	0	0	1,470	0.82
4,152	69.2	2.88	0	5.139	61.7	0	0	1,532	0.85
4,164	69.4	2.89	0	5.139	61.7	0	0	1,594	0.89
4,176	69.6	2.90	0	5.139	61.7	0	0	1,655	0.92
4,188	69.8	2.91	0	5.139	61.7	0	0	1,717	0.96
4,200	70.0	2.92	0	5.139	61.7	0	0	1,779	0.99
4,212	70.2	2.93	0	5.139	61.7	0	0	1,840	1.03
4,224	70.4	2.93	0	5.139	61.7	100	1,200	702	0.39
4,236	70.6	2.94	0	5.139	61.7	0	0	764	0.43
4,248	70.8	2.95	0	5.139	61.7	0	0	825	0.46
4,260	71.0	2.96	0	5.139	61.7	0	0	887	0.49
4,272	71.2	2.97	0	5.139	61.7	0	0	949	0.53
4,284	71.4	2.98	0	5.139	61.7	0	0	1,010	0.56
4,296	71.6	2.98	0	5.139	61.7	0	0	1,072	0.60
4,308	71.8	2.99	0	5.139	61.7	0	0	1,134	0.63
4,320	72.0	3.00	0	5.139	61.7	0	0	1,195	0.67
4,332	72.2	3.01	0	5.139	61.7	0	0	1,257	0.70
4,344	72.4	3.02	0	5.139	61.7	0	0	1,319	0.73
4,356	72.6	3.03	0	5.139	61.7	0	0	1,380	0.77
4,368	72.8	3.03	0	5.139	61.7	0	0	1,442	0.80
4,380	73.0	3.04	0	5.139	61.7	0	0	1,504	0.84
4,392	73.2	3.05	0	5.139	61.7	0	0	1,565	0.87
4,404	73.4	3.06	0	5.139	61.7	0	0	1,627	0.91
4,416	73.6	3.07	0	5.139	61.7	0	0	1,689	0.94
4,428	73.8	3.08	0	5.139	61.7	0	0	1,750	0.97
4,440	74.0	3.08	0	5.139	61.7	0	0	1,812	1.01
4,452	74.2	3.09	0	5.139	61.7	100	1,200	674	0.38
4,464	74.4	3.10	0	5.139	61.7	0	0	735	0.41
4,476	74.6	3.11	0	5.139	61.7	0	0	797	0.44
4,488	74.8	3.12	0	5.139	61.7	0	0	859	0.48
4,500	75.0	3.13	0	5.139	61.7	0	0	920	0.51
4,512	75.2	3.13	0	5.139	61.7	0	0	982	0.55
4,524	75.4	3.14	0	5.139	61.7	0	0	1,044	0.58
4,536	75.6	3.15	0	5.139	61.7	0	0	1,105	0.62
4,548	75.8	3.16	0	5.139	61.7	0	0	1,167	0.65
4,560	76.0	3.17	0	5.139	61.7	0	0	1,229	0.68
4,572	76.2	3.18	0	5.139	61.7	0	0	1,290	0.72
4,584	76.4	3.18	0	5.139	61.7	0	0	1,352	0.75
4,596	76.6	3.19	0	5.139	61.7	0	0	1,414	0.79
4,608	76.8	3.20	0	5.139	61.7	0	0	1,475	0.82
4,620	77.0	3.21	0	5.139	61.7	0	0	1,537	0.86
4,632	77.2	3.22	0	5.139	61.7	0	0	1,599	0.89
4,644	77.4	3.23	0	5.139	61.7	0	0	1,660	0.92
4,656	77.6	3.23	0	5.139	61.7	0	0	1,722	0.96
4,668	77.8	3.24	0	5.139	61.7	0	0	1,784	0.99

Attachment 7 - Cell 2 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,680	78.0	3.25	0	5.139	61.7	0	0	1,845	1.03
4,692	78.2	3.26	0	5.139	61.7	100	1,200	707	0.39
4,704	78.4	3.27	0	5.139	61.7	0	0	769	0.43
4,716	78.6	3.28	0	5.139	61.7	0	0	830	0.46
4,728	78.8	3.28	0	5.139	61.7	0	0	892	0.50
4,740	79.0	3.29	0	5.139	61.7	0	0	954	0.53
4,752	79.2	3.30	0	5.139	61.7	0	0	1,015	0.57
4,764	79.4	3.31	0	5.139	61.7	0	0	1,077	0.60
4,776	79.6	3.32	0	5.139	61.7	0	0	1,139	0.63
4,788	79.8	3.33	0	5.139	61.7	0	0	1,200	0.67
4,800	80.0	3.33	0	5.139	61.7	0	0	1,262	0.70
4,812	80.2	3.34	0	5.139	61.7	0	0	1,324	0.74
4,824	80.4	3.35	0	5.139	61.7	0	0	1,385	0.77
4,836	80.6	3.36	0	5.139	61.7	0	0	1,447	0.81
4,848	80.8	3.37	0	5.139	61.7	0	0	1,509	0.84
4,860	81.0	3.38	0	5.139	61.7	0	0	1,570	0.87
4,872	81.2	3.38	0	5.139	61.7	0	0	1,632	0.91
4,884	81.4	3.39	0	5.139	61.7	0	0	1,694	0.94
4,896	81.6	3.40	0	5.139	61.7	0	0	1,755	0.98
4,908	81.8	3.41	0	5.139	61.7	0	0	1,817	1.01
4,920	82.0	3.42	0	5.139	61.7	100	1,200	679	0.38
4,932	82.2	3.43	0	5.139	61.7	0	0	740	0.41
4,944	82.4	3.43	0	5.139	61.7	0	0	802	0.45
4,956	82.6	3.44	0	5.139	61.7	0	0	864	0.48
4,968	82.8	3.45	0	5.139	61.7	0	0	925	0.52
4,980	83.0	3.46	0	5.139	61.7	0	0	987	0.55
4,992	83.2	3.47	0	5.139	61.7	0	0	1,049	0.58
5,004	83.4	3.48	0	5.139	61.7	0	0	1,110	0.62
5,016	83.6	3.48	0	5.139	61.7	0	0	1,172	0.65
5,028	83.8	3.49	0	5.139	61.7	0	0	1,234	0.69
5,040	84.0	3.50	0	5.139	61.7	0	0	1,295	0.72
5,052	84.2	3.51	0	5.139	61.7	0	0	1,357	0.76
5,064	84.4	3.52	0	5.139	61.7	0	0	1,419	0.79
5,076	84.6	3.53	0	5.139	61.7	0	0	1,480	0.82
5,088	84.8	3.53	0	5.139	61.7	0	0	1,542	0.86
5,100	85.0	3.54	0	5.139	61.7	0	0	1,604	0.89
5,112	85.2	3.55	0	5.139	61.7	0	0	1,665	0.93
5,124	85.4	3.56	0	5.139	61.7	0	0	1,727	0.96
5,136	85.6	3.57	0	5.139	61.7	0	0	1,789	1.00
5,148	85.8	3.58	0	5.139	61.7	0	0	1,850	1.03
5,160	86.0	3.58	0	5.139	61.7	100	1,200	712	0.40
5,172	86.2	3.59	0	5.139	61.7	0	0	774	0.43
5,184	86.4	3.60	0	5.139	61.7	0	0	835	0.47
5,196	86.6	3.61	0	5.139	61.7	0	0	897	0.50
5,208	86.8	3.62	0	5.139	61.7	0	0	959	0.53
5,220	87.0	3.63	0	5.139	61.7	0	0	1,020	0.57
5,232	87.2	3.63	0	5.139	61.7	0	0	1,082	0.60
5,244	87.4	3.64	0	5.139	61.7	0	0	1,144	0.64
5,256	87.6	3.65	0	5.139	61.7	0	0	1,205	0.67
5,268	87.8	3.66	0	5.139	61.7	0	0	1,267	0.71
5,280	88.0	3.67	0	5.139	61.7	0	0	1,329	0.74
5,292	88.2	3.68	0	5.139	61.7	0	0	1,390	0.77
5,304	88.4	3.68	0	5.139	61.7	0	0	1,452	0.81
5,316	88.6	3.69	0	5.139	61.7	0	0	1,514	0.84
5,328	88.8	3.70	0	5.139	61.7	0	0	1,575	0.88
5,340	89.0	3.71	0	5.139	61.7	0	0	1,637	0.91
5,352	89.2	3.72	0	5.139	61.7	0	0	1,699	0.95
5,364	89.4	3.73	0	5.139	61.7	0	0	1,760	0.98
5,376	89.6	3.73	0	5.139	61.7	0	0	1,822	1.01
5,388	89.8	3.74	0	5.139	61.7	100	1,200	684	0.38
5,400	90.0	3.75	0	5.139	61.7	0	0	745	0.42
5,412	90.2	3.76	0	5.139	61.7	0	0	807	0.45
5,424	90.4	3.77	0	5.139	61.7	0	0	869	0.48
5,436	90.6	3.78	0	5.139	61.7	0	0	930	0.52
5,448	90.8	3.78	0	5.139	61.7	0	0	992	0.55

Attachment 7 - Cell 2 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,460	91.0	3.79	0	5.139	61.7	0	0	1,054	0.59
5,472	91.2	3.80	0	5.139	61.7	0	0	1,115	0.62
5,484	91.4	3.81	0	5.139	61.7	0	0	1,177	0.66
5,496	91.6	3.82	0	5.139	61.7	0	0	1,239	0.69
5,508	91.8	3.83	0	5.139	61.7	0	0	1,300	0.72
5,520	92.0	3.83	0	5.139	61.7	0	0	1,362	0.76
5,532	92.2	3.84	0	5.139	61.7	0	0	1,424	0.79
5,544	92.4	3.85	0	5.139	61.7	0	0	1,485	0.83
5,556	92.6	3.86	0	5.139	61.7	0	0	1,547	0.86
5,568	92.8	3.87	0	5.139	61.7	0	0	1,609	0.90
5,580	93.0	3.88	0	5.139	61.7	0	0	1,670	0.93
5,592	93.2	3.88	0	5.139	61.7	0	0	1,732	0.96
5,604	93.4	3.89	0	5.139	61.7	0	0	1,794	1.00
5,616	93.6	3.90	0	5.139	61.7	0	0	1,855	1.03
5,628	93.8	3.91	0	5.139	61.7	100	1,200	717	0.40
5,640	94.0	3.92	0	5.139	61.7	0	0	779	0.43
5,652	94.2	3.93	0	5.139	61.7	0	0	840	0.47
5,664	94.4	3.93	0	5.139	61.7	0	0	902	0.50
5,676	94.6	3.94	0	5.139	61.7	0	0	964	0.54
5,688	94.8	3.95	0	5.139	61.7	0	0	1,025	0.57
5,700	95.0	3.96	0	5.139	61.7	0	0	1,087	0.61
5,712	95.2	3.97	0	5.139	61.7	0	0	1,149	0.64
5,724	95.4	3.98	0	5.139	61.7	0	0	1,210	0.67
5,736	95.6	3.98	0	5.139	61.7	0	0	1,272	0.71
5,748	95.8	3.99	0	5.139	61.7	0	0	1,334	0.74
5,760	96.0	4.00	0	5.139	61.7	0	0	1,395	0.78
5,772	96.2	4.01	0	5.139	61.7	0	0	1,457	0.81
5,784	96.4	4.02	0	5.139	61.7	0	0	1,519	0.85
5,796	96.6	4.03	0	5.139	61.7	0	0	1,580	0.88
5,808	96.8	4.03	0	5.139	61.7	0	0	1,642	0.91
5,820	97.0	4.04	0	5.139	61.7	0	0	1,704	0.95
5,832	97.2	4.05	0	5.139	61.7	0	0	1,765	0.98
5,844	97.4	4.06	0	5.139	61.7	0	0	1,827	1.02
5,856	97.6	4.07	0	5.139	61.7	100	1,200	689	0.38
5,868	97.8	4.08	0	5.139	61.7	0	0	750	0.42
5,880	98.0	4.08	0	5.139	61.7	0	0	812	0.45
5,892	98.2	4.09	0	5.139	61.7	0	0	874	0.49
5,904	98.4	4.10	0	5.139	61.7	0	0	935	0.52
5,916	98.6	4.11	0	5.139	61.7	0	0	997	0.56
5,928	98.8	4.12	0	5.139	61.7	0	0	1,059	0.59
5,940	99.0	4.13	0	5.139	61.7	0	0	1,120	0.62
5,952	99.2	4.13	0	5.139	61.7	0	0	1,182	0.66
5,964	99.4	4.14	0	5.139	61.7	0	0	1,244	0.69
5,976	99.6	4.15	0	5.139	61.7	0	0	1,305	0.73
5,988	99.8	4.16	0	5.139	61.7	0	0	1,367	0.76
6,000	100.0	4.17	0	5.139	61.7	0	0	1,429	0.80
6,012	100.2	4.18	0	5.139	61.7	0	0	1,490	0.83
6,024	100.4	4.18	0	5.139	61.7	0	0	1,552	0.86
6,036	100.6	4.19	0	5.139	61.7	0	0	1,614	0.90
6,048	100.8	4.20	0	5.139	61.7	0	0	1,675	0.93
6,060	101.0	4.21	0	5.139	61.7	0	0	1,737	0.97
6,072	101.2	4.22	0	5.139	61.7	0	0	1,799	1.00
6,084	101.4	4.23	0	5.139	61.7	100	1,200	660	0.37
6,096	101.6	4.23	0	5.139	61.7	0	0	722	0.40
6,108	101.8	4.24	0	5.139	61.7	0	0	784	0.44
6,120	102.0	4.25	0	5.139	61.7	0	0	845	0.47
6,132	102.2	4.26	0	5.139	61.7	0	0	907	0.51
6,144	102.4	4.27	0	5.139	61.7	0	0	969	0.54
6,156	102.6	4.28	0	5.139	61.7	0	0	1,030	0.57
6,168	102.8	4.28	0	5.139	61.7	0	0	1,092	0.61
6,180	103.0	4.29	0	5.139	61.7	0	0	1,154	0.64
6,192	103.2	4.30	0	5.139	61.7	0	0	1,215	0.68
6,204	103.4	4.31	0	5.139	61.7	0	0	1,277	0.71
6,216	103.6	4.32	0	5.139	61.7	0	0	1,339	0.75
6,228	103.8	4.33	0	5.139	61.7	0	0	1,400	0.78

Attachment 7 - Cell 2 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,240	104.0	4.33	0	5.139	61.7	0	0	1,462	0.81
6,252	104.2	4.34	0	5.139	61.7	0	0	1,524	0.85
6,264	104.4	4.35	0	5.139	61.7	0	0	1,585	0.88
6,276	104.6	4.36	0	5.139	61.7	0	0	1,647	0.92
6,288	104.8	4.37	0	5.139	61.7	0	0	1,709	0.95
6,300	105.0	4.38	0	5.139	61.7	0	0	1,770	0.99
6,312	105.2	4.38	0	5.139	61.7	0	0	1,832	1.02
6,324	105.4	4.39	0	5.139	61.7	100	1,200	694	0.39
6,336	105.6	4.40	0	5.139	61.7	0	0	755	0.42
6,348	105.8	4.41	0	5.139	61.7	0	0	817	0.46
6,360	106.0	4.42	0	5.139	61.7	0	0	879	0.49
6,372	106.2	4.43	0	5.139	61.7	0	0	940	0.52
6,384	106.4	4.43	0	5.139	61.7	0	0	1,002	0.56
6,396	106.6	4.44	0	5.139	61.7	0	0	1,064	0.59
6,408	106.8	4.45	0	5.139	61.7	0	0	1,125	0.63
6,420	107.0	4.46	0	5.139	61.7	0	0	1,187	0.66
6,432	107.2	4.47	0	5.139	61.7	0	0	1,249	0.70
6,444	107.4	4.48	0	5.139	61.7	0	0	1,310	0.73
6,456	107.6	4.48	0	5.139	61.7	0	0	1,372	0.76
6,468	107.8	4.49	0	5.139	61.7	0	0	1,434	0.80
6,480	108.0	4.50	0	5.139	61.7	0	0	1,495	0.83
6,492	108.2	4.51	0	5.139	61.7	0	0	1,557	0.87
6,504	108.4	4.52	0	5.139	61.7	0	0	1,619	0.90
6,516	108.6	4.53	0	5.139	61.7	0	0	1,680	0.94
6,528	108.8	4.53	0	5.139	61.7	0	0	1,742	0.97
6,540	109.0	4.54	0	5.139	61.7	0	0	1,804	1.00
6,552	109.2	4.55	0	5.139	61.7	100	1,200	665	0.37
6,564	109.4	4.56	0	5.139	61.7	0	0	727	0.40
6,576	109.6	4.57	0	5.139	61.7	0	0	789	0.44
6,588	109.8	4.58	0	5.139	61.7	0	0	850	0.47
6,600	110.0	4.58	0	5.139	61.7	0	0	912	0.51
6,612	110.2	4.59	0	5.139	61.7	0	0	974	0.54
6,624	110.4	4.60	0	5.139	61.7	0	0	1,035	0.58
6,636	110.6	4.61	0	5.139	61.7	0	0	1,097	0.61
6,648	110.8	4.62	0	5.139	61.7	0	0	1,159	0.65
6,660	111.0	4.63	0	5.139	61.7	0	0	1,220	0.68
6,672	111.2	4.63	0	5.139	61.7	0	0	1,282	0.71
6,684	111.4	4.64	0	5.139	61.7	0	0	1,344	0.75
6,696	111.6	4.65	0	5.139	61.7	0	0	1,405	0.78
6,708	111.8	4.66	0	5.139	61.7	0	0	1,467	0.82
6,720	112.0	4.67	0	5.139	61.7	0	0	1,529	0.85
6,732	112.2	4.68	0	5.139	61.7	0	0	1,590	0.89
6,744	112.4	4.68	0	5.139	61.7	0	0	1,652	0.92
6,756	112.6	4.69	0	5.139	61.7	0	0	1,714	0.95
6,768	112.8	4.70	0	5.139	61.7	0	0	1,775	0.99
6,780	113.0	4.71	0	5.139	61.7	0	0	1,837	1.02
6,792	113.2	4.72	0	5.139	61.7	100	1,200	699	0.39
6,804	113.4	4.73	0	5.139	61.7	0	0	760	0.42
6,816	113.6	4.73	0	5.139	61.7	0	0	822	0.46
6,828	113.8	4.74	0	5.139	61.7	0	0	884	0.49
6,840	114.0	4.75	0	5.139	61.7	0	0	945	0.53
6,852	114.2	4.76	0	5.139	61.7	0	0	1,007	0.56
6,864	114.4	4.77	0	5.139	61.7	0	0	1,069	0.60
6,876	114.6	4.78	0	5.139	61.7	0	0	1,130	0.63
6,888	114.8	4.78	0	5.139	61.7	0	0	1,192	0.66
6,900	115.0	4.79	0	5.139	61.7	0	0	1,254	0.70
6,912	115.2	4.80	0	5.139	61.7	0	0	1,315	0.73
6,924	115.4	4.81	0	5.139	61.7	0	0	1,377	0.77
6,936	115.6	4.82	0	5.139	61.7	0	0	1,439	0.80
6,948	115.8	4.83	0	5.139	61.7	0	0	1,500	0.84
6,960	116.0	4.83	0	5.139	61.7	0	0	1,562	0.87
6,972	116.2	4.84	0	5.139	61.7	0	0	1,624	0.90
6,984	116.4	4.85	0	5.139	61.7	0	0	1,685	0.94
6,996	116.6	4.86	0	5.139	61.7	0	0	1,747	0.97
7,008	116.8	4.87	0	5.139	61.7	0	0	1,809	1.01

Attachment 7 - Cell 2 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,020	117.0	4.88	0	5.139	61.7	100	1,200	670	0.37
7,032	117.2	4.88	0	5.139	61.7	0	0	732	0.41
7,044	117.4	4.89	0	5.139	61.7	0	0	794	0.44
7,056	117.6	4.90	0	5.139	61.7	0	0	855	0.48
7,068	117.8	4.91	0	5.139	61.7	0	0	917	0.51
7,080	118.0	4.92	0	5.139	61.7	0	0	979	0.55
7,092	118.2	4.93	0	5.139	61.7	0	0	1,040	0.58
7,104	118.4	4.93	0	5.139	61.7	0	0	1,102	0.61
7,116	118.6	4.94	0	5.139	61.7	0	0	1,164	0.65
7,128	118.8	4.95	0	5.139	61.7	0	0	1,225	0.68
7,140	119.0	4.96	0	5.139	61.7	0	0	1,287	0.72
7,152	119.2	4.97	0	5.139	61.7	0	0	1,349	0.75
7,164	119.4	4.98	0	5.139	61.7	0	0	1,410	0.79
7,176	119.6	4.98	0	5.139	61.7	0	0	1,472	0.82
7,188	119.8	4.99	0	5.139	61.7	0	0	1,534	0.85
7,200	120.0	5.00	0	5.139	61.7	0	0	1,595	0.89
7,212	120.2	5.01	0	5.139	61.7	0	0	1,657	0.92
7,224	120.4	5.02	0	5.139	61.7	0	0	1,719	0.96
7,236	120.6	5.03	0	5.139	61.7	0	0	1,780	0.99
7,248	120.8	5.03	0	5.139	61.7	0	0	1,842	1.03
7,260	121.0	5.04	0	5.139	61.7	100	1,200	704	0.39
7,272	121.2	5.05	0	5.139	61.7	0	0	765	0.43
7,284	121.4	5.06	0	5.139	61.7	0	0	827	0.46
7,296	121.6	5.07	0	5.139	61.7	0	0	889	0.49
7,308	121.8	5.08	0	5.139	61.7	0	0	950	0.53
7,320	122.0	5.08	0	5.139	61.7	0	0	1,012	0.56
7,332	122.2	5.09	0	5.139	61.7	0	0	1,074	0.60
7,344	122.4	5.10	0	5.139	61.7	0	0	1,135	0.63
7,356	122.6	5.11	0	5.139	61.7	0	0	1,197	0.67
7,368	122.8	5.12	0	5.139	61.7	0	0	1,259	0.70
7,380	123.0	5.13	0	5.139	61.7	0	0	1,320	0.74
7,392	123.2	5.13	0	5.139	61.7	0	0	1,382	0.77
7,404	123.4	5.14	0	5.139	61.7	0	0	1,444	0.80
7,416	123.6	5.15	0	5.139	61.7	0	0	1,505	0.84
7,428	123.8	5.16	0	5.139	61.7	0	0	1,567	0.87
7,440	124.0	5.17	0	5.139	61.7	0	0	1,629	0.91
7,452	124.2	5.18	0	5.139	61.7	0	0	1,690	0.94
7,464	124.4	5.18	0	5.139	61.7	0	0	1,752	0.98
7,476	124.6	5.19	0	5.139	61.7	0	0	1,814	1.01
7,488	124.8	5.20	0	5.139	61.7	100	1,200	675	0.38
7,500	125.0	5.21	0	5.139	61.7	0	0	737	0.41
7,512	125.2	5.22	0	5.139	61.7	0	0	799	0.44
7,524	125.4	5.23	0	5.139	61.7	0	0	860	0.48
7,536	125.6	5.23	0	5.139	61.7	0	0	922	0.51
7,548	125.8	5.24	0	5.139	61.7	0	0	984	0.55
7,560	126.0	5.25	0	5.139	61.7	0	0	1,045	0.58
7,572	126.2	5.26	0	5.139	61.7	0	0	1,107	0.62
7,584	126.4	5.27	0	5.139	61.7	0	0	1,169	0.65
7,596	126.6	5.28	0	5.139	61.7	0	0	1,230	0.69
7,608	126.8	5.28	0	5.139	61.7	0	0	1,292	0.72
7,620	127.0	5.29	0	5.139	61.7	0	0	1,354	0.75
7,632	127.2	5.30	0	5.139	61.7	0	0	1,415	0.79
7,644	127.4	5.31	0	5.139	61.7	0	0	1,477	0.82
7,656	127.6	5.32	0	5.139	61.7	0	0	1,539	0.86
7,668	127.8	5.33	0	5.139	61.7	0	0	1,600	0.89
7,680	128.0	5.33	0	5.139	61.7	0	0	1,662	0.93
7,692	128.2	5.34	0	5.139	61.7	0	0	1,724	0.96
7,704	128.4	5.35	0	5.139	61.7	0	0	1,785	0.99
7,716	128.6	5.36	0	5.139	61.7	0	0	1,847	1.03
7,728	128.8	5.37	0	5.139	61.7	100	1,200	709	0.39
7,740	129.0	5.38	0	5.139	61.7	0	0	770	0.43
7,752	129.2	5.38	0	5.139	61.7	0	0	832	0.46
7,764	129.4	5.39	0	5.139	61.7	0	0	894	0.50
7,776	129.6	5.40	0	5.139	61.7	0	0	955	0.53
7,788	129.8	5.41	0	5.139	61.7	0	0	1,017	0.57

Attachment 7 - Cell 2 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,800	130.0	5.42	0	5.139	61.7	0	0	1,079	0.60
7,812	130.2	5.43	0	5.139	61.7	0	0	1,140	0.64
7,824	130.4	5.43	0	5.139	61.7	0	0	1,202	0.67
7,836	130.6	5.44	0	5.139	61.7	0	0	1,264	0.70
7,848	130.8	5.45	0	5.139	61.7	0	0	1,325	0.74
7,860	131.0	5.46	0	5.139	61.7	0	0	1,387	0.77
7,872	131.2	5.47	0	5.139	61.7	0	0	1,449	0.81
7,884	131.4	5.48	0	5.139	61.7	0	0	1,510	0.84
7,896	131.6	5.48	0	5.139	61.7	0	0	1,572	0.88
7,908	131.8	5.49	0	5.139	61.7	0	0	1,634	0.91
7,920	132.0	5.50	0	5.139	61.7	0	0	1,695	0.94
7,932	132.2	5.51	0	5.139	61.7	0	0	1,757	0.98
7,944	132.4	5.52	0	5.139	61.7	0	0	1,819	1.01
7,956	132.6	5.53	0	5.139	61.7	100	1,200	680	0.38
7,968	132.8	5.53	0	5.139	61.7	0	0	742	0.41
7,980	133.0	5.54	0	5.139	61.7	0	0	804	0.45
7,992	133.2	5.55	0	5.139	61.7	0	0	865	0.48
8,004	133.4	5.56	0	5.139	61.7	0	0	927	0.52
8,016	133.6	5.57	0	5.139	61.7	0	0	989	0.55
8,028	133.8	5.58	0	5.139	61.7	0	0	1,050	0.59
8,040	134.0	5.58	0	5.139	61.7	0	0	1,112	0.62
8,052	134.2	5.59	0	5.139	61.7	0	0	1,174	0.65
8,064	134.4	5.60	0	5.139	61.7	0	0	1,235	0.69
8,076	134.6	5.61	0	5.139	61.7	0	0	1,297	0.72
8,088	134.8	5.62	0	5.139	61.7	0	0	1,359	0.76
8,100	135.0	5.63	0	5.139	61.7	0	0	1,420	0.79
8,112	135.2	5.63	0	5.139	61.7	0	0	1,482	0.83
8,124	135.4	5.64	0	5.139	61.7	0	0	1,544	0.86
8,136	135.6	5.65	0	5.139	61.7	0	0	1,605	0.89
8,148	135.8	5.66	0	5.139	61.7	0	0	1,667	0.93
8,160	136.0	5.67	0	5.139	61.7	0	0	1,729	0.96
8,172	136.2	5.68	0	5.139	61.7	0	0	1,790	1.00
8,184	136.4	5.68	0	5.139	61.7	0	0	1,852	1.03
8,196	136.6	5.69	0	5.139	61.7	100	1,200	714	0.40
8,208	136.8	5.70	0	5.139	61.7	0	0	775	0.43
8,220	137.0	5.71	0	5.139	61.7	0	0	837	0.47
8,232	137.2	5.72	0	5.139	61.7	0	0	899	0.50
8,244	137.4	5.73	0	5.139	61.7	0	0	960	0.53
8,256	137.6	5.73	0	5.139	61.7	0	0	1,022	0.57
8,268	137.8	5.74	0	5.139	61.7	0	0	1,084	0.60
8,280	138.0	5.75	0	5.139	61.7	0	0	1,145	0.64
8,292	138.2	5.76	0	5.139	61.7	0	0	1,207	0.67
8,304	138.4	5.77	0	5.139	61.7	0	0	1,269	0.71
8,316	138.6	5.78	0	5.139	61.7	0	0	1,330	0.74
8,328	138.8	5.78	0	5.139	61.7	0	0	1,392	0.78
8,340	139.0	5.79	0	5.139	61.7	0	0	1,454	0.81
8,352	139.2	5.80	0	5.139	61.7	0	0	1,515	0.84
8,364	139.4	5.81	0	5.139	61.7	0	0	1,577	0.88
8,376	139.6	5.82	0	5.139	61.7	0	0	1,639	0.91
8,388	139.8	5.83	0	5.139	61.7	0	0	1,700	0.95
8,400	140.0	5.83	0	5.139	61.7	0	0	1,762	0.98
8,412	140.2	5.84	0	5.139	61.7	0	0	1,824	1.02
8,424	140.4	5.85	0	5.139	61.7	100	1,200	685	0.38
8,436	140.6	5.86	0	5.139	61.7	0	0	747	0.42
8,448	140.8	5.87	0	5.139	61.7	0	0	809	0.45
8,460	141.0	5.88	0	5.139	61.7	0	0	870	0.48
8,472	141.2	5.88	0	5.139	61.7	0	0	932	0.52
8,484	141.4	5.89	0	5.139	61.7	0	0	994	0.55
8,496	141.6	5.90	0	5.139	61.7	0	0	1,055	0.59
8,508	141.8	5.91	0	5.139	61.7	0	0	1,117	0.62
8,520	142.0	5.92	0	5.139	61.7	0	0	1,179	0.66
8,532	142.2	5.93	0	5.139	61.7	0	0	1,240	0.69
8,544	142.4	5.93	0	5.139	61.7	0	0	1,302	0.73
8,556	142.6	5.94	0	5.139	61.7	0	0	1,364	0.76
8,568	142.8	5.95	0	5.139	61.7	0	0	1,425	0.79

Attachment 7 - Cell 2 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,580	143.0	5.96	0	5.139	61.7	0	0	1,487	0.83
8,592	143.2	5.97	0	5.139	61.7	0	0	1,549	0.86
8,604	143.4	5.98	0	5.139	61.7	0	0	1,610	0.90
8,616	143.6	5.98	0	5.139	61.7	0	0	1,672	0.93
8,628	143.8	5.99	0	5.139	61.7	0	0	1,734	0.97
8,640	144.0	6.00	0	5.139	61.7	0	0	1,795	1.00
8,652	144.2	6.01	0	5.139	61.7	100	1,200	657	0.37
8,664	144.4	6.02	0	5.139	61.7	0	0	719	0.40
8,676	144.6	6.03	0	5.139	61.7	0	0	780	0.43
8,688	144.8	6.03	0	5.139	61.7	0	0	842	0.47
8,700	145.0	6.04	0	5.139	61.7	0	0	904	0.50
8,712	145.2	6.05	0	5.139	61.7	0	0	965	0.54
8,724	145.4	6.06	0	5.139	61.7	0	0	1,027	0.57
8,736	145.6	6.07	0	5.139	61.7	0	0	1,089	0.61
8,748	145.8	6.08	0	5.139	61.7	0	0	1,150	0.64
8,760	146.0	6.08	0	5.139	61.7	0	0	1,212	0.68
8,772	146.2	6.09	0	5.139	61.7	0	0	1,274	0.71
8,784	146.4	6.10	0	5.139	61.7	0	0	1,335	0.74
8,796	146.6	6.11	0	5.139	61.7	0	0	1,397	0.78
8,808	146.8	6.12	0	5.139	61.7	0	0	1,459	0.81
8,820	147.0	6.13	0	5.139	61.7	0	0	1,520	0.85
8,832	147.2	6.13	0	5.139	61.7	0	0	1,582	0.88
8,844	147.4	6.14	0	5.139	61.7	0	0	1,644	0.92
8,856	147.6	6.15	0	5.139	61.7	0	0	1,705	0.95
8,868	147.8	6.16	0	5.139	61.7	0	0	1,767	0.98
8,880	148.0	6.17	0	5.139	61.7	0	0	1,829	1.02
8,892	148.2	6.18	0	5.139	61.7	100	1,200	690	0.38
8,904	148.4	6.18	0	5.139	61.7	0	0	752	0.42
8,916	148.6	6.19	0	5.139	61.7	0	0	814	0.45
8,928	148.8	6.20	0	5.139	61.7	0	0	875	0.49
8,940	149.0	6.21	0	5.139	61.7	0	0	937	0.52
8,952	149.2	6.22	0	5.139	61.7	0	0	999	0.56
8,964	149.4	6.23	0	5.139	61.7	0	0	1,060	0.59
8,976	149.6	6.23	0	5.139	61.7	0	0	1,122	0.62
8,988	149.8	6.24	0	5.139	61.7	0	0	1,184	0.66
9,000	150.0	6.25	0	5.139	61.7	0	0	1,245	0.69
9,012	150.2	6.26	0	5.139	61.7	0	0	1,307	0.73
9,024	150.4	6.27	0	5.139	61.7	0	0	1,369	0.76
9,036	150.6	6.28	0	5.139	61.7	0	0	1,430	0.80
9,048	150.8	6.28	0	5.139	61.7	0	0	1,492	0.83
9,060	151.0	6.29	0	5.139	61.7	0	0	1,554	0.87
9,072	151.2	6.30	0	5.139	61.7	0	0	1,615	0.90
9,084	151.4	6.31	0	5.139	61.7	0	0	1,677	0.93
9,096	151.6	6.32	0	5.139	61.7	0	0	1,739	0.97
9,108	151.8	6.33	0	5.139	61.7	0	0	1,800	1.00
9,120	152.0	6.33	0	5.139	61.7	100	1,200	662	0.37
9,132	152.2	6.34	0	5.139	61.7	0	0	724	0.40
9,144	152.4	6.35	0	5.139	61.7	0	0	785	0.44
9,156	152.6	6.36	0	5.139	61.7	0	0	847	0.47
9,168	152.8	6.37	0	5.139	61.7	0	0	909	0.51
9,180	153.0	6.38	0	5.139	61.7	0	0	970	0.54
9,192	153.2	6.38	0	5.139	61.7	0	0	1,032	0.57
9,204	153.4	6.39	0	5.139	61.7	0	0	1,094	0.61
9,216	153.6	6.40	0	5.139	61.7	0	0	1,155	0.64
9,228	153.8	6.41	0	5.139	61.7	0	0	1,217	0.68
9,240	154.0	6.42	0	5.139	61.7	0	0	1,279	0.71
9,252	154.2	6.43	0	5.139	61.7	0	0	1,340	0.75
9,264	154.4	6.43	0	5.139	61.7	0	0	1,402	0.78
9,276	154.6	6.44	0	5.139	61.7	0	0	1,464	0.82
9,288	154.8	6.45	0	5.139	61.7	0	0	1,525	0.85
9,300	155.0	6.46	0	5.139	61.7	0	0	1,587	0.88
9,312	155.2	6.47	0	5.139	61.7	0	0	1,649	0.92
9,324	155.4	6.48	0	5.139	61.7	0	0	1,710	0.95
9,336	155.6	6.48	0	5.139	61.7	0	0	1,772	0.99
9,348	155.8	6.49	0	5.139	61.7	0	0	1,834	1.02

Attachment 7 - Cell 2 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
9,360	156.0	6.50	0	5.139	61.7	100	1,200	695	0.39
9,372	156.2	6.51	0	5.139	61.7	0	0	757	0.42
9,384	156.4	6.52	0	5.139	61.7	0	0	819	0.46
9,396	156.6	6.53	0	5.139	61.7	0	0	880	0.49
9,408	156.8	6.53	0	5.139	61.7	0	0	942	0.52
9,420	157.0	6.54	0	5.139	61.7	0	0	1,004	0.56
9,432	157.2	6.55	0	5.139	61.7	0	0	1,065	0.59
9,444	157.4	6.56	0	5.139	61.7	0	0	1,127	0.63
9,456	157.6	6.57	0	5.139	61.7	0	0	1,189	0.66
9,468	157.8	6.58	0	5.139	61.7	0	0	1,250	0.70
9,480	158.0	6.58	0	5.139	61.7	0	0	1,312	0.73
9,492	158.2	6.59	0	5.139	61.7	0	0	1,374	0.77
9,504	158.4	6.60	0	5.139	61.7	0	0	1,435	0.80
9,516	158.6	6.61	0	5.139	61.7	0	0	1,497	0.83
9,528	158.8	6.62	0	5.139	61.7	0	0	1,559	0.87
9,540	159.0	6.63	0	5.139	61.7	0	0	1,620	0.90
9,552	159.2	6.63	0	5.139	61.7	0	0	1,682	0.94
9,564	159.4	6.64	0	5.139	61.7	0	0	1,744	0.97
9,576	159.6	6.65	0	5.139	61.7	0	0	1,805	1.01
9,588	159.8	6.66	0	5.139	61.7	100	1,200	667	0.37
9,600	160.0	6.67	0	5.139	61.7	0	0	729	0.41
9,612	160.2	6.68	0	5.139	61.7	0	0	790	0.44
9,624	160.4	6.68	0	5.139	61.7	0	0	852	0.47
9,636	160.6	6.69	0	5.139	61.7	0	0	914	0.51
9,648	160.8	6.70	0	5.139	61.7	0	0	975	0.54
9,660	161.0	6.71	0	5.139	61.7	0	0	1,037	0.58
9,672	161.2	6.72	0	5.139	61.7	0	0	1,099	0.61
9,684	161.4	6.73	0	5.139	61.7	0	0	1,160	0.65
9,696	161.6	6.73	0	5.139	61.7	0	0	1,222	0.68
9,708	161.8	6.74	0	5.139	61.7	0	0	1,284	0.71
9,720	162.0	6.75	0	5.139	61.7	0	0	1,345	0.75
9,732	162.2	6.76	0	5.139	61.7	0	0	1,407	0.78
9,744	162.4	6.77	0	5.139	61.7	0	0	1,469	0.82
9,756	162.6	6.78	0	5.139	61.7	0	0	1,530	0.85
9,768	162.8	6.78	0	5.139	61.7	0	0	1,592	0.89
9,780	163.0	6.79	0	5.139	61.7	0	0	1,654	0.92
9,792	163.2	6.80	0	5.139	61.7	0	0	1,715	0.96
9,804	163.4	6.81	0	5.139	61.7	0	0	1,777	0.99
9,816	163.6	6.82	0	5.139	61.7	0	0	1,839	1.02
9,828	163.8	6.83	0	5.139	61.7	100	1,200	700	0.39
9,840	164.0	6.83	0	5.139	61.7	0	0	762	0.42
9,852	164.2	6.84	0	5.139	61.7	0	0	824	0.46
9,864	164.4	6.85	0	5.139	61.7	0	0	885	0.49
9,876	164.6	6.86	0	5.139	61.7	0	0	947	0.53
9,888	164.8	6.87	0	5.139	61.7	0	0	1,009	0.56
9,900	165.0	6.88	0	5.139	61.7	0	0	1,070	0.60
9,912	165.2	6.88	0	5.139	61.7	0	0	1,132	0.63
9,924	165.4	6.89	0	5.139	61.7	0	0	1,194	0.66
9,936	165.6	6.90	0	5.139	61.7	0	0	1,255	0.70
9,948	165.8	6.91	0	5.139	61.7	0	0	1,317	0.73
9,960	166.0	6.92	0	5.139	61.7	0	0	1,379	0.77
9,972	166.2	6.93	0	5.139	61.7	0	0	1,440	0.80
9,984	166.4	6.93	0	5.139	61.7	0	0	1,502	0.84
9,996	166.6	6.94	0	5.139	61.7	0	0	1,564	0.87
10,008	166.8	6.95	0	5.139	61.7	0	0	1,625	0.91
10,020	167.0	6.96	0	5.139	61.7	0	0	1,687	0.94
10,032	167.2	6.97	0	5.139	61.7	0	0	1,749	0.97
10,044	167.4	6.98	0	5.139	61.7	0	0	1,810	1.01
10,056	167.6	6.98	0	5.139	61.7	100	1,200	672	0.37
10,068	167.8	6.99	0	5.139	61.7	0	0	734	0.41
10,080	168.0	7.00	0	5.139	61.7	0	0	795	0.44

ATTACHMENT 8

Cell 2 Leachate Collection Sump – Average Conditions

Attachment 8 - Cell 2 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
0	0.0	0.00	0	5.9	0.0	0	0	0	3,590	1.00
12	0.2	0.01	0	5.9	71.2	0	0	0	3,662	1.02
24	0.4	0.02	0	5.9	71.2	100	0	1,200	2,533	0.71
36	0.6	0.03	0	5.9	71.2	100	0	1,200	1,404	0.39
48	0.8	0.03	0	5.9	71.2	0	0	0	1,475	0.41
60	1.0	0.04	0	5.9	71.2	0	0	0	1,547	0.43
72	1.2	0.05	0	5.9	71.2	0	0	0	1,618	0.45
84	1.4	0.06	0	5.9	71.2	0	0	0	1,689	0.47
96	1.6	0.07	0	5.9	71.2	0	0	0	1,760	0.49
108	1.8	0.08	0	5.9	71.2	0	0	0	1,831	0.51
120	2.0	0.08	0	5.9	71.2	0	0	0	1,903	0.53
132	2.2	0.09	0	5.9	71.2	0	0	0	1,974	0.55
144	2.4	0.10	0	5.9	71.2	0	0	0	2,045	0.57
156	2.6	0.11	0	5.9	71.2	0	0	0	2,116	0.59
168	2.8	0.12	0	5.9	71.2	0	0	0	2,188	0.61
180	3.0	0.13	0	5.9	71.2	0	0	0	2,259	0.63
192	3.2	0.13	0	5.9	71.2	0	0	0	2,330	0.65
204	3.4	0.14	0	5.9	71.2	0	0	0	2,401	0.67
216	3.6	0.15	0	5.9	71.2	0	0	0	2,472	0.69
228	3.8	0.16	0	5.9	71.2	0	0	0	2,544	0.71
240	4.0	0.17	0	5.9	71.2	0	0	0	2,615	0.73
252	4.2	0.18	0	5.9	71.2	0	0	0	2,686	0.75
264	4.4	0.18	0	5.9	71.2	0	0	0	2,757	0.77
276	4.6	0.19	0	5.9	71.2	0	0	0	2,829	0.79
288	4.8	0.20	0	5.9	71.2	0	0	0	2,900	0.81
300	5.0	0.21	0	5.9	71.2	0	0	0	2,971	0.83
312	5.2	0.22	0	5.9	71.2	0	0	0	3,042	0.85
324	5.4	0.23	0	5.9	71.2	0	0	0	3,113	0.87
336	5.6	0.23	0	5.9	71.2	0	0	0	3,185	0.89
348	5.8	0.24	0	5.9	71.2	0	0	0	3,256	0.91
360	6.0	0.25	0	5.9	71.2	0	0	0	3,327	0.93
372	6.2	0.26	0	5.9	71.2	0	0	0	3,398	0.95
384	6.4	0.27	0	5.9	71.2	0	0	0	3,470	0.97
396	6.6	0.28	0	5.9	71.2	0	0	0	3,541	0.99
408	6.8	0.28	0	5.9	71.2	0	0	0	3,612	1.01
420	7.0	0.29	0	5.9	71.2	100	0	1,200	2,483	0.69
432	7.2	0.30	0	5.9	71.2	100	0	1,200	1,355	0.38
444	7.4	0.31	0	5.9	71.2	0	0	0	1,426	0.40
456	7.6	0.32	0	5.9	71.2	0	0	0	1,497	0.42
468	7.8	0.33	0	5.9	71.2	0	0	0	1,568	0.44
480	8.0	0.33	0	5.9	71.2	0	0	0	1,639	0.46
492	8.2	0.34	0	5.9	71.2	0	0	0	1,711	0.48
504	8.4	0.35	0	5.9	71.2	0	0	0	1,782	0.50
516	8.6	0.36	0	5.9	71.2	0	0	0	1,853	0.52
528	8.8	0.37	0	5.9	71.2	0	0	0	1,924	0.54
540	9.0	0.38	0	5.9	71.2	0	0	0	1,996	0.56
552	9.2	0.38	0	5.9	71.2	0	0	0	2,067	0.58
564	9.4	0.39	0	5.9	71.2	0	0	0	2,138	0.60
576	9.6	0.40	0	5.9	71.2	0	0	0	2,209	0.62
588	9.8	0.41	0	5.9	71.2	0	0	0	2,280	0.64
600	10.0	0.42	0	5.9	71.2	0	0	0	2,352	0.65
612	10.2	0.43	0	5.9	71.2	0	0	0	2,423	0.67
624	10.4	0.43	0	5.9	71.2	0	0	0	2,494	0.69
636	10.6	0.44	0	5.9	71.2	0	0	0	2,565	0.71
648	10.8	0.45	0	5.9	71.2	0	0	0	2,637	0.73
660	11.0	0.46	0	5.9	71.2	0	0	0	2,708	0.75
672	11.2	0.47	0	5.9	71.2	0	0	0	2,779	0.77
684	11.4	0.48	0	5.9	71.2	0	0	0	2,850	0.79
696	11.6	0.48	0	5.9	71.2	0	0	0	2,921	0.81
708	11.8	0.49	0	5.9	71.2	0	0	0	2,993	0.83
720	12.0	0.50	0	5.9	71.2	0	0	0	3,064	0.85
732	12.2	0.51	0	5.9	71.2	0	0	0	3,135	0.87
744	12.4	0.52	0	5.9	71.2	0	0	0	3,206	0.89
756	12.6	0.53	0	5.9	71.2	0	0	0	3,278	0.91
768	12.8	0.53	0	5.9	71.2	0	0	0	3,349	0.93
780	13.0	0.54	0	5.9	71.2	0	0	0	3,420	0.95
792	13.2	0.55	0	5.9	71.2	0	0	0	3,491	0.97
804	13.4	0.56	0	5.9	71.2	0	0	0	3,562	0.99
816	13.6	0.57	0	5.9	71.2	0	0	0	3,634	1.01
828	13.8	0.58	0	5.9	71.2	100	0	1,200	2,505	0.70
840	14.0	0.58	0	5.9	71.2	100	0	1,200	1,376	0.38
852	14.2	0.59	0	5.9	71.2	0	0	0	1,447	0.40
864	14.4	0.60	0	5.9	71.2	0	0	0	1,519	0.42
876	14.6	0.61	0	5.9	71.2	0	0	0	1,590	0.44
888	14.8	0.62	0	5.9	71.2	0	0	0	1,661	0.46
900	15.0	0.63	0	5.9	71.2	0	0	0	1,732	0.48

Attachment 8 - Cell 2 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
912	15.2	0.63	0	5.9	71.2	0	0	0	1,803	0.50
924	15.4	0.64	0	5.9	71.2	0	0	0	1,875	0.52
936	15.6	0.65	0	5.9	71.2	0	0	0	1,946	0.54
948	15.8	0.66	0	5.9	71.2	0	0	0	2,017	0.56
960	16.0	0.67	0	5.9	71.2	0	0	0	2,088	0.58
972	16.2	0.68	0	5.9	71.2	0	0	0	2,160	0.60
984	16.4	0.68	0	5.9	71.2	0	0	0	2,231	0.62
996	16.6	0.69	0	5.9	71.2	0	0	0	2,302	0.64
1,008	16.8	0.70	0	5.9	71.2	0	0	0	2,373	0.66
1,020	17.0	0.71	0	5.9	71.2	0	0	0	2,445	0.68
1,032	17.2	0.72	0	5.9	71.2	0	0	0	2,516	0.70
1,044	17.4	0.73	0	5.9	71.2	0	0	0	2,587	0.72
1,056	17.6	0.73	0	5.9	71.2	0	0	0	2,658	0.74
1,068	17.8	0.74	0	5.9	71.2	0	0	0	2,729	0.76
1,080	18.0	0.75	0	5.9	71.2	0	0	0	2,801	0.78
1,092	18.2	0.76	0	5.9	71.2	0	0	0	2,872	0.80
1,104	18.4	0.77	0	5.9	71.2	0	0	0	2,943	0.82
1,116	18.6	0.78	0	5.9	71.2	0	0	0	3,014	0.84
1,128	18.8	0.78	0	5.9	71.2	0	0	0	3,086	0.86
1,140	19.0	0.79	0	5.9	71.2	0	0	0	3,157	0.88
1,152	19.2	0.80	0	5.9	71.2	0	0	0	3,228	0.90
1,164	19.4	0.81	0	5.9	71.2	0	0	0	3,299	0.92
1,176	19.6	0.82	0	5.9	71.2	0	0	0	3,370	0.94
1,188	19.8	0.83	0	5.9	71.2	0	0	0	3,442	0.96
1,200	20.0	0.83	0	5.9	71.2	0	0	0	3,513	0.98
1,212	20.2	0.84	0	5.9	71.2	0	0	0	3,584	1.00
1,224	20.4	0.85	0	5.9	71.2	0	0	0	3,655	1.02
1,236	20.6	0.86	0	5.9	71.2	100	0	1,200	2,527	0.70
1,248	20.8	0.87	0	5.9	71.2	100	0	1,200	1,398	0.39
1,260	21.0	0.88	0	5.9	71.2	0	0	0	1,469	0.41
1,272	21.2	0.88	0	5.9	71.2	0	0	0	1,540	0.43
1,284	21.4	0.89	0	5.9	71.2	0	0	0	1,611	0.45
1,296	21.6	0.90	0	5.9	71.2	0	0	0	1,683	0.47
1,308	21.8	0.91	0	5.9	71.2	0	0	0	1,754	0.49
1,320	22.0	0.92	0	5.9	71.2	0	0	0	1,825	0.51
1,332	22.2	0.93	0	5.9	71.2	0	0	0	1,896	0.53
1,344	22.4	0.93	0	5.9	71.2	0	0	0	1,968	0.55
1,356	22.6	0.94	0	5.9	71.2	0	0	0	2,039	0.57
1,368	22.8	0.95	0	5.9	71.2	0	0	0	2,110	0.59
1,380	23.0	0.96	0	5.9	71.2	0	0	0	2,181	0.61
1,392	23.2	0.97	0	5.9	71.2	0	0	0	2,252	0.63
1,404	23.4	0.98	0	5.9	71.2	0	0	0	2,324	0.65
1,416	23.6	0.98	0	5.9	71.2	0	0	0	2,395	0.67
1,428	23.8	0.99	0	5.9	71.2	0	0	0	2,466	0.69
1,440	24.0	1.00	0	5.9	71.2	0	0	0	2,537	0.71
1,452	24.2	1.01	0	5.9	71.2	0	0	0	2,609	0.73
1,464	24.4	1.02	0	5.9	71.2	0	0	0	2,680	0.75
1,476	24.6	1.03	0	5.9	71.2	0	0	0	2,751	0.77
1,488	24.8	1.03	0	5.9	71.2	0	0	0	2,822	0.79
1,500	25.0	1.04	0	5.9	71.2	0	0	0	2,894	0.81
1,512	25.2	1.05	0	5.9	71.2	0	0	0	2,965	0.83
1,524	25.4	1.06	0	5.9	71.2	0	0	0	3,036	0.85
1,536	25.6	1.07	0	5.9	71.2	0	0	0	3,107	0.87
1,548	25.8	1.08	0	5.9	71.2	0	0	0	3,178	0.89
1,560	26.0	1.08	0	5.9	71.2	0	0	0	3,250	0.91
1,572	26.2	1.09	0	5.9	71.2	0	0	0	3,321	0.92
1,584	26.4	1.10	0	5.9	71.2	0	0	0	3,392	0.94
1,596	26.6	1.11	0	5.9	71.2	0	0	0	3,463	0.96
1,608	26.8	1.12	0	5.9	71.2	0	0	0	3,535	0.98
1,620	27.0	1.13	0	5.9	71.2	0	0	0	3,606	1.00
1,632	27.2	1.13	0	5.9	71.2	100	0	1,200	2,477	0.69
1,644	27.4	1.14	0	5.9	71.2	100	0	1,200	1,348	0.38
1,656	27.6	1.15	0	5.9	71.2	0	0	0	1,419	0.40
1,668	27.8	1.16	0	5.9	71.2	0	0	0	1,491	0.42
1,680	28.0	1.17	0	5.9	71.2	0	0	0	1,562	0.44
1,692	28.2	1.18	0	5.9	71.2	0	0	0	1,633	0.45
1,704	28.4	1.18	0	5.9	71.2	0	0	0	1,704	0.47
1,716	28.6	1.19	0	5.9	71.2	0	0	0	1,776	0.49
1,728	28.8	1.20	0	5.9	71.2	0	0	0	1,847	0.51
1,740	29.0	1.21	0	5.9	71.2	0	0	0	1,918	0.53
1,752	29.2	1.22	0	5.9	71.2	0	0	0	1,989	0.55
1,764	29.4	1.23	0	5.9	71.2	0	0	0	2,060	0.57
1,776	29.6	1.23	0	5.9	71.2	0	0	0	2,132	0.59
1,788	29.8	1.24	0	5.9	71.2	0	0	0	2,203	0.61
1,800	30.0	1.25	0	5.9	71.2	0	0	0	2,274	0.63
1,812	30.2	1.26	0	5.9	71.2	0	0	0	2,345	0.65

Attachment 8 - Cell 2 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,824	30.4	1.27	0	5.9	71.2	0	0	0	2,417	0.67
1,836	30.6	1.28	0	5.9	71.2	0	0	0	2,488	0.69
1,848	30.8	1.28	0	5.9	71.2	0	0	0	2,559	0.71
1,860	31.0	1.29	0	5.9	71.2	0	0	0	2,630	0.73
1,872	31.2	1.30	0	5.9	71.2	0	0	0	2,701	0.75
1,884	31.4	1.31	0	5.9	71.2	0	0	0	2,773	0.77
1,896	31.6	1.32	0	5.9	71.2	0	0	0	2,844	0.79
1,908	31.8	1.33	0	5.9	71.2	0	0	0	2,915	0.81
1,920	32.0	1.33	0	5.9	71.2	0	0	0	2,986	0.83
1,932	32.2	1.34	0	5.9	71.2	0	0	0	3,058	0.85
1,944	32.4	1.35	0	5.9	71.2	0	0	0	3,129	0.87
1,956	32.6	1.36	0	5.9	71.2	0	0	0	3,200	0.89
1,968	32.8	1.37	0	5.9	71.2	0	0	0	3,271	0.91
1,980	33.0	1.38	0	5.9	71.2	0	0	0	3,343	0.93
1,992	33.2	1.38	0	5.9	71.2	0	0	0	3,414	0.95
2,004	33.4	1.39	0	5.9	71.2	0	0	0	3,485	0.97
2,016	33.6	1.40	0	5.9	71.2	0	0	0	3,556	0.99
2,028	33.8	1.41	0	5.9	71.2	0	0	0	3,627	1.01
2,040	34.0	1.42	0	5.9	71.2	100	0	1,200	2,499	0.70
2,052	34.2	1.43	0	5.9	71.2	100	0	1,200	1,370	0.38
2,064	34.4	1.43	0	5.9	71.2	0	0	0	1,441	0.40
2,076	34.6	1.44	0	5.9	71.2	0	0	0	1,512	0.42
2,088	34.8	1.45	0	5.9	71.2	0	0	0	1,584	0.44
2,100	35.0	1.46	0	5.9	71.2	0	0	0	1,655	0.46
2,112	35.2	1.47	0	5.9	71.2	0	0	0	1,726	0.48
2,124	35.4	1.48	0	5.9	71.2	0	0	0	1,797	0.50
2,136	35.6	1.48	0	5.9	71.2	0	0	0	1,868	0.52
2,148	35.8	1.49	0	5.9	71.2	0	0	0	1,940	0.54
2,160	36.0	1.50	0	5.9	71.2	0	0	0	2,011	0.56
2,172	36.2	1.51	0	5.9	71.2	0	0	0	2,082	0.58
2,184	36.4	1.52	0	5.9	71.2	0	0	0	2,153	0.60
2,196	36.6	1.53	0	5.9	71.2	0	0	0	2,225	0.62
2,208	36.8	1.53	0	5.9	71.2	0	0	0	2,296	0.64
2,220	37.0	1.54	0	5.9	71.2	0	0	0	2,367	0.66
2,232	37.2	1.55	0	5.9	71.2	0	0	0	2,438	0.68
2,244	37.4	1.56	0	5.9	71.2	0	0	0	2,509	0.70
2,256	37.6	1.57	0	5.9	71.2	0	0	0	2,581	0.72
2,268	37.8	1.58	0	5.9	71.2	0	0	0	2,652	0.74
2,280	38.0	1.58	0	5.9	71.2	0	0	0	2,723	0.76
2,292	38.2	1.59	0	5.9	71.2	0	0	0	2,794	0.78
2,304	38.4	1.60	0	5.9	71.2	0	0	0	2,866	0.80
2,316	38.6	1.61	0	5.9	71.2	0	0	0	2,937	0.82
2,328	38.8	1.62	0	5.9	71.2	0	0	0	3,008	0.84
2,340	39.0	1.63	0	5.9	71.2	0	0	0	3,079	0.86
2,352	39.2	1.63	0	5.9	71.2	0	0	0	3,150	0.88
2,364	39.4	1.64	0	5.9	71.2	0	0	0	3,222	0.90
2,376	39.6	1.65	0	5.9	71.2	0	0	0	3,293	0.92
2,388	39.8	1.66	0	5.9	71.2	0	0	0	3,364	0.94
2,400	40.0	1.67	0	5.9	71.2	0	0	0	3,435	0.96
2,412	40.2	1.68	0	5.9	71.2	0	0	0	3,507	0.98
2,424	40.4	1.68	0	5.9	71.2	0	0	0	3,578	1.00
2,436	40.6	1.69	0	5.9	71.2	0	0	0	3,649	1.02
2,448	40.8	1.70	0	5.9	71.2	100	0	1,200	2,520	0.70
2,460	41.0	1.71	0	5.9	71.2	100	0	1,200	1,392	0.39
2,472	41.2	1.72	0	5.9	71.2	0	0	0	1,463	0.41
2,484	41.4	1.73	0	5.9	71.2	0	0	0	1,534	0.43
2,496	41.6	1.73	0	5.9	71.2	0	0	0	1,605	0.45
2,508	41.8	1.74	0	5.9	71.2	0	0	0	1,676	0.47
2,520	42.0	1.75	0	5.9	71.2	0	0	0	1,748	0.49
2,532	42.2	1.76	0	5.9	71.2	0	0	0	1,819	0.51
2,544	42.4	1.77	0	5.9	71.2	0	0	0	1,890	0.53
2,556	42.6	1.78	0	5.9	71.2	0	0	0	1,961	0.55
2,568	42.8	1.78	0	5.9	71.2	0	0	0	2,033	0.57
2,580	43.0	1.79	0	5.9	71.2	0	0	0	2,104	0.59
2,592	43.2	1.80	0	5.9	71.2	0	0	0	2,175	0.61
2,604	43.4	1.81	0	5.9	71.2	0	0	0	2,246	0.63
2,616	43.6	1.82	0	5.9	71.2	0	0	0	2,317	0.65
2,628	43.8	1.83	0	5.9	71.2	0	0	0	2,389	0.67
2,640	44.0	1.83	0	5.9	71.2	0	0	0	2,460	0.69
2,652	44.2	1.84	0	5.9	71.2	0	0	0	2,531	0.70
2,664	44.4	1.85	0	5.9	71.2	0	0	0	2,602	0.72
2,676	44.6	1.86	0	5.9	71.2	0	0	0	2,674	0.74
2,688	44.8	1.87	0	5.9	71.2	0	0	0	2,745	0.76
2,700	45.0	1.88	0	5.9	71.2	0	0	0	2,816	0.78
2,712	45.2	1.88	0	5.9	71.2	0	0	0	2,887	0.80
2,724	45.4	1.89	0	5.9	71.2	0	0	0	2,958	0.82

Attachment 8 - Cell 2 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
2,736	45.6	1.90	0	5.9	71.2	0	0	0	3,030	0.84
2,748	45.8	1.91	0	5.9	71.2	0	0	0	3,101	0.86
2,760	46.0	1.92	0	5.9	71.2	0	0	0	3,172	0.88
2,772	46.2	1.93	0	5.9	71.2	0	0	0	3,243	0.90
2,784	46.4	1.93	0	5.9	71.2	0	0	0	3,315	0.92
2,796	46.6	1.94	0	5.9	71.2	0	0	0	3,386	0.94
2,808	46.8	1.95	0	5.9	71.2	0	0	0	3,457	0.96
2,820	47.0	1.96	0	5.9	71.2	0	0	0	3,528	0.98
2,832	47.2	1.97	0	5.9	71.2	0	0	0	3,599	1.00
2,844	47.4	1.98	0	5.9	71.2	100	0	1,200	2,471	0.69
2,856	47.6	1.98	0	5.9	71.2	100	0	1,200	1,342	0.37
2,868	47.8	1.99	0	5.9	71.2	0	0	0	1,413	0.39
2,880	48.0	2.00	0	5.9	71.2	0	0	0	1,484	0.41
2,892	48.2	2.01	0	5.9	71.2	0	0	0	1,556	0.43
2,904	48.4	2.02	0	5.9	71.2	0	0	0	1,627	0.45
2,916	48.6	2.03	0	5.9	71.2	0	0	0	1,698	0.47
2,928	48.8	2.03	0	5.9	71.2	0	0	0	1,769	0.49
2,940	49.0	2.04	0	5.9	71.2	0	0	0	1,841	0.51
2,952	49.2	2.05	0	5.9	71.2	0	0	0	1,912	0.53
2,964	49.4	2.06	0	5.9	71.2	0	0	0	1,983	0.55
2,976	49.6	2.07	0	5.9	71.2	0	0	0	2,054	0.57
2,988	49.8	2.08	0	5.9	71.2	0	0	0	2,125	0.59
3,000	50.0	2.08	0	5.9	71.2	0	0	0	2,197	0.61
3,012	50.2	2.09	0	5.9	71.2	0	0	0	2,268	0.63
3,024	50.4	2.10	0	5.9	71.2	0	0	0	2,339	0.65
3,036	50.6	2.11	0	5.9	71.2	0	0	0	2,410	0.67
3,048	50.8	2.12	0	5.9	71.2	0	0	0	2,482	0.69
3,060	51.0	2.13	0	5.9	71.2	0	0	0	2,553	0.71
3,072	51.2	2.13	0	5.9	71.2	0	0	0	2,624	0.73
3,084	51.4	2.14	0	5.9	71.2	0	0	0	2,695	0.75
3,096	51.6	2.15	0	5.9	71.2	0	0	0	2,766	0.77
3,108	51.8	2.16	0	5.9	71.2	0	0	0	2,838	0.79
3,120	52.0	2.17	0	5.9	71.2	0	0	0	2,909	0.81
3,132	52.2	2.18	0	5.9	71.2	0	0	0	2,980	0.83
3,144	52.4	2.18	0	5.9	71.2	0	0	0	3,051	0.85
3,156	52.6	2.19	0	5.9	71.2	0	0	0	3,123	0.87
3,168	52.8	2.20	0	5.9	71.2	0	0	0	3,194	0.89
3,180	53.0	2.21	0	5.9	71.2	0	0	0	3,265	0.91
3,192	53.2	2.22	0	5.9	71.2	0	0	0	3,336	0.93
3,204	53.4	2.23	0	5.9	71.2	0	0	0	3,407	0.95
3,216	53.6	2.23	0	5.9	71.2	0	0	0	3,479	0.97
3,228	53.8	2.24	0	5.9	71.2	0	0	0	3,550	0.99
3,240	54.0	2.25	0	5.9	71.2	0	0	0	3,621	1.01
3,252	54.2	2.26	0	5.9	71.2	100	0	1,200	2,492	0.69
3,264	54.4	2.27	0	5.9	71.2	100	0	1,200	1,364	0.38
3,276	54.6	2.28	0	5.9	71.2	0	0	0	1,435	0.40
3,288	54.8	2.28	0	5.9	71.2	0	0	0	1,506	0.42
3,300	55.0	2.29	0	5.9	71.2	0	0	0	1,577	0.44
3,312	55.2	2.30	0	5.9	71.2	0	0	0	1,648	0.46
3,324	55.4	2.31	0	5.9	71.2	0	0	0	1,720	0.48
3,336	55.6	2.32	0	5.9	71.2	0	0	0	1,791	0.50
3,348	55.8	2.33	0	5.9	71.2	0	0	0	1,862	0.52
3,360	56.0	2.33	0	5.9	71.2	0	0	0	1,933	0.54
3,372	56.2	2.34	0	5.9	71.2	0	0	0	2,005	0.56
3,384	56.4	2.35	0	5.9	71.2	0	0	0	2,076	0.58
3,396	56.6	2.36	0	5.9	71.2	0	0	0	2,147	0.60
3,408	56.8	2.37	0	5.9	71.2	0	0	0	2,218	0.62
3,420	57.0	2.38	0	5.9	71.2	0	0	0	2,290	0.64
3,432	57.2	2.38	0	5.9	71.2	0	0	0	2,361	0.66
3,444	57.4	2.39	0	5.9	71.2	0	0	0	2,432	0.68
3,456	57.6	2.40	0	5.9	71.2	0	0	0	2,503	0.70
3,468	57.8	2.41	0	5.9	71.2	0	0	0	2,574	0.72
3,480	58.0	2.42	0	5.9	71.2	0	0	0	2,646	0.74
3,492	58.2	2.43	0	5.9	71.2	0	0	0	2,717	0.76
3,504	58.4	2.43	0	5.9	71.2	0	0	0	2,788	0.78
3,516	58.6	2.44	0	5.9	71.2	0	0	0	2,859	0.80
3,528	58.8	2.45	0	5.9	71.2	0	0	0	2,931	0.82
3,540	59.0	2.46	0	5.9	71.2	0	0	0	3,002	0.84
3,552	59.2	2.47	0	5.9	71.2	0	0	0	3,073	0.86
3,564	59.4	2.48	0	5.9	71.2	0	0	0	3,144	0.88
3,576	59.6	2.48	0	5.9	71.2	0	0	0	3,215	0.90
3,588	59.8	2.49	0	5.9	71.2	0	0	0	3,287	0.92
3,600	60.0	2.50	0	5.9	71.2	0	0	0	3,358	0.94
3,612	60.2	2.51	0	5.9	71.2	0	0	0	3,429	0.96
3,624	60.4	2.52	0	5.9	71.2	0	0	0	3,500	0.97
3,636	60.6	2.53	0	5.9	71.2	0	0	0	3,572	0.99

Attachment 8 - Cell 2 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,648	60.8	2.53	0	5.9	71.2	0	0	0	3,643	1.01
3,660	61.0	2.54	0	5.9	71.2	100	0	1,200	2,514	0.70
3,672	61.2	2.55	0	5.9	71.2	100	0	1,200	1,385	0.39
3,684	61.4	2.56	0	5.9	71.2	0	0	0	1,456	0.41
3,696	61.6	2.57	0	5.9	71.2	0	0	0	1,528	0.43
3,708	61.8	2.58	0	5.9	71.2	0	0	0	1,599	0.45
3,720	62.0	2.58	0	5.9	71.2	0	0	0	1,670	0.47
3,732	62.2	2.59	0	5.9	71.2	0	0	0	1,741	0.49
3,744	62.4	2.60	0	5.9	71.2	0	0	0	1,813	0.50
3,756	62.6	2.61	0	5.9	71.2	0	0	0	1,884	0.52
3,768	62.8	2.62	0	5.9	71.2	0	0	0	1,955	0.54
3,780	63.0	2.63	0	5.9	71.2	0	0	0	2,026	0.56
3,792	63.2	2.63	0	5.9	71.2	0	0	0	2,097	0.58
3,804	63.4	2.64	0	5.9	71.2	0	0	0	2,169	0.60
3,816	63.6	2.65	0	5.9	71.2	0	0	0	2,240	0.62
3,828	63.8	2.66	0	5.9	71.2	0	0	0	2,311	0.64
3,840	64.0	2.67	0	5.9	71.2	0	0	0	2,382	0.66
3,852	64.2	2.68	0	5.9	71.2	0	0	0	2,454	0.68
3,864	64.4	2.68	0	5.9	71.2	0	0	0	2,525	0.70
3,876	64.6	2.69	0	5.9	71.2	0	0	0	2,596	0.72
3,888	64.8	2.70	0	5.9	71.2	0	0	0	2,667	0.74
3,900	65.0	2.71	0	5.9	71.2	0	0	0	2,739	0.76
3,912	65.2	2.72	0	5.9	71.2	0	0	0	2,810	0.78
3,924	65.4	2.73	0	5.9	71.2	0	0	0	2,881	0.80
3,936	65.6	2.73	0	5.9	71.2	0	0	0	2,952	0.82
3,948	65.8	2.74	0	5.9	71.2	0	0	0	3,023	0.84
3,960	66.0	2.75	0	5.9	71.2	0	0	0	3,095	0.86
3,972	66.2	2.76	0	5.9	71.2	0	0	0	3,166	0.88
3,984	66.4	2.77	0	5.9	71.2	0	0	0	3,237	0.90
3,996	66.6	2.78	0	5.9	71.2	0	0	0	3,308	0.92
4,008	66.8	2.78	0	5.9	71.2	0	0	0	3,380	0.94
4,020	67.0	2.79	0	5.9	71.2	0	0	0	3,451	0.96
4,032	67.2	2.80	0	5.9	71.2	0	0	0	3,522	0.98
4,044	67.4	2.81	0	5.9	71.2	0	0	0	3,593	1.00
4,056	67.6	2.82	0	5.9	71.2	100	0	1,200	2,464	0.69
4,068	67.8	2.83	0	5.9	71.2	100	0	1,200	1,336	0.37
4,080	68.0	2.83	0	5.9	71.2	0	0	0	1,407	0.39
4,092	68.2	2.84	0	5.9	71.2	0	0	0	1,478	0.41
4,104	68.4	2.85	0	5.9	71.2	0	0	0	1,549	0.43
4,116	68.6	2.86	0	5.9	71.2	0	0	0	1,621	0.45
4,128	68.8	2.87	0	5.9	71.2	0	0	0	1,692	0.47
4,140	69.0	2.88	0	5.9	71.2	0	0	0	1,763	0.49
4,152	69.2	2.88	0	5.9	71.2	0	0	0	1,834	0.51
4,164	69.4	2.89	0	5.9	71.2	0	0	0	1,905	0.53
4,176	69.6	2.90	0	5.9	71.2	0	0	0	1,977	0.55
4,188	69.8	2.91	0	5.9	71.2	0	0	0	2,048	0.57
4,200	70.0	2.92	0	5.9	71.2	0	0	0	2,119	0.59
4,212	70.2	2.93	0	5.9	71.2	0	0	0	2,190	0.61
4,224	70.4	2.93	0	5.9	71.2	0	0	0	2,262	0.63
4,236	70.6	2.94	0	5.9	71.2	0	0	0	2,333	0.65
4,248	70.8	2.95	0	5.9	71.2	0	0	0	2,404	0.67
4,260	71.0	2.96	0	5.9	71.2	0	0	0	2,475	0.69
4,272	71.2	2.97	0	5.9	71.2	0	0	0	2,546	0.71
4,284	71.4	2.98	0	5.9	71.2	0	0	0	2,618	0.73
4,296	71.6	2.98	0	5.9	71.2	0	0	0	2,689	0.75
4,308	71.8	2.99	0	5.9	71.2	0	0	0	2,760	0.77
4,320	72.0	3.00	0	5.9	71.2	0	0	0	2,831	0.79
4,332	72.2	3.01	0	5.9	71.2	0	0	0	2,903	0.81
4,344	72.4	3.02	0	5.9	71.2	0	0	0	2,974	0.83
4,356	72.6	3.03	0	5.9	71.2	0	0	0	3,045	0.85
4,368	72.8	3.03	0	5.9	71.2	0	0	0	3,116	0.87
4,380	73.0	3.04	0	5.9	71.2	0	0	0	3,188	0.89
4,392	73.2	3.05	0	5.9	71.2	0	0	0	3,259	0.91
4,404	73.4	3.06	0	5.9	71.2	0	0	0	3,330	0.93
4,416	73.6	3.07	0	5.9	71.2	0	0	0	3,401	0.95
4,428	73.8	3.08	0	5.9	71.2	0	0	0	3,472	0.97
4,440	74.0	3.08	0	5.9	71.2	0	0	0	3,544	0.99
4,452	74.2	3.09	0	5.9	71.2	0	0	0	3,615	1.01
4,464	74.4	3.10	0	5.9	71.2	100	0	1,200	2,486	0.69
4,476	74.6	3.11	0	5.9	71.2	100	0	1,200	1,357	0.38
4,488	74.8	3.12	0	5.9	71.2	0	0	0	1,429	0.40
4,500	75.0	3.13	0	5.9	71.2	0	0	0	1,500	0.42
4,512	75.2	3.13	0	5.9	71.2	0	0	0	1,571	0.44
4,524	75.4	3.14	0	5.9	71.2	0	0	0	1,642	0.46
4,536	75.6	3.15	0	5.9	71.2	0	0	0	1,713	0.48
4,548	75.8	3.16	0	5.9	71.2	0	0	0	1,785	0.50

Attachment 8 - Cell 2 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,560	76.0	3.17	0	5.9	71.2	0	0	0	1,856	0.52
4,572	76.2	3.18	0	5.9	71.2	0	0	0	1,927	0.54
4,584	76.4	3.18	0	5.9	71.2	0	0	0	1,998	0.56
4,596	76.6	3.19	0	5.9	71.2	0	0	0	2,070	0.58
4,608	76.8	3.20	0	5.9	71.2	0	0	0	2,141	0.60
4,620	77.0	3.21	0	5.9	71.2	0	0	0	2,212	0.62
4,632	77.2	3.22	0	5.9	71.2	0	0	0	2,283	0.64
4,644	77.4	3.23	0	5.9	71.2	0	0	0	2,354	0.66
4,656	77.6	3.23	0	5.9	71.2	0	0	0	2,426	0.68
4,668	77.8	3.24	0	5.9	71.2	0	0	0	2,497	0.70
4,680	78.0	3.25	0	5.9	71.2	0	0	0	2,568	0.72
4,692	78.2	3.26	0	5.9	71.2	0	0	0	2,639	0.74
4,704	78.4	3.27	0	5.9	71.2	0	0	0	2,711	0.75
4,716	78.6	3.28	0	5.9	71.2	0	0	0	2,782	0.77
4,728	78.8	3.28	0	5.9	71.2	0	0	0	2,853	0.79
4,740	79.0	3.29	0	5.9	71.2	0	0	0	2,924	0.81
4,752	79.2	3.30	0	5.9	71.2	0	0	0	2,995	0.83
4,764	79.4	3.31	0	5.9	71.2	0	0	0	3,067	0.85
4,776	79.6	3.32	0	5.9	71.2	0	0	0	3,138	0.87
4,788	79.8	3.33	0	5.9	71.2	0	0	0	3,209	0.89
4,800	80.0	3.33	0	5.9	71.2	0	0	0	3,280	0.91
4,812	80.2	3.34	0	5.9	71.2	0	0	0	3,352	0.93
4,824	80.4	3.35	0	5.9	71.2	0	0	0	3,423	0.95
4,836	80.6	3.36	0	5.9	71.2	0	0	0	3,494	0.97
4,848	80.8	3.37	0	5.9	71.2	0	0	0	3,565	0.99
4,860	81.0	3.38	0	5.9	71.2	0	0	0	3,637	1.01
4,872	81.2	3.38	0	5.9	71.2	100	0	1,200	2,508	0.70
4,884	81.4	3.39	0	5.9	71.2	100	0	1,200	1,379	0.38
4,896	81.6	3.40	0	5.9	71.2	0	0	0	1,450	0.40
4,908	81.8	3.41	0	5.9	71.2	0	0	0	1,521	0.42
4,920	82.0	3.42	0	5.9	71.2	0	0	0	1,593	0.44
4,932	82.2	3.43	0	5.9	71.2	0	0	0	1,664	0.46
4,944	82.4	3.43	0	5.9	71.2	0	0	0	1,735	0.48
4,956	82.6	3.44	0	5.9	71.2	0	0	0	1,806	0.50
4,968	82.8	3.45	0	5.9	71.2	0	0	0	1,878	0.52
4,980	83.0	3.46	0	5.9	71.2	0	0	0	1,949	0.54
4,992	83.2	3.47	0	5.9	71.2	0	0	0	2,020	0.56
5,004	83.4	3.48	0	5.9	71.2	0	0	0	2,091	0.58
5,016	83.6	3.48	0	5.9	71.2	0	0	0	2,162	0.60
5,028	83.8	3.49	0	5.9	71.2	0	0	0	2,234	0.62
5,040	84.0	3.50	0	5.9	71.2	0	0	0	2,305	0.64
5,052	84.2	3.51	0	5.9	71.2	0	0	0	2,376	0.66
5,064	84.4	3.52	0	5.9	71.2	0	0	0	2,447	0.68
5,076	84.6	3.53	0	5.9	71.2	0	0	0	2,519	0.70
5,088	84.8	3.53	0	5.9	71.2	0	0	0	2,590	0.72
5,100	85.0	3.54	0	5.9	71.2	0	0	0	2,661	0.74
5,112	85.2	3.55	0	5.9	71.2	0	0	0	2,732	0.76
5,124	85.4	3.56	0	5.9	71.2	0	0	0	2,803	0.78
5,136	85.6	3.57	0	5.9	71.2	0	0	0	2,875	0.80
5,148	85.8	3.58	0	5.9	71.2	0	0	0	2,946	0.82
5,160	86.0	3.58	0	5.9	71.2	0	0	0	3,017	0.84
5,172	86.2	3.59	0	5.9	71.2	0	0	0	3,088	0.86
5,184	86.4	3.60	0	5.9	71.2	0	0	0	3,160	0.88
5,196	86.6	3.61	0	5.9	71.2	0	0	0	3,231	0.90
5,208	86.8	3.62	0	5.9	71.2	0	0	0	3,302	0.92
5,220	87.0	3.63	0	5.9	71.2	0	0	0	3,373	0.94
5,232	87.2	3.63	0	5.9	71.2	0	0	0	3,444	0.96
5,244	87.4	3.64	0	5.9	71.2	0	0	0	3,516	0.98
5,256	87.6	3.65	0	5.9	71.2	0	0	0	3,587	1.00
5,268	87.8	3.66	0	5.9	71.2	0	0	0	3,658	1.02
5,280	88.0	3.67	0	5.9	71.2	100	0	1,200	2,529	0.70
5,292	88.2	3.68	0	5.9	71.2	100	0	1,200	1,401	0.39
5,304	88.4	3.68	0	5.9	71.2	0	0	0	1,472	0.41
5,316	88.6	3.69	0	5.9	71.2	0	0	0	1,543	0.43
5,328	88.8	3.70	0	5.9	71.2	0	0	0	1,614	0.45
5,340	89.0	3.71	0	5.9	71.2	0	0	0	1,686	0.47
5,352	89.2	3.72	0	5.9	71.2	0	0	0	1,757	0.49
5,364	89.4	3.73	0	5.9	71.2	0	0	0	1,828	0.51
5,376	89.6	3.73	0	5.9	71.2	0	0	0	1,899	0.53
5,388	89.8	3.74	0	5.9	71.2	0	0	0	1,970	0.55
5,400	90.0	3.75	0	5.9	71.2	0	0	0	2,042	0.57
5,412	90.2	3.76	0	5.9	71.2	0	0	0	2,113	0.59
5,424	90.4	3.77	0	5.9	71.2	0	0	0	2,184	0.61
5,436	90.6	3.78	0	5.9	71.2	0	0	0	2,255	0.63
5,448	90.8	3.78	0	5.9	71.2	0	0	0	2,327	0.65
5,460	91.0	3.79	0	5.9	71.2	0	0	0	2,398	0.67

Attachment 8 - Cell 2 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,472	91.2	3.80	0	5.9	71.2	0	0	0	2,469	0.69
5,484	91.4	3.81	0	5.9	71.2	0	0	0	2,540	0.71
5,496	91.6	3.82	0	5.9	71.2	0	0	0	2,611	0.73
5,508	91.8	3.83	0	5.9	71.2	0	0	0	2,683	0.75
5,520	92.0	3.83	0	5.9	71.2	0	0	0	2,754	0.77
5,532	92.2	3.84	0	5.9	71.2	0	0	0	2,825	0.79
5,544	92.4	3.85	0	5.9	71.2	0	0	0	2,896	0.81
5,556	92.6	3.86	0	5.9	71.2	0	0	0	2,968	0.83
5,568	92.8	3.87	0	5.9	71.2	0	0	0	3,039	0.85
5,580	93.0	3.88	0	5.9	71.2	0	0	0	3,110	0.87
5,592	93.2	3.88	0	5.9	71.2	0	0	0	3,181	0.89
5,604	93.4	3.89	0	5.9	71.2	0	0	0	3,252	0.91
5,616	93.6	3.90	0	5.9	71.2	0	0	0	3,324	0.93
5,628	93.8	3.91	0	5.9	71.2	0	0	0	3,395	0.95
5,640	94.0	3.92	0	5.9	71.2	0	0	0	3,466	0.97
5,652	94.2	3.93	0	5.9	71.2	0	0	0	3,537	0.99
5,664	94.4	3.93	0	5.9	71.2	0	0	0	3,609	1.01
5,676	94.6	3.94	0	5.9	71.2	100	0	1,200	2,480	0.69
5,688	94.8	3.95	0	5.9	71.2	100	0	1,200	1,351	0.38
5,700	95.0	3.96	0	5.9	71.2	0	0	0	1,422	0.40
5,712	95.2	3.97	0	5.9	71.2	0	0	0	1,493	0.42
5,724	95.4	3.98	0	5.9	71.2	0	0	0	1,565	0.44
5,736	95.6	3.98	0	5.9	71.2	0	0	0	1,636	0.46
5,748	95.8	3.99	0	5.9	71.2	0	0	0	1,707	0.48
5,760	96.0	4.00	0	5.9	71.2	0	0	0	1,778	0.50
5,772	96.2	4.01	0	5.9	71.2	0	0	0	1,850	0.52
5,784	96.4	4.02	0	5.9	71.2	0	0	0	1,921	0.53
5,796	96.6	4.03	0	5.9	71.2	0	0	0	1,992	0.55
5,808	96.8	4.03	0	5.9	71.2	0	0	0	2,063	0.57
5,820	97.0	4.04	0	5.9	71.2	0	0	0	2,135	0.59
5,832	97.2	4.05	0	5.9	71.2	0	0	0	2,206	0.61
5,844	97.4	4.06	0	5.9	71.2	0	0	0	2,277	0.63
5,856	97.6	4.07	0	5.9	71.2	0	0	0	2,348	0.65
5,868	97.8	4.08	0	5.9	71.2	0	0	0	2,419	0.67
5,880	98.0	4.08	0	5.9	71.2	0	0	0	2,491	0.69
5,892	98.2	4.09	0	5.9	71.2	0	0	0	2,562	0.71
5,904	98.4	4.10	0	5.9	71.2	0	0	0	2,633	0.73
5,916	98.6	4.11	0	5.9	71.2	0	0	0	2,704	0.75
5,928	98.8	4.12	0	5.9	71.2	0	0	0	2,776	0.77
5,940	99.0	4.13	0	5.9	71.2	0	0	0	2,847	0.79
5,952	99.2	4.13	0	5.9	71.2	0	0	0	2,918	0.81
5,964	99.4	4.14	0	5.9	71.2	0	0	0	2,989	0.83
5,976	99.6	4.15	0	5.9	71.2	0	0	0	3,060	0.85
5,988	99.8	4.16	0	5.9	71.2	0	0	0	3,132	0.87
6,000	100.0	4.17	0	5.9	71.2	0	0	0	3,203	0.89
6,012	100.2	4.18	0	5.9	71.2	0	0	0	3,274	0.91
6,024	100.4	4.18	0	5.9	71.2	0	0	0	3,345	0.93
6,036	100.6	4.19	0	5.9	71.2	0	0	0	3,417	0.95
6,048	100.8	4.20	0	5.9	71.2	0	0	0	3,488	0.97
6,060	101.0	4.21	0	5.9	71.2	0	0	0	3,559	0.99
6,072	101.2	4.22	0	5.9	71.2	0	0	0	3,630	1.01
6,084	101.4	4.23	0	5.9	71.2	100	0	1,200	2,501	0.70
6,096	101.6	4.23	0	5.9	71.2	100	0	1,200	1,373	0.38
6,108	101.8	4.24	0	5.9	71.2	0	0	0	1,444	0.40
6,120	102.0	4.25	0	5.9	71.2	0	0	0	1,515	0.42
6,132	102.2	4.26	0	5.9	71.2	0	0	0	1,586	0.44
6,144	102.4	4.27	0	5.9	71.2	0	0	0	1,658	0.46
6,156	102.6	4.28	0	5.9	71.2	0	0	0	1,729	0.48
6,168	102.8	4.28	0	5.9	71.2	0	0	0	1,800	0.50
6,180	103.0	4.29	0	5.9	71.2	0	0	0	1,871	0.52
6,192	103.2	4.30	0	5.9	71.2	0	0	0	1,942	0.54
6,204	103.4	4.31	0	5.9	71.2	0	0	0	2,014	0.56
6,216	103.6	4.32	0	5.9	71.2	0	0	0	2,085	0.58
6,228	103.8	4.33	0	5.9	71.2	0	0	0	2,156	0.60
6,240	104.0	4.33	0	5.9	71.2	0	0	0	2,227	0.62
6,252	104.2	4.34	0	5.9	71.2	0	0	0	2,299	0.64
6,264	104.4	4.35	0	5.9	71.2	0	0	0	2,370	0.66
6,276	104.6	4.36	0	5.9	71.2	0	0	0	2,441	0.68
6,288	104.8	4.37	0	5.9	71.2	0	0	0	2,512	0.70
6,300	105.0	4.38	0	5.9	71.2	0	0	0	2,584	0.72
6,312	105.2	4.38	0	5.9	71.2	0	0	0	2,655	0.74
6,324	105.4	4.39	0	5.9	71.2	0	0	0	2,726	0.76
6,336	105.6	4.40	0	5.9	71.2	0	0	0	2,797	0.78
6,348	105.8	4.41	0	5.9	71.2	0	0	0	2,868	0.80
6,360	106.0	4.42	0	5.9	71.2	0	0	0	2,940	0.82
6,372	106.2	4.43	0	5.9	71.2	0	0	0	3,011	0.84

Attachment 8 - Cell 2 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,384	106.4	4.43	0	5.9	71.2	0	0	0	3,082	0.86
6,396	106.6	4.44	0	5.9	71.2	0	0	0	3,153	0.88
6,408	106.8	4.45	0	5.9	71.2	0	0	0	3,225	0.90
6,420	107.0	4.46	0	5.9	71.2	0	0	0	3,296	0.92
6,432	107.2	4.47	0	5.9	71.2	0	0	0	3,367	0.94
6,444	107.4	4.48	0	5.9	71.2	0	0	0	3,438	0.96
6,456	107.6	4.48	0	5.9	71.2	0	0	0	3,509	0.98
6,468	107.8	4.49	0	5.9	71.2	0	0	0	3,581	1.00
6,480	108.0	4.50	0	5.9	71.2	0	0	0	3,652	1.02
6,492	108.2	4.51	0	5.9	71.2	100	0	1,200	2,523	0.70
6,504	108.4	4.52	0	5.9	71.2	100	0	1,200	1,394	0.39
6,516	108.6	4.53	0	5.9	71.2	0	0	0	1,466	0.41
6,528	108.8	4.53	0	5.9	71.2	0	0	0	1,537	0.43
6,540	109.0	4.54	0	5.9	71.2	0	0	0	1,608	0.45
6,552	109.2	4.55	0	5.9	71.2	0	0	0	1,679	0.47
6,564	109.4	4.56	0	5.9	71.2	0	0	0	1,750	0.49
6,576	109.6	4.57	0	5.9	71.2	0	0	0	1,822	0.51
6,588	109.8	4.58	0	5.9	71.2	0	0	0	1,893	0.53
6,600	110.0	4.58	0	5.9	71.2	0	0	0	1,964	0.55
6,612	110.2	4.59	0	5.9	71.2	0	0	0	2,035	0.57
6,624	110.4	4.60	0	5.9	71.2	0	0	0	2,107	0.59
6,636	110.6	4.61	0	5.9	71.2	0	0	0	2,178	0.61
6,648	110.8	4.62	0	5.9	71.2	0	0	0	2,249	0.63
6,660	111.0	4.63	0	5.9	71.2	0	0	0	2,320	0.65
6,672	111.2	4.63	0	5.9	71.2	0	0	0	2,391	0.67
6,684	111.4	4.64	0	5.9	71.2	0	0	0	2,463	0.69
6,696	111.6	4.65	0	5.9	71.2	0	0	0	2,534	0.71
6,708	111.8	4.66	0	5.9	71.2	0	0	0	2,605	0.73
6,720	112.0	4.67	0	5.9	71.2	0	0	0	2,676	0.75
6,732	112.2	4.68	0	5.9	71.2	0	0	0	2,748	0.77
6,744	112.4	4.68	0	5.9	71.2	0	0	0	2,819	0.79
6,756	112.6	4.69	0	5.9	71.2	0	0	0	2,890	0.80
6,768	112.8	4.70	0	5.9	71.2	0	0	0	2,961	0.82
6,780	113.0	4.71	0	5.9	71.2	0	0	0	3,033	0.84
6,792	113.2	4.72	0	5.9	71.2	0	0	0	3,104	0.86
6,804	113.4	4.73	0	5.9	71.2	0	0	0	3,175	0.88
6,816	113.6	4.73	0	5.9	71.2	0	0	0	3,246	0.90
6,828	113.8	4.74	0	5.9	71.2	0	0	0	3,317	0.92
6,840	114.0	4.75	0	5.9	71.2	0	0	0	3,389	0.94
6,852	114.2	4.76	0	5.9	71.2	0	0	0	3,460	0.96
6,864	114.4	4.77	0	5.9	71.2	0	0	0	3,531	0.98
6,876	114.6	4.78	0	5.9	71.2	0	0	0	3,602	1.00
6,888	114.8	4.78	0	5.9	71.2	100	0	1,200	2,474	0.69
6,900	115.0	4.79	0	5.9	71.2	100	0	1,200	1,345	0.37
6,912	115.2	4.80	0	5.9	71.2	0	0	0	1,416	0.39
6,924	115.4	4.81	0	5.9	71.2	0	0	0	1,487	0.41
6,936	115.6	4.82	0	5.9	71.2	0	0	0	1,558	0.43
6,948	115.8	4.83	0	5.9	71.2	0	0	0	1,630	0.45
6,960	116.0	4.83	0	5.9	71.2	0	0	0	1,701	0.47
6,972	116.2	4.84	0	5.9	71.2	0	0	0	1,772	0.49
6,984	116.4	4.85	0	5.9	71.2	0	0	0	1,843	0.51
6,996	116.6	4.86	0	5.9	71.2	0	0	0	1,915	0.53
7,008	116.8	4.87	0	5.9	71.2	0	0	0	1,986	0.55
7,020	117.0	4.88	0	5.9	71.2	0	0	0	2,057	0.57
7,032	117.2	4.88	0	5.9	71.2	0	0	0	2,128	0.59
7,044	117.4	4.89	0	5.9	71.2	0	0	0	2,199	0.61
7,056	117.6	4.90	0	5.9	71.2	0	0	0	2,271	0.63
7,068	117.8	4.91	0	5.9	71.2	0	0	0	2,342	0.65
7,080	118.0	4.92	0	5.9	71.2	0	0	0	2,413	0.67
7,092	118.2	4.93	0	5.9	71.2	0	0	0	2,484	0.69
7,104	118.4	4.93	0	5.9	71.2	0	0	0	2,556	0.71
7,116	118.6	4.94	0	5.9	71.2	0	0	0	2,627	0.73
7,128	118.8	4.95	0	5.9	71.2	0	0	0	2,698	0.75
7,140	119.0	4.96	0	5.9	71.2	0	0	0	2,769	0.77
7,152	119.2	4.97	0	5.9	71.2	0	0	0	2,840	0.79
7,164	119.4	4.98	0	5.9	71.2	0	0	0	2,912	0.81
7,176	119.6	4.98	0	5.9	71.2	0	0	0	2,983	0.83
7,188	119.8	4.99	0	5.9	71.2	0	0	0	3,054	0.85
7,200	120.0	5.00	0	5.9	71.2	0	0	0	3,125	0.87
7,212	120.2	5.01	0	5.9	71.2	0	0	0	3,197	0.89
7,224	120.4	5.02	0	5.9	71.2	0	0	0	3,268	0.91
7,236	120.6	5.03	0	5.9	71.2	0	0	0	3,339	0.93
7,248	120.8	5.03	0	5.9	71.2	0	0	0	3,410	0.95
7,260	121.0	5.04	0	5.9	71.2	0	0	0	3,482	0.97
7,272	121.2	5.05	0	5.9	71.2	0	0	0	3,553	0.99
7,284	121.4	5.06	0	5.9	71.2	0	0	0	3,624	1.01

Attachment 8 - Cell 2 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,296	121.6	5.07	0	5.9	71.2	100	0	1,200	2,495	0.69
7,308	121.8	5.08	0	5.9	71.2	100	0	1,200	1,366	0.38
7,320	122.0	5.08	0	5.9	71.2	0	0	0	1,438	0.40
7,332	122.2	5.09	0	5.9	71.2	0	0	0	1,509	0.42
7,344	122.4	5.10	0	5.9	71.2	0	0	0	1,580	0.44
7,356	122.6	5.11	0	5.9	71.2	0	0	0	1,651	0.46
7,368	122.8	5.12	0	5.9	71.2	0	0	0	1,723	0.48
7,380	123.0	5.13	0	5.9	71.2	0	0	0	1,794	0.50
7,392	123.2	5.13	0	5.9	71.2	0	0	0	1,865	0.52
7,404	123.4	5.14	0	5.9	71.2	0	0	0	1,936	0.54
7,416	123.6	5.15	0	5.9	71.2	0	0	0	2,007	0.56
7,428	123.8	5.16	0	5.9	71.2	0	0	0	2,079	0.58
7,440	124.0	5.17	0	5.9	71.2	0	0	0	2,150	0.60
7,452	124.2	5.18	0	5.9	71.2	0	0	0	2,221	0.62
7,464	124.4	5.18	0	5.9	71.2	0	0	0	2,292	0.64
7,476	124.6	5.19	0	5.9	71.2	0	0	0	2,364	0.66
7,488	124.8	5.20	0	5.9	71.2	0	0	0	2,435	0.68
7,500	125.0	5.21	0	5.9	71.2	0	0	0	2,506	0.70
7,512	125.2	5.22	0	5.9	71.2	0	0	0	2,577	0.72
7,524	125.4	5.23	0	5.9	71.2	0	0	0	2,648	0.74
7,536	125.6	5.23	0	5.9	71.2	0	0	0	2,720	0.76
7,548	125.8	5.24	0	5.9	71.2	0	0	0	2,791	0.78
7,560	126.0	5.25	0	5.9	71.2	0	0	0	2,862	0.80
7,572	126.2	5.26	0	5.9	71.2	0	0	0	2,933	0.82
7,584	126.4	5.27	0	5.9	71.2	0	0	0	3,005	0.84
7,596	126.6	5.28	0	5.9	71.2	0	0	0	3,076	0.86
7,608	126.8	5.28	0	5.9	71.2	0	0	0	3,147	0.88
7,620	127.0	5.29	0	5.9	71.2	0	0	0	3,218	0.90
7,632	127.2	5.30	0	5.9	71.2	0	0	0	3,289	0.92
7,644	127.4	5.31	0	5.9	71.2	0	0	0	3,361	0.94
7,656	127.6	5.32	0	5.9	71.2	0	0	0	3,432	0.96
7,668	127.8	5.33	0	5.9	71.2	0	0	0	3,503	0.98
7,680	128.0	5.33	0	5.9	71.2	0	0	0	3,574	1.00
7,692	128.2	5.34	0	5.9	71.2	0	0	0	3,646	1.02
7,704	128.4	5.35	0	5.9	71.2	100	0	1,200	2,517	0.70
7,716	128.6	5.36	0	5.9	71.2	100	0	1,200	1,388	0.39
7,728	128.8	5.37	0	5.9	71.2	0	0	0	1,459	0.41
7,740	129.0	5.38	0	5.9	71.2	0	0	0	1,531	0.43
7,752	129.2	5.38	0	5.9	71.2	0	0	0	1,602	0.45
7,764	129.4	5.39	0	5.9	71.2	0	0	0	1,673	0.47
7,776	129.6	5.40	0	5.9	71.2	0	0	0	1,744	0.49
7,788	129.8	5.41	0	5.9	71.2	0	0	0	1,815	0.51
7,800	130.0	5.42	0	5.9	71.2	0	0	0	1,887	0.53
7,812	130.2	5.43	0	5.9	71.2	0	0	0	1,958	0.55
7,824	130.4	5.43	0	5.9	71.2	0	0	0	2,029	0.57
7,836	130.6	5.44	0	5.9	71.2	0	0	0	2,100	0.58
7,848	130.8	5.45	0	5.9	71.2	0	0	0	2,172	0.60
7,860	131.0	5.46	0	5.9	71.2	0	0	0	2,243	0.62
7,872	131.2	5.47	0	5.9	71.2	0	0	0	2,314	0.64
7,884	131.4	5.48	0	5.9	71.2	0	0	0	2,385	0.66
7,896	131.6	5.48	0	5.9	71.2	0	0	0	2,456	0.68
7,908	131.8	5.49	0	5.9	71.2	0	0	0	2,528	0.70
7,920	132.0	5.50	0	5.9	71.2	0	0	0	2,599	0.72
7,932	132.2	5.51	0	5.9	71.2	0	0	0	2,670	0.74
7,944	132.4	5.52	0	5.9	71.2	0	0	0	2,741	0.76
7,956	132.6	5.53	0	5.9	71.2	0	0	0	2,813	0.78
7,968	132.8	5.53	0	5.9	71.2	0	0	0	2,884	0.80
7,980	133.0	5.54	0	5.9	71.2	0	0	0	2,955	0.82
7,992	133.2	5.55	0	5.9	71.2	0	0	0	3,026	0.84
8,004	133.4	5.56	0	5.9	71.2	0	0	0	3,097	0.86
8,016	133.6	5.57	0	5.9	71.2	0	0	0	3,169	0.88
8,028	133.8	5.58	0	5.9	71.2	0	0	0	3,240	0.90
8,040	134.0	5.58	0	5.9	71.2	0	0	0	3,311	0.92
8,052	134.2	5.59	0	5.9	71.2	0	0	0	3,382	0.94
8,064	134.4	5.60	0	5.9	71.2	0	0	0	3,454	0.96
8,076	134.6	5.61	0	5.9	71.2	0	0	0	3,525	0.98
8,088	134.8	5.62	0	5.9	71.2	0	0	0	3,596	1.00
8,100	135.0	5.63	0	5.9	71.2	100	0	1,200	2,467	0.69
8,112	135.2	5.63	0	5.9	71.2	100	0	1,200	1,338	0.37
8,124	135.4	5.64	0	5.9	71.2	0	0	0	1,410	0.39
8,136	135.6	5.65	0	5.9	71.2	0	0	0	1,481	0.41
8,148	135.8	5.66	0	5.9	71.2	0	0	0	1,552	0.43
8,160	136.0	5.67	0	5.9	71.2	0	0	0	1,623	0.45
8,172	136.2	5.68	0	5.9	71.2	0	0	0	1,695	0.47
8,184	136.4	5.68	0	5.9	71.2	0	0	0	1,766	0.49
8,196	136.6	5.69	0	5.9	71.2	0	0	0	1,837	0.51

Attachment 8 - Cell 2 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,208	136.8	5.70	0	5.9	71.2	0	0	0	1,908	0.53
8,220	137.0	5.71	0	5.9	71.2	0	0	0	1,980	0.55
8,232	137.2	5.72	0	5.9	71.2	0	0	0	2,051	0.57
8,244	137.4	5.73	0	5.9	71.2	0	0	0	2,122	0.59
8,256	137.6	5.73	0	5.9	71.2	0	0	0	2,193	0.61
8,268	137.8	5.74	0	5.9	71.2	0	0	0	2,264	0.63
8,280	138.0	5.75	0	5.9	71.2	0	0	0	2,336	0.65
8,292	138.2	5.76	0	5.9	71.2	0	0	0	2,407	0.67
8,304	138.4	5.77	0	5.9	71.2	0	0	0	2,478	0.69
8,316	138.6	5.78	0	5.9	71.2	0	0	0	2,549	0.71
8,328	138.8	5.78	0	5.9	71.2	0	0	0	2,621	0.73
8,340	139.0	5.79	0	5.9	71.2	0	0	0	2,692	0.75
8,352	139.2	5.80	0	5.9	71.2	0	0	0	2,763	0.77
8,364	139.4	5.81	0	5.9	71.2	0	0	0	2,834	0.79
8,376	139.6	5.82	0	5.9	71.2	0	0	0	2,905	0.81
8,388	139.8	5.83	0	5.9	71.2	0	0	0	2,977	0.83
8,400	140.0	5.83	0	5.9	71.2	0	0	0	3,048	0.85
8,412	140.2	5.84	0	5.9	71.2	0	0	0	3,119	0.87
8,424	140.4	5.85	0	5.9	71.2	0	0	0	3,190	0.89
8,436	140.6	5.86	0	5.9	71.2	0	0	0	3,262	0.91
8,448	140.8	5.87	0	5.9	71.2	0	0	0	3,333	0.93
8,460	141.0	5.88	0	5.9	71.2	0	0	0	3,404	0.95
8,472	141.2	5.88	0	5.9	71.2	0	0	0	3,475	0.97
8,484	141.4	5.89	0	5.9	71.2	0	0	0	3,546	0.99
8,496	141.6	5.90	0	5.9	71.2	0	0	0	3,618	1.01
8,508	141.8	5.91	0	5.9	71.2	100	0	1,200	2,489	0.69
8,520	142.0	5.92	0	5.9	71.2	100	0	1,200	1,360	0.38
8,532	142.2	5.93	0	5.9	71.2	0	0	0	1,431	0.40
8,544	142.4	5.93	0	5.9	71.2	0	0	0	1,503	0.42
8,556	142.6	5.94	0	5.9	71.2	0	0	0	1,574	0.44
8,568	142.8	5.95	0	5.9	71.2	0	0	0	1,645	0.46
8,580	143.0	5.96	0	5.9	71.2	0	0	0	1,716	0.48
8,592	143.2	5.97	0	5.9	71.2	0	0	0	1,787	0.50
8,604	143.4	5.98	0	5.9	71.2	0	0	0	1,859	0.52
8,616	143.6	5.98	0	5.9	71.2	0	0	0	1,930	0.54
8,628	143.8	5.99	0	5.9	71.2	0	0	0	2,001	0.56
8,640	144.0	6.00	0	5.9	71.2	0	0	0	2,072	0.58
8,652	144.2	6.01	0	5.9	71.2	0	0	0	2,144	0.60
8,664	144.4	6.02	0	5.9	71.2	0	0	0	2,215	0.62
8,676	144.6	6.03	0	5.9	71.2	0	0	0	2,286	0.64
8,688	144.8	6.03	0	5.9	71.2	0	0	0	2,357	0.66
8,700	145.0	6.04	0	5.9	71.2	0	0	0	2,429	0.68
8,712	145.2	6.05	0	5.9	71.2	0	0	0	2,500	0.70
8,724	145.4	6.06	0	5.9	71.2	0	0	0	2,571	0.72
8,736	145.6	6.07	0	5.9	71.2	0	0	0	2,642	0.74
8,748	145.8	6.08	0	5.9	71.2	0	0	0	2,713	0.76
8,760	146.0	6.08	0	5.9	71.2	0	0	0	2,785	0.78
8,772	146.2	6.09	0	5.9	71.2	0	0	0	2,856	0.80
8,784	146.4	6.10	0	5.9	71.2	0	0	0	2,927	0.82
8,796	146.6	6.11	0	5.9	71.2	0	0	0	2,998	0.84
8,808	146.8	6.12	0	5.9	71.2	0	0	0	3,070	0.85
8,820	147.0	6.13	0	5.9	71.2	0	0	0	3,141	0.87
8,832	147.2	6.13	0	5.9	71.2	0	0	0	3,212	0.89
8,844	147.4	6.14	0	5.9	71.2	0	0	0	3,283	0.91
8,856	147.6	6.15	0	5.9	71.2	0	0	0	3,354	0.93
8,868	147.8	6.16	0	5.9	71.2	0	0	0	3,426	0.95
8,880	148.0	6.17	0	5.9	71.2	0	0	0	3,497	0.97
8,892	148.2	6.18	0	5.9	71.2	0	0	0	3,568	0.99
8,904	148.4	6.18	0	5.9	71.2	0	0	0	3,639	1.01
8,916	148.6	6.19	0	5.9	71.2	100	0	1,200	2,511	0.70
8,928	148.8	6.20	0	5.9	71.2	100	0	1,200	1,382	0.38
8,940	149.0	6.21	0	5.9	71.2	0	0	0	1,453	0.40
8,952	149.2	6.22	0	5.9	71.2	0	0	0	1,524	0.42
8,964	149.4	6.23	0	5.9	71.2	0	0	0	1,595	0.44
8,976	149.6	6.23	0	5.9	71.2	0	0	0	1,667	0.46
8,988	149.8	6.24	0	5.9	71.2	0	0	0	1,738	0.48
9,000	150.0	6.25	0	5.9	71.2	0	0	0	1,809	0.50
9,012	150.2	6.26	0	5.9	71.2	0	0	0	1,880	0.52
9,024	150.4	6.27	0	5.9	71.2	0	0	0	1,952	0.54
9,036	150.6	6.28	0	5.9	71.2	0	0	0	2,023	0.56
9,048	150.8	6.28	0	5.9	71.2	0	0	0	2,094	0.58
9,060	151.0	6.29	0	5.9	71.2	0	0	0	2,165	0.60
9,072	151.2	6.30	0	5.9	71.2	0	0	0	2,236	0.62
9,084	151.4	6.31	0	5.9	71.2	0	0	0	2,308	0.64
9,096	151.6	6.32	0	5.9	71.2	0	0	0	2,379	0.66
9,108	151.8	6.33	0	5.9	71.2	0	0	0	2,450	0.68

Attachment 8 - Cell 2 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
9,120	152.0	6.33	0	5.9	71.2	0	0	0	2,521	0.70
9,132	152.2	6.34	0	5.9	71.2	0	0	0	2,593	0.72
9,144	152.4	6.35	0	5.9	71.2	0	0	0	2,664	0.74
9,156	152.6	6.36	0	5.9	71.2	0	0	0	2,735	0.76
9,168	152.8	6.37	0	5.9	71.2	0	0	0	2,806	0.78
9,180	153.0	6.38	0	5.9	71.2	0	0	0	2,878	0.80
9,192	153.2	6.38	0	5.9	71.2	0	0	0	2,949	0.82
9,204	153.4	6.39	0	5.9	71.2	0	0	0	3,020	0.84
9,216	153.6	6.40	0	5.9	71.2	0	0	0	3,091	0.86
9,228	153.8	6.41	0	5.9	71.2	0	0	0	3,162	0.88
9,240	154.0	6.42	0	5.9	71.2	0	0	0	3,234	0.90
9,252	154.2	6.43	0	5.9	71.2	0	0	0	3,305	0.92
9,264	154.4	6.43	0	5.9	71.2	0	0	0	3,376	0.94
9,276	154.6	6.44	0	5.9	71.2	0	0	0	3,447	0.96
9,288	154.8	6.45	0	5.9	71.2	0	0	0	3,519	0.98
9,300	155.0	6.46	0	5.9	71.2	0	0	0	3,590	1.00
9,312	155.2	6.47	0	5.9	71.2	0	0	0	3,661	1.02
9,324	155.4	6.48	0	5.9	71.2	100	0	1,200	2,532	0.71
9,336	155.6	6.48	0	5.9	71.2	100	0	1,200	1,403	0.39
9,348	155.8	6.49	0	5.9	71.2	0	0	0	1,475	0.41
9,360	156.0	6.50	0	5.9	71.2	0	0	0	1,546	0.43
9,372	156.2	6.51	0	5.9	71.2	0	0	0	1,617	0.45
9,384	156.4	6.52	0	5.9	71.2	0	0	0	1,688	0.47
9,396	156.6	6.53	0	5.9	71.2	0	0	0	1,760	0.49
9,408	156.8	6.53	0	5.9	71.2	0	0	0	1,831	0.51
9,420	157.0	6.54	0	5.9	71.2	0	0	0	1,902	0.53
9,432	157.2	6.55	0	5.9	71.2	0	0	0	1,973	0.55
9,444	157.4	6.56	0	5.9	71.2	0	0	0	2,044	0.57
9,456	157.6	6.57	0	5.9	71.2	0	0	0	2,116	0.59
9,468	157.8	6.58	0	5.9	71.2	0	0	0	2,187	0.61
9,480	158.0	6.58	0	5.9	71.2	0	0	0	2,258	0.63
9,492	158.2	6.59	0	5.9	71.2	0	0	0	2,329	0.65
9,504	158.4	6.60	0	5.9	71.2	0	0	0	2,401	0.67
9,516	158.6	6.61	0	5.9	71.2	0	0	0	2,472	0.69
9,528	158.8	6.62	0	5.9	71.2	0	0	0	2,543	0.71
9,540	159.0	6.63	0	5.9	71.2	0	0	0	2,614	0.73
9,552	159.2	6.63	0	5.9	71.2	0	0	0	2,685	0.75
9,564	159.4	6.64	0	5.9	71.2	0	0	0	2,757	0.77
9,576	159.6	6.65	0	5.9	71.2	0	0	0	2,828	0.79
9,588	159.8	6.66	0	5.9	71.2	0	0	0	2,899	0.81
9,600	160.0	6.67	0	5.9	71.2	0	0	0	2,970	0.83
9,612	160.2	6.68	0	5.9	71.2	0	0	0	3,042	0.85
9,624	160.4	6.68	0	5.9	71.2	0	0	0	3,113	0.87
9,636	160.6	6.69	0	5.9	71.2	0	0	0	3,184	0.89
9,648	160.8	6.70	0	5.9	71.2	0	0	0	3,255	0.91
9,660	161.0	6.71	0	5.9	71.2	0	0	0	3,327	0.93
9,672	161.2	6.72	0	5.9	71.2	0	0	0	3,398	0.95
9,684	161.4	6.73	0	5.9	71.2	0	0	0	3,469	0.97
9,696	161.6	6.73	0	5.9	71.2	0	0	0	3,540	0.99
9,708	161.8	6.74	0	5.9	71.2	0	0	0	3,611	1.01
9,720	162.0	6.75	0	5.9	71.2	100	0	1,200	2,483	0.69
9,732	162.2	6.76	0	5.9	71.2	100	0	1,200	1,354	0.38
9,744	162.4	6.77	0	5.9	71.2	0	0	0	1,425	0.40
9,756	162.6	6.78	0	5.9	71.2	0	0	0	1,496	0.42
9,768	162.8	6.78	0	5.9	71.2	0	0	0	1,568	0.44
9,780	163.0	6.79	0	5.9	71.2	0	0	0	1,639	0.46
9,792	163.2	6.80	0	5.9	71.2	0	0	0	1,710	0.48
9,804	163.4	6.81	0	5.9	71.2	0	0	0	1,781	0.50
9,816	163.6	6.82	0	5.9	71.2	0	0	0	1,852	0.52
9,828	163.8	6.83	0	5.9	71.2	0	0	0	1,924	0.54
9,840	164.0	6.83	0	5.9	71.2	0	0	0	1,995	0.56
9,852	164.2	6.84	0	5.9	71.2	0	0	0	2,066	0.58
9,864	164.4	6.85	0	5.9	71.2	0	0	0	2,137	0.60
9,876	164.6	6.86	0	5.9	71.2	0	0	0	2,209	0.62
9,888	164.8	6.87	0	5.9	71.2	0	0	0	2,280	0.63
9,900	165.0	6.88	0	5.9	71.2	0	0	0	2,351	0.65
9,912	165.2	6.88	0	5.9	71.2	0	0	0	2,422	0.67
9,924	165.4	6.89	0	5.9	71.2	0	0	0	2,493	0.69
9,936	165.6	6.90	0	5.9	71.2	0	0	0	2,565	0.71
9,948	165.8	6.91	0	5.9	71.2	0	0	0	2,636	0.73
9,960	166.0	6.92	0	5.9	71.2	0	0	0	2,707	0.75
9,972	166.2	6.93	0	5.9	71.2	0	0	0	2,778	0.77
9,984	166.4	6.93	0	5.9	71.2	0	0	0	2,850	0.79
9,996	166.6	6.94	0	5.9	71.2	0	0	0	2,921	0.81
10,008	166.8	6.95	0	5.9	71.2	0	0	0	2,992	0.83
10,020	167.0	6.96	0	5.9	71.2	0	0	0	3,063	0.85

Attachment 8 - Cell 2 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
10,032	167.2	6.97	0	5.9	71.2	0	0	0	3,134	0.87
10,044	167.4	6.98	0	5.9	71.2	0	0	0	3,206	0.89
10,056	167.6	6.98	0	5.9	71.2	0	0	0	3,277	0.91
10,068	167.8	6.99	0	5.9	71.2	0	0	0	3,348	0.93
10,080	168.0	7.00	0	5.9	71.2	0	0	0	3,419	0.95

ATTACHMENT 9

Cell 2 Leachate Collection Sump – Peak Conditions

Attachment 9 - Cell 2 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
0	0.0	0.00	0	62.1	0	0	0	0	3,590	1.00
12	0.2	0.01	0	62.1	745	0	0	0	4,335	1.21
24	0.4	0.02	0	62.1	745	100	0	1,200	3,880	1.08
36	0.6	0.03	0	62.1	745	100	0	1,200	3,425	0.95
48	0.8	0.03	0	62.1	745	100	0	1,200	2,970	0.83
60	1.0	0.04	0	62.1	745	100	0	1,200	2,515	0.70
72	1.2	0.05	0	62.1	745	100	0	1,200	2,060	0.57
84	1.4	0.06	0	62.1	745	100	0	1,200	1,605	0.45
96	1.6	0.07	0	62.1	745	0	0	0	2,350	0.65
108	1.8	0.08	0	62.1	745	0	0	0	3,095	0.86
120	2.0	0.08	0	62.1	745	0	0	0	3,840	1.07
132	2.2	0.09	0	62.1	745	100	0	1,200	3,385	0.94
144	2.4	0.10	0	62.1	745	100	0	1,200	2,930	0.82
156	2.6	0.11	0	62.1	745	100	0	1,200	2,475	0.69
168	2.8	0.12	0	62.1	745	100	0	1,200	2,020	0.56
180	3.0	0.13	0	62.1	745	100	0	1,200	1,565	0.44
192	3.2	0.13	0	62.1	745	0	0	0	2,310	0.64
204	3.4	0.14	0	62.1	745	0	0	0	3,055	0.85
216	3.6	0.15	0	62.1	745	0	0	0	3,800	1.06
228	3.8	0.16	0	62.1	745	100	0	1,200	3,345	0.93
240	4.0	0.17	0	62.1	745	100	0	1,200	2,890	0.81
252	4.2	0.18	0	62.1	745	100	0	1,200	2,435	0.68
264	4.4	0.18	0	62.1	745	100	0	1,200	1,980	0.55
276	4.6	0.19	0	62.1	745	100	0	1,200	1,525	0.42
288	4.8	0.20	0	62.1	745	0	0	0	2,270	0.63
300	5.0	0.21	7	62.1	825	0	0	0	3,095	0.86
312	5.2	0.22	7	62.1	825	0	0	0	3,920	1.09
324	5.4	0.23	7	62.1	825	100	0	1,200	3,544	0.99
336	5.6	0.23	7	62.1	825	100	0	1,200	3,169	0.88
348	5.8	0.24	7	62.1	825	100	0	1,200	2,794	0.78
360	6.0	0.25	7	62.1	825	100	0	1,200	2,418	0.67
372	6.2	0.26	13	62.1	904	100	0	1,200	2,123	0.59
384	6.4	0.27	13	62.1	904	100	0	1,200	1,827	0.51
396	6.6	0.28	13	62.1	904	100	0	1,200	1,532	0.43
408	6.8	0.28	20	62.1	984	0	0	0	2,516	0.70
420	7.0	0.29	20	62.1	984	0	0	0	3,500	0.97
432	7.2	0.30	20	62.1	984	0	0	0	4,484	1.25
444	7.4	0.31	27	62.1	1,064	100	0	1,200	4,348	1.21
456	7.6	0.32	27	62.1	1,064	100	0	1,200	4,212	1.17
468	7.8	0.33	27	62.1	1,064	100	0	1,200	4,076	1.14
480	8.0	0.33	33	62.1	1,144	100	0	1,200	4,019	1.12
492	8.2	0.34	33	62.1	1,144	100	0	1,200	3,963	1.10
504	8.4	0.35	33	62.1	1,144	100	0	1,200	3,906	1.09
516	8.6	0.36	40	62.1	1,223	100	0	1,200	3,929	1.09
528	8.8	0.37	40	62.1	1,223	100	0	1,200	3,953	1.10
540	9.0	0.38	46	62.1	1,303	100	0	1,200	4,056	1.13
552	9.2	0.38	46	62.1	1,303	100	0	1,200	4,158	1.16
564	9.4	0.39	53	62.1	1,383	100	0	1,200	4,341	1.21
576	9.6	0.40	53	62.1	1,383	100	0	1,200	4,524	1.26
588	9.8	0.41	60	62.1	1,462	100	0	1,200	4,786	1.33
600	10.0	0.42	60	62.1	1,462	100	0	1,200	5,048	1.41
612	10.2	0.43	66	62.1	1,542	100	0	1,200	5,391	1.50
624	10.4	0.43	66	62.1	1,542	100	0	1,200	5,733	1.60
636	10.6	0.44	73	62.1	1,622	100	0	1,200	6,154	1.71
648	10.8	0.45	80	62.1	1,701	100	0	1,200	6,656	1.85
660	11.0	0.46	86	62.1	1,781	100	0	1,200	7,237	2.11
672	11.2	0.47	93	62.1	1,861	100	0	1,200	7,898	2.17
684	11.4	0.48	100	62.1	1,941	100	0	1,200	8,639	2.23
696	11.6	0.48	106	62.1	2,020	100	0	1,200	9,459	2.30
708	11.8	0.49	139	62.1	2,419	100	0	1,200	10,678	2.39
720	12.0	0.50	206	62.1	3,216	100	0	1,200	12,694	2.52
732	12.2	0.51	239	62.1	3,614	100	0	1,200	15,108	2.66
744	12.4	0.52	325	62.1	4,651	100	0	1,200	18,559	2.84
756	12.6	0.53	485	62.1	6,564	100	0	1,200	23,922	3.08
768	12.8	0.53	611	62.1	8,078	100	0	1,200	30,800	3.34
780	13.0	0.54	711	62.1	9,274	100	0	1,200	38,874	3.59
792	13.2	0.55	777	62.1	10,071	100	0	1,200	47,745	3.83
804	13.4	0.56	824	62.1	10,629	100	0	1,200	57,173	4.06
816	13.6	0.57	857	62.1	11,027	100	550	7,800	60,400	4.13
828	13.8	0.58	870	62.1	11,187	100	550	7,800	63,787	4.20
840	14.0	0.58	877	62.1	11,266	100	550	7,800	67,253	4.27
852	14.2	0.59	877	62.1	11,266	100	550	7,800	70,720	4.34
864	14.4	0.60	870	62.1	11,187	100	550	7,800	74,106	4.40
876	14.6	0.61	857	62.1	11,027	100	550	7,800	77,333	4.46
888	14.8	0.62	844	62.1	10,868	100	550	7,800	80,401	4.52
900	15.0	0.63	830	62.1	10,708	100	550	7,800	83,310	4.57

Attachment 9 - Cell 2 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
912	15.2	0.63	817	62.1	10,549	100	550	7,800	86,059	4.62
924	15.4	0.64	797	62.1	10,310	100	550	7,800	88,568	4.66
936	15.6	0.65	784	62.1	10,150	100	550	7,800	90,919	4.70
948	15.8	0.66	764	62.1	9,911	100	550	7,800	93,030	4.73
960	16.0	0.67	744	62.1	9,672	100	550	7,800	94,902	4.76
972	16.2	0.68	724	62.1	9,433	100	550	7,800	96,535	4.79
984	16.4	0.68	704	62.1	9,194	100	550	7,800	97,929	4.81
996	16.6	0.69	684	62.1	8,955	100	550	7,800	99,084	4.83
1,008	16.8	0.70	664	62.1	8,716	100	550	7,800	100,000	4.84
1,020	17.0	0.71	644	62.1	8,477	100	550	7,800	100,676	4.85
1,032	17.2	0.72	631	62.1	8,317	100	550	7,800	101,193	4.86
1,044	17.4	0.73	611	62.1	8,078	100	550	7,800	101,471	4.86
1,056	17.6	0.73	598	62.1	7,919	100	550	7,800	101,590	4.86
1,068	17.8	0.74	578	62.1	7,679	100	550	7,800	101,469	4.86
1,080	18.0	0.75	565	62.1	7,520	100	550	7,800	101,190	4.86
1,092	18.2	0.76	551	62.1	7,361	100	550	7,800	100,750	4.85
1,104	18.4	0.77	538	62.1	7,201	100	550	7,800	100,151	4.84
1,116	18.6	0.78	525	62.1	7,042	100	550	7,800	99,393	4.83
1,128	18.8	0.78	511	62.1	6,882	100	550	7,800	98,476	4.82
1,140	19.0	0.79	498	62.1	6,723	100	550	7,800	97,399	4.80
1,152	19.2	0.80	485	62.1	6,564	100	550	7,800	96,162	4.78
1,164	19.4	0.81	478	62.1	6,484	100	550	7,800	94,846	4.76
1,176	19.6	0.82	465	62.1	6,324	100	550	7,800	93,371	4.74
1,188	19.8	0.83	452	62.1	6,165	100	550	7,800	91,736	4.71
1,200	20.0	0.83	445	62.1	6,085	100	550	7,800	90,021	4.68
1,212	20.2	0.84	432	62.1	5,926	100	550	7,800	88,147	4.65
1,224	20.4	0.85	425	62.1	5,846	100	550	7,800	86,193	4.62
1,236	20.6	0.86	412	62.1	5,687	100	550	7,800	84,080	4.58
1,248	20.8	0.87	405	62.1	5,607	100	550	7,800	81,887	4.54
1,260	21.0	0.88	399	62.1	5,527	100	550	7,800	79,615	4.50
1,272	21.2	0.88	385	62.1	5,368	100	550	7,800	77,183	4.46
1,284	21.4	0.89	379	62.1	5,288	100	550	7,800	74,671	4.41
1,296	21.6	0.90	372	62.1	5,209	100	550	7,800	72,080	4.36
1,308	21.8	0.91	365	62.1	5,129	100	550	7,800	69,408	4.31
1,320	22.0	0.92	359	62.1	5,049	100	550	7,800	66,658	4.26
1,332	22.2	0.93	352	62.1	4,969	100	550	7,800	63,827	4.20
1,344	22.4	0.93	345	62.1	4,890	100	550	7,800	60,917	4.14
1,356	22.6	0.94	339	62.1	4,810	100	550	7,800	57,927	4.07
1,368	22.8	0.95	339	62.1	4,810	100	550	7,800	54,937	4.01
1,380	23.0	0.96	332	62.1	4,730	100	550	7,800	51,867	3.93
1,392	23.2	0.97	325	62.1	4,651	100	550	7,800	48,718	3.86
1,404	23.4	0.98	319	62.1	4,571	100	550	7,800	45,489	3.77
1,416	23.6	0.98	319	62.1	4,571	100	550	7,800	42,260	3.69
1,428	23.8	0.99	312	62.1	4,491	100	550	7,800	38,951	3.59
1,440	24.0	1.00	306	62.1	4,412	100	550	7,800	35,562	3.49
1,452	24.2	1.01	292	62.1	4,252	100	550	7,800	32,015	3.38
1,464	24.4	1.02	279	62.1	4,093	100	550	7,800	28,307	3.25
1,476	24.6	1.03	272	62.1	4,013	100	550	7,800	24,520	3.10
1,488	24.8	1.03	259	62.1	3,854	100	550	7,800	20,574	2.94
1,500	25.0	1.04	246	62.1	3,694	100	550	7,800	16,468	2.74
1,512	25.2	1.05	239	62.1	3,614	100	550	7,800	12,282	2.49
1,524	25.4	1.06	239	62.1	3,614	100	550	7,800	8,097	2.19
1,536	25.6	1.07	239	62.1	3,614	100	550	7,800	3,911	1.09
1,548	25.8	1.08	239	62.1	3,614	100	0	1,200	6,326	1.76
1,560	26.0	1.08	239	62.1	3,614	100	0	1,200	8,740	2.24
1,572	26.2	1.09	239	62.1	3,614	100	0	1,200	11,155	2.42
1,584	26.4	1.10	239	62.1	3,614	100	0	1,200	13,569	2.57
1,596	26.6	1.11	232	62.1	3,535	100	0	1,200	15,904	2.71
1,608	26.8	1.12	232	62.1	3,535	100	0	1,200	18,238	2.83
1,620	27.0	1.13	232	62.1	3,535	100	0	1,200	20,573	2.94
1,632	27.2	1.13	232	62.1	3,535	100	0	1,200	22,908	3.04
1,644	27.4	1.14	232	62.1	3,535	100	0	1,200	25,243	3.13
1,656	27.6	1.15	232	62.1	3,535	100	0	1,200	27,577	3.22
1,668	27.8	1.16	232	62.1	3,535	100	0	1,200	29,912	3.31
1,680	28.0	1.17	232	62.1	3,535	100	0	1,200	32,247	3.38
1,692	28.2	1.18	232	62.1	3,535	100	0	1,200	34,582	3.46
1,704	28.4	1.18	232	62.1	3,535	100	0	1,200	36,916	3.53
1,716	28.6	1.19	232	62.1	3,535	100	0	1,200	39,251	3.60
1,728	28.8	1.20	232	62.1	3,535	100	0	1,200	41,586	3.67
1,740	29.0	1.21	232	62.1	3,535	100	0	1,200	43,921	3.73
1,752	29.2	1.22	226	62.1	3,455	100	0	1,200	46,176	3.79
1,764	29.4	1.23	226	62.1	3,455	100	0	1,200	48,431	3.85
1,776	29.6	1.23	226	62.1	3,455	100	0	1,200	50,686	3.90
1,788	29.8	1.24	226	62.1	3,455	100	0	1,200	52,941	3.96
1,800	30.0	1.25	226	62.1	3,455	100	0	1,200	55,196	4.01
1,812	30.2	1.26	226	62.1	3,455	100	550	7,800	50,851	3.91

Attachment 9 - Cell 2 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,824	30.4	1.27	226	62.1	3,455	100	550	7,800	46,506	3.80
1,836	30.6	1.28	226	62.1	3,455	100	550	7,800	42,161	3.68
1,848	30.8	1.28	226	62.1	3,455	100	550	7,800	37,816	3.56
1,860	31.0	1.29	226	62.1	3,455	100	550	7,800	33,471	3.42
1,872	31.2	1.30	226	62.1	3,455	100	550	7,800	29,126	3.28
1,884	31.4	1.31	219	62.1	3,375	100	550	7,800	24,701	3.11
1,896	31.6	1.32	219	62.1	3,375	100	550	7,800	20,277	2.92
1,908	31.8	1.33	219	62.1	3,375	100	550	7,800	15,852	2.70
1,920	32.0	1.33	219	62.1	3,375	100	550	7,800	11,427	2.44
1,932	32.2	1.34	219	62.1	3,375	100	550	7,800	7,002	1.95
1,944	32.4	1.35	219	62.1	3,375	100	0	1,200	9,178	2.28
1,956	32.6	1.36	219	62.1	3,375	100	0	1,200	11,353	2.43
1,968	32.8	1.37	219	62.1	3,375	100	0	1,200	13,528	2.57
1,980	33.0	1.38	219	62.1	3,375	100	0	1,200	15,704	2.70
1,992	33.2	1.38	219	62.1	3,375	100	0	1,200	17,879	2.81
2,004	33.4	1.39	219	62.1	3,375	100	0	1,200	20,054	2.91
2,016	33.6	1.40	219	62.1	3,375	100	0	1,200	22,230	3.01
2,028	33.8	1.41	213	62.1	3,296	100	0	1,200	24,325	3.10
2,040	34.0	1.42	213	62.1	3,296	100	0	1,200	26,421	3.18
2,052	34.2	1.43	213	62.1	3,296	100	0	1,200	28,517	3.26
2,064	34.4	1.43	213	62.1	3,296	100	0	1,200	30,612	3.33
2,076	34.6	1.44	213	62.1	3,296	100	0	1,200	32,708	3.40
2,088	34.8	1.45	213	62.1	3,296	100	0	1,200	34,803	3.47
2,100	35.0	1.46	213	62.1	3,296	100	0	1,200	36,899	3.53
2,112	35.2	1.47	213	62.1	3,296	100	0	1,200	38,995	3.59
2,124	35.4	1.48	213	62.1	3,296	100	0	1,200	41,090	3.65
2,136	35.6	1.48	213	62.1	3,296	100	0	1,200	43,186	3.71
2,148	35.8	1.49	213	62.1	3,296	100	0	1,200	45,282	3.77
2,160	36.0	1.50	213	62.1	3,296	100	0	1,200	47,377	3.82
2,172	36.2	1.51	213	62.1	3,296	100	0	1,200	49,473	3.87
2,184	36.4	1.52	206	62.1	3,216	100	0	1,200	51,489	3.92
2,196	36.6	1.53	206	62.1	3,216	100	0	1,200	53,505	3.97
2,208	36.8	1.53	206	62.1	3,216	100	0	1,200	55,520	4.02
2,220	37.0	1.54	206	62.1	3,216	100	550	7,800	50,936	3.91
2,232	37.2	1.55	206	62.1	3,216	100	550	7,800	46,352	3.80
2,244	37.4	1.56	206	62.1	3,216	100	550	7,800	41,768	3.67
2,256	37.6	1.57	206	62.1	3,216	100	550	7,800	37,184	3.54
2,268	37.8	1.58	206	62.1	3,216	100	550	7,800	32,600	3.40
2,280	38.0	1.58	206	62.1	3,216	100	550	7,800	28,016	3.24
2,292	38.2	1.59	206	62.1	3,216	100	550	7,800	23,432	3.06
2,304	38.4	1.60	206	62.1	3,216	100	550	7,800	18,848	2.86
2,316	38.6	1.61	199	62.1	3,136	100	550	7,800	14,184	2.61
2,328	38.8	1.62	199	62.1	3,136	100	550	7,800	9,520	2.30
2,340	39.0	1.63	199	62.1	3,136	100	550	7,800	4,856	1.35
2,352	39.2	1.63	199	62.1	3,136	100	0	1,200	6,793	1.89
2,364	39.4	1.64	199	62.1	3,136	100	0	1,200	8,729	2.24
2,376	39.6	1.65	199	62.1	3,136	100	0	1,200	10,665	2.39
2,388	39.8	1.66	199	62.1	3,136	100	0	1,200	12,601	2.52
2,400	40.0	1.67	199	62.1	3,136	100	0	1,200	14,537	2.63
2,412	40.2	1.68	199	62.1	3,136	100	0	1,200	16,474	2.74
2,424	40.4	1.68	199	62.1	3,136	100	0	1,200	18,410	2.84
2,436	40.6	1.69	199	62.1	3,136	100	0	1,200	20,346	2.93
2,448	40.8	1.70	199	62.1	3,136	100	0	1,200	22,282	3.01
2,460	41.0	1.71	199	62.1	3,136	100	0	1,200	24,218	3.09
2,472	41.2	1.72	193	62.1	3,056	100	0	1,200	26,075	3.16
2,484	41.4	1.73	193	62.1	3,056	100	0	1,200	27,931	3.23
2,496	41.6	1.73	193	62.1	3,056	100	0	1,200	29,788	3.30
2,508	41.8	1.74	193	62.1	3,056	100	0	1,200	31,644	3.36
2,520	42.0	1.75	193	62.1	3,056	100	0	1,200	33,501	3.43
2,532	42.2	1.76	193	62.1	3,056	100	0	1,200	35,357	3.48
2,544	42.4	1.77	193	62.1	3,056	100	0	1,200	37,214	3.54
2,556	42.6	1.78	193	62.1	3,056	100	0	1,200	39,070	3.60
2,568	42.8	1.78	193	62.1	3,056	100	0	1,200	40,927	3.65
2,580	43.0	1.79	193	62.1	3,056	100	0	1,200	42,783	3.70
2,592	43.2	1.80	193	62.1	3,056	100	0	1,200	44,640	3.75
2,604	43.4	1.81	193	62.1	3,056	100	0	1,200	46,496	3.80
2,616	43.6	1.82	186	62.1	2,977	100	0	1,200	48,273	3.84
2,628	43.8	1.83	186	62.1	2,977	100	0	1,200	50,050	3.89
2,640	44.0	1.83	186	62.1	2,977	100	0	1,200	51,827	3.93
2,652	44.2	1.84	186	62.1	2,977	100	0	1,200	53,603	3.97
2,664	44.4	1.85	186	62.1	2,977	100	0	1,200	55,380	4.02
2,676	44.6	1.86	186	62.1	2,977	100	550	7,800	50,557	3.90
2,688	44.8	1.87	186	62.1	2,977	100	550	7,800	45,734	3.78
2,700	45.0	1.88	186	62.1	2,977	100	550	7,800	40,911	3.65
2,712	45.2	1.88	186	62.1	2,977	100	550	7,800	36,087	3.51
2,724	45.4	1.89	186	62.1	2,977	100	550	7,800	31,264	3.35

Attachment 9 - Cell 2 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
2,736	45.6	1.90	186	62.1	2,977	100	550	7,800	26,441	3.18
2,748	45.8	1.91	186	62.1	2,977	100	550	7,800	21,618	2.98
2,760	46.0	1.92	179	62.1	2,897	100	550	7,800	16,715	2.75
2,772	46.2	1.93	179	62.1	2,897	100	550	7,800	11,812	2.46
2,784	46.4	1.93	179	62.1	2,897	100	550	7,800	6,909	1.92
2,796	46.6	1.94	179	62.1	2,897	100	0	1,200	8,606	2.23
2,808	46.8	1.95	179	62.1	2,897	100	0	1,200	10,303	2.36
2,820	47.0	1.96	179	62.1	2,897	100	0	1,200	12,000	2.48
2,832	47.2	1.97	179	62.1	2,897	100	0	1,200	13,697	2.58
2,844	47.4	1.98	179	62.1	2,897	100	0	1,200	15,394	2.68
2,856	47.6	1.98	179	62.1	2,897	100	0	1,200	17,091	2.77
2,868	47.8	1.99	179	62.1	2,897	100	0	1,200	18,789	2.85
2,880	48.0	2.00	179	62.1	2,897	100	0	1,200	20,486	2.93
2,892	48.2	2.01	179	62.1	2,897	100	0	1,200	22,183	3.01
2,904	48.4	2.02	179	62.1	2,897	100	0	1,200	23,880	3.08
2,916	48.6	2.03	173	62.1	2,817	100	0	1,200	25,497	3.14
2,928	48.8	2.03	173	62.1	2,817	100	0	1,200	27,115	3.20
2,940	49.0	2.04	173	62.1	2,817	100	0	1,200	28,732	3.26
2,952	49.2	2.05	173	62.1	2,817	100	0	1,200	30,349	3.32
2,964	49.4	2.06	173	62.1	2,817	100	0	1,200	31,967	3.38
2,976	49.6	2.07	173	62.1	2,817	100	0	1,200	33,584	3.43
2,988	49.8	2.08	173	62.1	2,817	100	0	1,200	35,201	3.48
3,000	50.0	2.08	173	62.1	2,817	100	0	1,200	36,819	3.53
3,012	50.2	2.09	173	62.1	2,817	100	0	1,200	38,436	3.58
3,024	50.4	2.10	173	62.1	2,817	100	0	1,200	40,054	3.62
3,036	50.6	2.11	173	62.1	2,817	100	0	1,200	41,671	3.67
3,048	50.8	2.12	166	62.1	2,738	100	0	1,200	43,209	3.71
3,060	51.0	2.13	166	62.1	2,738	100	0	1,200	44,746	3.75
3,072	51.2	2.13	166	62.1	2,738	100	0	1,200	46,284	3.79
3,084	51.4	2.14	166	62.1	2,738	100	0	1,200	47,822	3.83
3,096	51.6	2.15	166	62.1	2,738	100	0	1,200	49,359	3.87
3,108	51.8	2.16	166	62.1	2,738	100	0	1,200	50,897	3.91
3,120	52.0	2.17	166	62.1	2,738	100	0	1,200	52,435	3.95
3,132	52.2	2.18	166	62.1	2,738	100	0	1,200	53,972	3.98
3,144	52.4	2.18	166	62.1	2,738	100	0	1,200	55,510	4.02
3,156	52.6	2.19	166	62.1	2,738	100	550	7,800	50,448	3.90
3,168	52.8	2.20	166	62.1	2,738	100	550	7,800	45,385	3.77
3,180	53.0	2.21	166	62.1	2,738	100	550	7,800	40,323	3.63
3,192	53.2	2.22	166	62.1	2,738	100	550	7,800	35,261	3.48
3,204	53.4	2.23	166	62.1	2,738	100	550	7,800	30,198	3.32
3,216	53.6	2.23	159	62.1	2,658	100	550	7,800	25,056	3.13
3,228	53.8	2.24	159	62.1	2,658	100	550	7,800	19,914	2.91
3,240	54.0	2.25	159	62.1	2,658	100	550	7,800	14,772	2.64
3,252	54.2	2.26	159	62.1	2,658	100	550	7,800	9,630	2.31
3,264	54.4	2.27	159	62.1	2,658	100	550	7,800	4,488	1.25
3,276	54.6	2.28	159	62.1	2,658	100	0	1,200	5,946	1.66
3,288	54.8	2.28	159	62.1	2,658	100	0	1,200	7,404	2.13
3,300	55.0	2.29	159	62.1	2,658	100	0	1,200	8,862	2.25
3,312	55.2	2.30	159	62.1	2,658	100	0	1,200	10,320	2.36
3,324	55.4	2.31	159	62.1	2,658	100	0	1,200	11,778	2.46
3,336	55.6	2.32	159	62.1	2,658	100	0	1,200	13,236	2.55
3,348	55.8	2.33	159	62.1	2,658	100	0	1,200	14,694	2.64
3,360	56.0	2.33	153	62.1	2,578	100	0	1,200	16,072	2.72
3,372	56.2	2.34	153	62.1	2,578	100	0	1,200	17,450	2.79
3,384	56.4	2.35	153	62.1	2,578	100	0	1,200	18,829	2.86
3,396	56.6	2.36	153	62.1	2,578	100	0	1,200	20,207	2.92
3,408	56.8	2.37	153	62.1	2,578	100	0	1,200	21,585	2.98
3,420	57.0	2.38	153	62.1	2,578	100	0	1,200	22,963	3.04
3,432	57.2	2.38	153	62.1	2,578	100	0	1,200	24,342	3.10
3,444	57.4	2.39	153	62.1	2,578	100	0	1,200	25,720	3.15
3,456	57.6	2.40	153	62.1	2,578	100	0	1,200	27,098	3.20
3,468	57.8	2.41	153	62.1	2,578	100	0	1,200	28,476	3.25
3,480	58.0	2.42	153	62.1	2,578	100	0	1,200	29,855	3.30
3,492	58.2	2.43	153	62.1	2,578	100	0	1,200	31,233	3.35
3,504	58.4	2.43	146	62.1	2,499	100	0	1,200	32,531	3.39
3,516	58.6	2.44	146	62.1	2,499	100	0	1,200	33,830	3.44
3,528	58.8	2.45	146	62.1	2,499	100	0	1,200	35,128	3.48
3,540	59.0	2.46	146	62.1	2,499	100	0	1,200	36,427	3.52
3,552	59.2	2.47	146	62.1	2,499	100	0	1,200	37,726	3.56
3,564	59.4	2.48	146	62.1	2,499	100	0	1,200	39,024	3.59
3,576	59.6	2.48	146	62.1	2,499	100	0	1,200	40,323	3.63
3,588	59.8	2.49	146	62.1	2,499	100	0	1,200	41,621	3.67
3,600	60.0	2.50	146	62.1	2,499	100	0	1,200	42,920	3.70
3,612	60.2	2.51	146	62.1	2,499	100	0	1,200	44,218	3.74
3,624	60.4	2.52	146	62.1	2,499	100	0	1,200	45,517	3.77
3,636	60.6	2.53	146	62.1	2,499	100	0	1,200	46,815	3.81

Attachment 9 - Cell 2 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,648	60.8	2.53	146	62.1	2,499	100	0	1,200	48,114	3.84
3,660	61.0	2.54	146	62.1	2,499	100	0	1,200	49,412	3.87
3,672	61.2	2.55	139	62.1	2,419	100	0	1,200	50,631	3.90
3,684	61.4	2.56	139	62.1	2,419	100	0	1,200	51,850	3.93
3,696	61.6	2.57	139	62.1	2,419	100	0	1,200	53,069	3.96
3,708	61.8	2.58	139	62.1	2,419	100	0	1,200	54,288	3.99
3,720	62.0	2.58	139	62.1	2,419	100	0	1,200	55,507	4.02
3,732	62.2	2.59	139	62.1	2,419	100	550	7,800	50,125	3.89
3,744	62.4	2.60	139	62.1	2,419	100	550	7,800	44,744	3.75
3,756	62.6	2.61	139	62.1	2,419	100	550	7,800	39,363	3.60
3,768	62.8	2.62	139	62.1	2,419	100	550	7,800	33,982	3.44
3,780	63.0	2.63	139	62.1	2,419	100	550	7,800	28,601	3.26
3,792	63.2	2.63	139	62.1	2,419	100	550	7,800	23,220	3.05
3,804	63.4	2.64	139	62.1	2,419	100	550	7,800	17,839	2.81
3,816	63.6	2.65	133	62.1	2,339	100	550	7,800	12,378	2.50
3,828	63.8	2.66	133	62.1	2,339	100	550	7,800	6,917	1.93
3,840	64.0	2.67	133	62.1	2,339	100	0	1,200	8,056	2.18
3,852	64.2	2.68	133	62.1	2,339	100	0	1,200	9,195	2.28
3,864	64.4	2.68	133	62.1	2,339	100	0	1,200	10,334	2.36
3,876	64.6	2.69	133	62.1	2,339	100	0	1,200	11,473	2.44
3,888	64.8	2.70	133	62.1	2,339	100	0	1,200	12,612	2.52
3,900	65.0	2.71	133	62.1	2,339	100	0	1,200	13,752	2.59
3,912	65.2	2.72	133	62.1	2,339	100	0	1,200	14,891	2.65
3,924	65.4	2.73	133	62.1	2,339	100	0	1,200	16,030	2.71
3,936	65.6	2.73	133	62.1	2,339	100	0	1,200	17,169	2.77
3,948	65.8	2.74	133	62.1	2,339	100	0	1,200	18,308	2.83
3,960	66.0	2.75	133	62.1	2,339	100	0	1,200	19,447	2.88
3,972	66.2	2.76	133	62.1	2,339	100	0	1,200	20,586	2.94
3,984	66.4	2.77	126	62.1	2,259	100	0	1,200	21,646	2.98
3,996	66.6	2.78	126	62.1	2,259	100	0	1,200	22,705	3.03
4,008	66.8	2.78	126	62.1	2,259	100	0	1,200	23,765	3.07
4,020	67.0	2.79	126	62.1	2,259	100	0	1,200	24,824	3.12
4,032	67.2	2.80	126	62.1	2,259	100	0	1,200	25,883	3.16
4,044	67.4	2.81	126	62.1	2,259	100	0	1,200	26,943	3.20
4,056	67.6	2.82	126	62.1	2,259	100	0	1,200	28,002	3.24
4,068	67.8	2.83	126	62.1	2,259	100	0	1,200	29,062	3.28
4,080	68.0	2.83	126	62.1	2,259	100	0	1,200	30,121	3.31
4,092	68.2	2.84	126	62.1	2,259	100	0	1,200	31,181	3.35
4,104	68.4	2.85	126	62.1	2,259	100	0	1,200	32,240	3.38
4,116	68.6	2.86	126	62.1	2,259	100	0	1,200	33,299	3.42
4,128	68.8	2.87	120	62.1	2,180	100	0	1,200	34,279	3.45
4,140	69.0	2.88	120	62.1	2,180	100	0	1,200	35,259	3.48
4,152	69.2	2.88	120	62.1	2,180	100	0	1,200	36,239	3.51
4,164	69.4	2.89	120	62.1	2,180	100	0	1,200	37,218	3.54
4,176	69.6	2.90	120	62.1	2,180	100	0	1,200	38,198	3.57
4,188	69.8	2.91	120	62.1	2,180	100	0	1,200	39,178	3.60
4,200	70.0	2.92	120	62.1	2,180	100	0	1,200	40,158	3.63
4,212	70.2	2.93	120	62.1	2,180	100	0	1,200	41,137	3.66
4,224	70.4	2.93	120	62.1	2,180	100	0	1,200	42,117	3.68
4,236	70.6	2.94	120	62.1	2,180	100	0	1,200	43,097	3.71
4,248	70.8	2.95	120	62.1	2,180	100	0	1,200	44,076	3.74
4,260	71.0	2.96	120	62.1	2,180	100	0	1,200	45,056	3.76
4,272	71.2	2.97	120	62.1	2,180	100	0	1,200	46,036	3.79
4,284	71.4	2.98	113	62.1	2,100	100	0	1,200	46,936	3.81
4,296	71.6	2.98	113	62.1	2,100	100	0	1,200	47,836	3.83
4,308	71.8	2.99	113	62.1	2,100	100	0	1,200	48,736	3.86
4,320	72.0	3.00	113	62.1	2,100	100	0	1,200	49,636	3.88
4,332	72.2	3.01	113	62.1	2,100	100	0	1,200	50,536	3.90
4,344	72.4	3.02	113	62.1	2,100	100	0	1,200	51,436	3.92
4,356	72.6	3.03	113	62.1	2,100	100	0	1,200	52,336	3.94
4,368	72.8	3.03	113	62.1	2,100	100	0	1,200	53,236	3.97
4,380	73.0	3.04	113	62.1	2,100	100	0	1,200	54,136	3.99
4,392	73.2	3.05	113	62.1	2,100	100	0	1,200	55,036	4.01
4,404	73.4	3.06	113	62.1	2,100	100	550	7,800	49,336	3.87
4,416	73.6	3.07	113	62.1	2,100	100	550	7,800	43,636	3.72
4,428	73.8	3.08	113	62.1	2,100	100	550	7,800	37,936	3.56
4,440	74.0	3.08	106	62.1	2,020	100	550	7,800	32,156	3.38
4,452	74.2	3.09	106	62.1	2,020	100	550	7,800	26,377	3.18
4,464	74.4	3.10	106	62.1	2,020	100	550	7,800	20,597	2.94
4,476	74.6	3.11	106	62.1	2,020	100	550	7,800	14,817	2.65
4,488	74.8	3.12	106	62.1	2,020	100	550	7,800	9,038	2.26
4,500	75.0	3.13	106	62.1	2,020	100	550	7,800	3,258	0.91
4,512	75.2	3.13	106	62.1	2,020	100	0	1,200	4,078	1.14
4,524	75.4	3.14	106	62.1	2,020	100	0	1,200	4,898	1.36
4,536	75.6	3.15	106	62.1	2,020	100	0	1,200	5,719	1.59
4,548	75.8	3.16	106	62.1	2,020	100	0	1,200	6,539	1.82

Attachment 9 - Cell 2 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,560	76.0	3.17	106	62.1	2,020	100	0	1,200	7,359	2.12
4,572	76.2	3.18	106	62.1	2,020	100	0	1,200	8,180	2.19
4,584	76.4	3.18	106	62.1	2,020	100	0	1,200	9,000	2.26
4,596	76.6	3.19	100	62.1	1,941	100	0	1,200	9,741	2.32
4,608	76.8	3.20	100	62.1	1,941	100	0	1,200	10,481	2.37
4,620	77.0	3.21	100	62.1	1,941	100	0	1,200	11,222	2.42
4,632	77.2	3.22	100	62.1	1,941	100	0	1,200	11,962	2.47
4,644	77.4	3.23	100	62.1	1,941	100	0	1,200	12,703	2.52
4,656	77.6	3.23	100	62.1	1,941	100	0	1,200	13,444	2.57
4,668	77.8	3.24	100	62.1	1,941	100	0	1,200	14,184	2.61
4,680	78.0	3.25	100	62.1	1,941	100	0	1,200	14,925	2.65
4,692	78.2	3.26	100	62.1	1,941	100	0	1,200	15,665	2.69
4,704	78.4	3.27	100	62.1	1,941	100	0	1,200	16,406	2.73
4,716	78.6	3.28	100	62.1	1,941	100	0	1,200	17,147	2.77
4,728	78.8	3.28	100	62.1	1,941	100	0	1,200	17,887	2.81
4,740	79.0	3.29	100	62.1	1,941	100	0	1,200	18,628	2.85
4,752	79.2	3.30	100	62.1	1,941	100	0	1,200	19,368	2.88
4,764	79.4	3.31	93	62.1	1,861	100	0	1,200	20,029	2.91
4,776	79.6	3.32	93	62.1	1,861	100	0	1,200	20,690	2.94
4,788	79.8	3.33	93	62.1	1,861	100	0	1,200	21,351	2.97
4,800	80.0	3.33	93	62.1	1,861	100	0	1,200	22,012	3.00
4,812	80.2	3.34	93	62.1	1,861	100	0	1,200	22,673	3.03
4,824	80.4	3.35	93	62.1	1,861	100	0	1,200	23,334	3.06
4,836	80.6	3.36	93	62.1	1,861	100	0	1,200	23,995	3.08
4,848	80.8	3.37	93	62.1	1,861	100	0	1,200	24,655	3.11
4,860	81.0	3.38	93	62.1	1,861	100	0	1,200	25,316	3.14
4,872	81.2	3.38	93	62.1	1,861	100	0	1,200	25,977	3.16
4,884	81.4	3.39	93	62.1	1,861	100	0	1,200	26,638	3.19
4,896	81.6	3.40	93	62.1	1,861	100	0	1,200	27,299	3.21
4,908	81.8	3.41	93	62.1	1,861	100	0	1,200	27,960	3.24
4,920	82.0	3.42	86	62.1	1,781	100	0	1,200	28,541	3.26
4,932	82.2	3.43	86	62.1	1,781	100	0	1,200	29,122	3.28
4,944	82.4	3.43	86	62.1	1,781	100	0	1,200	29,703	3.30
4,956	82.6	3.44	86	62.1	1,781	100	0	1,200	30,285	3.32
4,968	82.8	3.45	86	62.1	1,781	100	0	1,200	30,866	3.34
4,980	83.0	3.46	86	62.1	1,781	100	0	1,200	31,447	3.36
4,992	83.2	3.47	86	62.1	1,781	100	0	1,200	32,028	3.38
5,004	83.4	3.48	86	62.1	1,781	100	0	1,200	32,609	3.40
5,016	83.6	3.48	86	62.1	1,781	100	0	1,200	33,191	3.42
5,028	83.8	3.49	86	62.1	1,781	100	0	1,200	33,772	3.43
5,040	84.0	3.50	86	62.1	1,781	100	0	1,200	34,353	3.45
5,052	84.2	3.51	86	62.1	1,781	100	0	1,200	34,934	3.47
5,064	84.4	3.52	86	62.1	1,781	100	0	1,200	35,515	3.49
5,076	84.6	3.53	86	62.1	1,781	100	0	1,200	36,096	3.51
5,088	84.8	3.53	80	62.1	1,701	100	0	1,200	36,598	3.52
5,100	85.0	3.54	80	62.1	1,701	100	0	1,200	37,099	3.54
5,112	85.2	3.55	80	62.1	1,701	100	0	1,200	37,601	3.55
5,124	85.4	3.56	80	62.1	1,701	100	0	1,200	38,102	3.57
5,136	85.6	3.57	80	62.1	1,701	100	0	1,200	38,604	3.58
5,148	85.8	3.58	80	62.1	1,701	100	0	1,200	39,105	3.60
5,160	86.0	3.58	80	62.1	1,701	100	0	1,200	39,607	3.61
5,172	86.2	3.59	80	62.1	1,701	100	0	1,200	40,108	3.63
5,184	86.4	3.60	80	62.1	1,701	100	0	1,200	40,610	3.64
5,196	86.6	3.61	80	62.1	1,701	100	0	1,200	41,111	3.65
5,208	86.8	3.62	80	62.1	1,701	100	0	1,200	41,613	3.67
5,220	87.0	3.63	80	62.1	1,701	100	0	1,200	42,114	3.68
5,232	87.2	3.63	80	62.1	1,701	100	0	1,200	42,616	3.70
5,244	87.4	3.64	80	62.1	1,701	100	0	1,200	43,117	3.71
5,256	87.6	3.65	80	62.1	1,701	100	0	1,200	43,619	3.72
5,268	87.8	3.66	73	62.1	1,622	100	0	1,200	44,040	3.73
5,280	88.0	3.67	73	62.1	1,622	100	0	1,200	44,462	3.75
5,292	88.2	3.68	73	62.1	1,622	100	0	1,200	44,884	3.76
5,304	88.4	3.68	73	62.1	1,622	100	0	1,200	45,306	3.77
5,316	88.6	3.69	73	62.1	1,622	100	0	1,200	45,728	3.78
5,328	88.8	3.70	73	62.1	1,622	100	0	1,200	46,149	3.79
5,340	89.0	3.71	73	62.1	1,622	100	0	1,200	46,571	3.80
5,352	89.2	3.72	73	62.1	1,622	100	0	1,200	46,993	3.81
5,364	89.4	3.73	73	62.1	1,622	100	0	1,200	47,415	3.82
5,376	89.6	3.73	73	62.1	1,622	100	0	1,200	47,836	3.83
5,388	89.8	3.74	73	62.1	1,622	100	0	1,200	48,258	3.84
5,400	90.0	3.75	73	62.1	1,622	100	0	1,200	48,680	3.86
5,412	90.2	3.76	73	62.1	1,622	100	0	1,200	49,102	3.87
5,424	90.4	3.77	66	62.1	1,542	100	0	1,200	49,444	3.87
5,436	90.6	3.78	66	62.1	1,542	100	0	1,200	49,786	3.88
5,448	90.8	3.78	66	62.1	1,542	100	0	1,200	50,128	3.89
5,460	91.0	3.79	66	62.1	1,542	100	0	1,200	50,470	3.90

Attachment 9 - Cell 2 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,472	91.2	3.80	66	62.1	1,542	100	0	1,200	50,812	3.91
5,484	91.4	3.81	66	62.1	1,542	100	0	1,200	51,154	3.92
5,496	91.6	3.82	66	62.1	1,542	100	0	1,200	51,496	3.92
5,508	91.8	3.83	66	62.1	1,542	100	0	1,200	51,838	3.93
5,520	92.0	3.83	66	62.1	1,542	100	0	1,200	52,180	3.94
5,532	92.2	3.84	66	62.1	1,542	100	0	1,200	52,522	3.95
5,544	92.4	3.85	66	62.1	1,542	100	0	1,200	52,864	3.96
5,556	92.6	3.86	66	62.1	1,542	100	0	1,200	53,206	3.96
5,568	92.8	3.87	66	62.1	1,542	100	0	1,200	53,549	3.97
5,580	93.0	3.88	66	62.1	1,542	100	0	1,200	53,891	3.98
5,592	93.2	3.88	66	62.1	1,542	100	0	1,200	54,233	3.99
5,604	93.4	3.89	66	62.1	1,542	100	0	1,200	54,575	4.00
5,616	93.6	3.90	60	62.1	1,462	100	0	1,200	54,837	4.00
5,628	93.8	3.91	60	62.1	1,462	100	550	7,800	48,499	3.85
5,640	94.0	3.92	60	62.1	1,462	100	550	7,800	42,162	3.68
5,652	94.2	3.93	60	62.1	1,462	100	550	7,800	35,824	3.50
5,664	94.4	3.93	60	62.1	1,462	100	550	7,800	29,486	3.29
5,676	94.6	3.94	60	62.1	1,462	100	550	7,800	23,149	3.05
5,688	94.8	3.95	60	62.1	1,462	100	550	7,800	16,811	2.75
5,700	95.0	3.96	60	62.1	1,462	100	550	7,800	10,474	2.37
5,712	95.2	3.97	60	62.1	1,462	100	550	7,800	4,136	1.15
5,724	95.4	3.98	60	62.1	1,462	100	0	1,200	4,398	1.23
5,736	95.6	3.98	60	62.1	1,462	100	0	1,200	4,661	1.30
5,748	95.8	3.99	60	62.1	1,462	100	0	1,200	4,923	1.37
5,760	96.0	4.00	53	62.1	1,383	100	0	1,200	5,106	1.42
5,772	96.2	4.01	53	62.1	1,383	100	0	1,200	5,288	1.47
5,784	96.4	4.02	53	62.1	1,383	100	0	1,200	5,471	1.52
5,796	96.6	4.03	53	62.1	1,383	100	0	1,200	5,654	1.57
5,808	96.8	4.03	53	62.1	1,383	100	0	1,200	5,836	1.63
5,820	97.0	4.04	53	62.1	1,383	100	0	1,200	6,019	1.68
5,832	97.2	4.05	53	62.1	1,383	100	0	1,200	6,202	1.73
5,844	97.4	4.06	53	62.1	1,383	100	0	1,200	6,384	1.78
5,856	97.6	4.07	53	62.1	1,383	100	0	1,200	6,567	1.83
5,868	97.8	4.08	53	62.1	1,383	100	0	1,200	6,749	1.88
5,880	98.0	4.08	53	62.1	1,383	100	0	1,200	6,932	1.93
5,892	98.2	4.09	53	62.1	1,383	100	0	1,200	7,115	1.98
5,904	98.4	4.10	53	62.1	1,383	100	0	1,200	7,297	2.12
5,916	98.6	4.11	53	62.1	1,383	100	0	1,200	7,480	2.13
5,928	98.8	4.12	53	62.1	1,383	100	0	1,200	7,663	2.15
5,940	99.0	4.13	53	62.1	1,383	100	0	1,200	7,845	2.17
5,952	99.2	4.13	53	62.1	1,383	100	0	1,200	8,028	2.18
5,964	99.4	4.14	53	62.1	1,383	100	0	1,200	8,211	2.20
5,976	99.6	4.15	46	62.1	1,303	100	0	1,200	8,314	2.21
5,988	99.8	4.16	46	62.1	1,303	100	0	1,200	8,417	2.21
6,000	100.0	4.17	46	62.1	1,303	100	0	1,200	8,520	2.22
6,012	100.2	4.18	46	62.1	1,303	100	0	1,200	8,622	2.23
6,024	100.4	4.18	46	62.1	1,303	100	0	1,200	8,725	2.24
6,036	100.6	4.19	46	62.1	1,303	100	0	1,200	8,828	2.25
6,048	100.8	4.20	46	62.1	1,303	100	0	1,200	8,931	2.26
6,060	101.0	4.21	46	62.1	1,303	100	0	1,200	9,034	2.26
6,072	101.2	4.22	46	62.1	1,303	100	0	1,200	9,137	2.27
6,084	101.4	4.23	46	62.1	1,303	100	0	1,200	9,240	2.28
6,096	101.6	4.23	46	62.1	1,303	100	0	1,200	9,343	2.29
6,108	101.8	4.24	46	62.1	1,303	100	0	1,200	9,446	2.30
6,120	102.0	4.25	46	62.1	1,303	100	0	1,200	9,549	2.30
6,132	102.2	4.26	46	62.1	1,303	100	0	1,200	9,652	2.31
6,144	102.4	4.27	46	62.1	1,303	100	0	1,200	9,755	2.32
6,156	102.6	4.28	40	62.1	1,223	100	0	1,200	9,778	2.32
6,168	102.8	4.28	40	62.1	1,223	100	0	1,200	9,801	2.32
6,180	103.0	4.29	40	62.1	1,223	100	0	1,200	9,825	2.32
6,192	103.2	4.30	40	62.1	1,223	100	0	1,200	9,848	2.33
6,204	103.4	4.31	40	62.1	1,223	100	0	1,200	9,871	2.33
6,216	103.6	4.32	40	62.1	1,223	100	0	1,200	9,894	2.33
6,228	103.8	4.33	40	62.1	1,223	100	0	1,200	9,917	2.33
6,240	104.0	4.33	40	62.1	1,223	100	0	1,200	9,941	2.33
6,252	104.2	4.34	40	62.1	1,223	100	0	1,200	9,964	2.34
6,264	104.4	4.35	40	62.1	1,223	100	0	1,200	9,987	2.34
6,276	104.6	4.36	40	62.1	1,223	100	0	1,200	10,010	2.34
6,288	104.8	4.37	40	62.1	1,223	100	0	1,200	10,034	2.34
6,300	105.0	4.38	40	62.1	1,223	100	0	1,200	10,057	2.34
6,312	105.2	4.38	40	62.1	1,223	100	0	1,200	10,080	2.34
6,324	105.4	4.39	40	62.1	1,223	100	0	1,200	10,103	2.35
6,336	105.6	4.40	40	62.1	1,223	100	0	1,200	10,127	2.35
6,348	105.8	4.41	40	62.1	1,223	100	0	1,200	10,150	2.35
6,360	106.0	4.42	33	62.1	1,144	100	0	1,200	10,093	2.34
6,372	106.2	4.43	33	62.1	1,144	100	0	1,200	10,037	2.34

Attachment 9 - Cell 2 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,384	106.4	4.43	33	62.1	1,144	100	0	1,200	9,980	2.34
6,396	106.6	4.44	33	62.1	1,144	100	0	1,200	9,924	2.33
6,408	106.8	4.45	33	62.1	1,144	100	0	1,200	9,867	2.33
6,420	107.0	4.46	33	62.1	1,144	100	0	1,200	9,811	2.32
6,432	107.2	4.47	33	62.1	1,144	100	0	1,200	9,755	2.32
6,444	107.4	4.48	33	62.1	1,144	100	0	1,200	9,698	2.32
6,456	107.6	4.48	33	62.1	1,144	100	0	1,200	9,642	2.31
6,468	107.8	4.49	33	62.1	1,144	100	0	1,200	9,585	2.31
6,480	108.0	4.50	33	62.1	1,144	100	0	1,200	9,529	2.30
6,492	108.2	4.51	33	62.1	1,144	100	0	1,200	9,472	2.30
6,504	108.4	4.52	33	62.1	1,144	100	0	1,200	9,416	2.29
6,516	108.6	4.53	33	62.1	1,144	100	0	1,200	9,359	2.29
6,528	108.8	4.53	33	62.1	1,144	100	0	1,200	9,303	2.29
6,540	109.0	4.54	33	62.1	1,144	100	0	1,200	9,246	2.28
6,552	109.2	4.55	33	62.1	1,144	100	0	1,200	9,190	2.28
6,564	109.4	4.56	33	62.1	1,144	100	0	1,200	9,133	2.27
6,576	109.6	4.57	33	62.1	1,144	100	0	1,200	9,077	2.27
6,588	109.8	4.58	27	62.1	1,064	100	0	1,200	8,941	2.26
6,600	110.0	4.58	27	62.1	1,064	100	0	1,200	8,805	2.25
6,612	110.2	4.59	27	62.1	1,064	100	0	1,200	8,668	2.23
6,624	110.4	4.60	27	62.1	1,064	100	0	1,200	8,532	2.22
6,636	110.6	4.61	27	62.1	1,064	100	0	1,200	8,396	2.21
6,648	110.8	4.62	27	62.1	1,064	100	0	1,200	8,260	2.20
6,660	111.0	4.63	27	62.1	1,064	100	0	1,200	8,124	2.19
6,672	111.2	4.63	27	62.1	1,064	100	0	1,200	7,987	2.18
6,684	111.4	4.64	27	62.1	1,064	100	0	1,200	7,851	2.17
6,696	111.6	4.65	27	62.1	1,064	100	0	1,200	7,715	2.15
6,708	111.8	4.66	27	62.1	1,064	100	0	1,200	7,579	2.14
6,720	112.0	4.67	27	62.1	1,064	100	0	1,200	7,443	2.13
6,732	112.2	4.68	27	62.1	1,064	100	0	1,200	7,307	2.12
6,744	112.4	4.68	27	62.1	1,064	100	0	1,200	7,170	2.00
6,756	112.6	4.69	27	62.1	1,064	100	0	1,200	7,034	1.96
6,768	112.8	4.70	27	62.1	1,064	100	0	1,200	6,898	1.92
6,780	113.0	4.71	27	62.1	1,064	100	0	1,200	6,762	1.88
6,792	113.2	4.72	27	62.1	1,064	100	0	1,200	6,626	1.85
6,804	113.4	4.73	27	62.1	1,064	100	0	1,200	6,490	1.81
6,816	113.6	4.73	20	62.1	984	100	0	1,200	6,274	1.75
6,828	113.8	4.74	20	62.1	984	100	0	1,200	6,058	1.69
6,840	114.0	4.75	20	62.1	984	100	0	1,200	5,842	1.63
6,852	114.2	4.76	20	62.1	984	100	0	1,200	5,626	1.57
6,864	114.4	4.77	20	62.1	984	100	0	1,200	5,410	1.51
6,876	114.6	4.78	20	62.1	984	100	0	1,200	5,194	1.45
6,888	114.8	4.78	20	62.1	984	100	0	1,200	4,978	1.39
6,900	115.0	4.79	20	62.1	984	100	0	1,200	4,762	1.33
6,912	115.2	4.80	20	62.1	984	100	0	1,200	4,547	1.27
6,924	115.4	4.81	20	62.1	984	100	0	1,200	4,331	1.21
6,936	115.6	4.82	20	62.1	984	100	0	1,200	4,115	1.15
6,948	115.8	4.83	20	62.1	984	100	0	1,200	3,899	1.09
6,960	116.0	4.83	20	62.1	984	100	0	1,200	3,683	1.03
6,972	116.2	4.84	20	62.1	984	100	0	1,200	3,467	0.97
6,984	116.4	4.85	20	62.1	984	100	0	1,200	3,251	0.91
6,996	116.6	4.86	20	62.1	984	100	0	1,200	3,035	0.85
7,008	116.8	4.87	20	62.1	984	100	0	1,200	2,819	0.79
7,020	117.0	4.88	20	62.1	984	100	0	1,200	2,604	0.73
7,032	117.2	4.88	20	62.1	984	100	0	1,200	2,388	0.67
7,044	117.4	4.89	13	62.1	904	100	0	1,200	2,092	0.58
7,056	117.6	4.90	13	62.1	904	100	0	1,200	1,797	0.50
7,068	117.8	4.91	13	62.1	904	100	0	1,200	1,501	0.42
7,080	118.0	4.92	13	62.1	904	0	0	0	2,405	0.67
7,092	118.2	4.93	13	62.1	904	0	0	0	3,310	0.92
7,104	118.4	4.93	13	62.1	904	0	0	0	4,214	1.17
7,116	118.6	4.94	13	62.1	904	100	0	1,200	3,919	1.09
7,128	118.8	4.95	13	62.1	904	100	0	1,200	3,623	1.01
7,140	119.0	4.96	13	62.1	904	100	0	1,200	3,327	0.93
7,152	119.2	4.97	13	62.1	904	100	0	1,200	3,032	0.84
7,164	119.4	4.98	13	62.1	904	100	0	1,200	2,736	0.76
7,176	119.6	4.98	13	62.1	904	100	0	1,200	2,441	0.68
7,188	119.8	4.99	13	62.1	904	100	0	1,200	2,145	0.60
7,200	120.0	5.00	13	62.1	904	100	0	1,200	1,849	0.52
7,212	120.2	5.01	0	62.1	745	100	0	1,200	1,394	0.39
7,224	120.4	5.02	0	62.1	745	0	0	0	2,139	0.60
7,236	120.6	5.03	0	62.1	745	0	0	0	2,884	0.80
7,248	120.8	5.03	0	62.1	745	0	0	0	3,629	1.01
7,260	121.0	5.04	0	62.1	745	100	0	1,200	3,174	0.88
7,272	121.2	5.05	0	62.1	745	100	0	1,200	2,719	0.76
7,284	121.4	5.06	0	62.1	745	100	0	1,200	2,264	0.63

Attachment 9 - Cell 2 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,296	121.6	5.07	0	62.1	745	100	0	1,200	1,809	0.50
7,308	121.8	5.08	0	62.1	745	100	0	1,200	1,354	0.38
7,320	122.0	5.08	0	62.1	745	0	0	0	2,099	0.58
7,332	122.2	5.09	0	62.1	745	0	0	0	2,844	0.79
7,344	122.4	5.10	0	62.1	745	0	0	0	3,589	1.00
7,356	122.6	5.11	0	62.1	745	0	0	0	4,334	1.21
7,368	122.8	5.12	0	62.1	745	100	0	1,200	3,879	1.08
7,380	123.0	5.13	0	62.1	745	100	0	1,200	3,424	0.95
7,392	123.2	5.13	0	62.1	745	100	0	1,200	2,969	0.83
7,404	123.4	5.14	0	62.1	745	100	0	1,200	2,514	0.70
7,416	123.6	5.15	0	62.1	745	100	0	1,200	2,059	0.57
7,428	123.8	5.16	0	62.1	745	100	0	1,200	1,604	0.45
7,440	124.0	5.17	0	62.1	745	0	0	0	2,349	0.65
7,452	124.2	5.18	0	62.1	745	0	0	0	3,094	0.86
7,464	124.4	5.18	0	62.1	745	0	0	0	3,839	1.07
7,476	124.6	5.19	0	62.1	745	100	0	1,200	3,384	0.94
7,488	124.8	5.20	0	62.1	745	100	0	1,200	2,929	0.82
7,500	125.0	5.21	0	62.1	745	100	0	1,200	2,474	0.69
7,512	125.2	5.22	0	62.1	745	100	0	1,200	2,019	0.56
7,524	125.4	5.23	0	62.1	745	100	0	1,200	1,564	0.44
7,536	125.6	5.23	0	62.1	745	0	0	0	2,309	0.64
7,548	125.8	5.24	0	62.1	745	0	0	0	3,054	0.85
7,560	126.0	5.25	0	62.1	745	0	0	0	3,799	1.06
7,572	126.2	5.26	0	62.1	745	100	0	1,200	3,344	0.93
7,584	126.4	5.27	0	62.1	745	100	0	1,200	2,889	0.80
7,596	126.6	5.28	0	62.1	745	100	0	1,200	2,434	0.68
7,608	126.8	5.28	0	62.1	745	100	0	1,200	1,979	0.55
7,620	127.0	5.29	0	62.1	745	100	0	1,200	1,524	0.42
7,632	127.2	5.30	0	62.1	745	0	0	0	2,269	0.63
7,644	127.4	5.31	0	62.1	745	0	0	0	3,014	0.84
7,656	127.6	5.32	0	62.1	745	0	0	0	3,759	1.05
7,668	127.8	5.33	0	62.1	745	100	0	1,200	3,304	0.92
7,680	128.0	5.33	0	62.1	745	100	0	1,200	2,849	0.79
7,692	128.2	5.34	0	62.1	745	100	0	1,200	2,394	0.67
7,704	128.4	5.35	0	62.1	745	100	0	1,200	1,939	0.54
7,716	128.6	5.36	0	62.1	745	100	0	1,200	1,484	0.41
7,728	128.8	5.37	0	62.1	745	0	0	0	2,229	0.62
7,740	129.0	5.38	0	62.1	745	0	0	0	2,974	0.83
7,752	129.2	5.38	0	62.1	745	0	0	0	3,719	1.04
7,764	129.4	5.39	0	62.1	745	100	0	1,200	3,264	0.91
7,776	129.6	5.40	0	62.1	745	100	0	1,200	2,809	0.78
7,788	129.8	5.41	0	62.1	745	100	0	1,200	2,354	0.66
7,800	130.0	5.42	0	62.1	745	100	0	1,200	1,899	0.53
7,812	130.2	5.43	0	62.1	745	100	0	1,200	1,444	0.40
7,824	130.4	5.43	0	62.1	745	0	0	0	2,189	0.61
7,836	130.6	5.44	0	62.1	745	0	0	0	2,934	0.82
7,848	130.8	5.45	0	62.1	745	0	0	0	3,679	1.02
7,860	131.0	5.46	0	62.1	745	100	0	1,200	3,224	0.90
7,872	131.2	5.47	0	62.1	745	100	0	1,200	2,769	0.77
7,884	131.4	5.48	0	62.1	745	100	0	1,200	2,314	0.64
7,896	131.6	5.48	0	62.1	745	100	0	1,200	1,859	0.52
7,908	131.8	5.49	0	62.1	745	100	0	1,200	1,404	0.39
7,920	132.0	5.50	0	62.1	745	0	0	0	2,149	0.60
7,932	132.2	5.51	0	62.1	745	0	0	0	2,894	0.81
7,944	132.4	5.52	0	62.1	745	0	0	0	3,639	1.01
7,956	132.6	5.53	0	62.1	745	100	0	1,200	3,184	0.89
7,968	132.8	5.53	0	62.1	745	100	0	1,200	2,729	0.76
7,980	133.0	5.54	0	62.1	745	100	0	1,200	2,274	0.63
7,992	133.2	5.55	0	62.1	745	100	0	1,200	1,819	0.51
8,004	133.4	5.56	0	62.1	745	100	0	1,200	1,364	0.38
8,016	133.6	5.57	0	62.1	745	0	0	0	2,109	0.59
8,028	133.8	5.58	0	62.1	745	0	0	0	2,854	0.79
8,040	134.0	5.58	0	62.1	745	0	0	0	3,599	1.00
8,052	134.2	5.59	0	62.1	745	100	0	1,200	3,144	0.88
8,064	134.4	5.60	0	62.1	745	100	0	1,200	2,689	0.75
8,076	134.6	5.61	0	62.1	745	100	0	1,200	2,234	0.62
8,088	134.8	5.62	0	62.1	745	100	0	1,200	1,779	0.50
8,100	135.0	5.63	0	62.1	745	0	0	0	2,524	0.70
8,112	135.2	5.63	0	62.1	745	0	0	0	3,269	0.91
8,124	135.4	5.64	0	62.1	745	0	0	0	4,014	1.12
8,136	135.6	5.65	0	62.1	745	100	0	1,200	3,559	0.99
8,148	135.8	5.66	0	62.1	745	100	0	1,200	3,104	0.86
8,160	136.0	5.67	0	62.1	745	100	0	1,200	2,649	0.74
8,172	136.2	5.68	0	62.1	745	100	0	1,200	2,194	0.61
8,184	136.4	5.68	0	62.1	745	100	0	1,200	1,739	0.48
8,196	136.6	5.69	0	62.1	745	0	0	0	2,484	0.69

Attachment 9 - Cell 2 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,208	136.8	5.70	0	62.1	745	0	0	0	3,229	0.90
8,220	137.0	5.71	0	62.1	745	0	0	0	3,974	1.11
8,232	137.2	5.72	0	62.1	745	100	0	1,200	3,519	0.98
8,244	137.4	5.73	0	62.1	745	100	0	1,200	3,064	0.85
8,256	137.6	5.73	0	62.1	745	100	0	1,200	2,609	0.73
8,268	137.8	5.74	0	62.1	745	100	0	1,200	2,154	0.60
8,280	138.0	5.75	0	62.1	745	100	0	1,200	1,699	0.47
8,292	138.2	5.76	0	62.1	745	0	0	0	2,444	0.68
8,304	138.4	5.77	0	62.1	745	0	0	0	3,189	0.89
8,316	138.6	5.78	0	62.1	745	0	0	0	3,934	1.10
8,328	138.8	5.78	0	62.1	745	100	0	1,200	3,479	0.97
8,340	139.0	5.79	0	62.1	745	100	0	1,200	3,024	0.84
8,352	139.2	5.80	0	62.1	745	100	0	1,200	2,569	0.72
8,364	139.4	5.81	0	62.1	745	100	0	1,200	2,114	0.59
8,376	139.6	5.82	0	62.1	745	100	0	1,200	1,659	0.46
8,388	139.8	5.83	0	62.1	745	0	0	0	2,404	0.67
8,400	140.0	5.83	0	62.1	745	0	0	0	3,149	0.88
8,412	140.2	5.84	0	62.1	745	0	0	0	3,894	1.08
8,424	140.4	5.85	0	62.1	745	100	0	1,200	3,439	0.96
8,436	140.6	5.86	0	62.1	745	100	0	1,200	2,984	0.83
8,448	140.8	5.87	0	62.1	745	100	0	1,200	2,529	0.70
8,460	141.0	5.88	0	62.1	745	100	0	1,200	2,074	0.58
8,472	141.2	5.88	0	62.1	745	100	0	1,200	1,619	0.45
8,484	141.4	5.89	0	62.1	745	0	0	0	2,364	0.66
8,496	141.6	5.90	0	62.1	745	0	0	0	3,109	0.87
8,508	141.8	5.91	0	62.1	745	0	0	0	3,854	1.07
8,520	142.0	5.92	0	62.1	745	100	0	1,200	3,399	0.95
8,532	142.2	5.93	0	62.1	745	100	0	1,200	2,944	0.82
8,544	142.4	5.93	0	62.1	745	100	0	1,200	2,489	0.69
8,556	142.6	5.94	0	62.1	745	100	0	1,200	2,034	0.57
8,568	142.8	5.95	0	62.1	745	100	0	1,200	1,579	0.44
8,580	143.0	5.96	0	62.1	745	0	0	0	2,324	0.65
8,592	143.2	5.97	0	62.1	745	0	0	0	3,069	0.85
8,604	143.4	5.98	0	62.1	745	0	0	0	3,814	1.06
8,616	143.6	5.98	0	62.1	745	100	0	1,200	3,359	0.94
8,628	143.8	5.99	0	62.1	745	100	0	1,200	2,904	0.81
8,640	144.0	6.00	0	62.1	745	100	0	1,200	2,449	0.68
8,652	144.2	6.01	0	62.1	745	100	0	1,200	1,994	0.56
8,664	144.4	6.02	0	62.1	745	100	0	1,200	1,539	0.43
8,676	144.6	6.03	0	62.1	745	0	0	0	2,284	0.64
8,688	144.8	6.03	0	62.1	745	0	0	0	3,029	0.84
8,700	145.0	6.04	0	62.1	745	0	0	0	3,774	1.05
8,712	145.2	6.05	0	62.1	745	100	0	1,200	3,319	0.92
8,724	145.4	6.06	0	62.1	745	100	0	1,200	2,864	0.80
8,736	145.6	6.07	0	62.1	745	100	0	1,200	2,409	0.67
8,748	145.8	6.08	0	62.1	745	100	0	1,200	1,954	0.54
8,760	146.0	6.08	0	62.1	745	100	0	1,200	1,499	0.42
8,772	146.2	6.09	0	62.1	745	0	0	0	2,244	0.62
8,784	146.4	6.10	0	62.1	745	0	0	0	2,989	0.83
8,796	146.6	6.11	0	62.1	745	0	0	0	3,734	1.04
8,808	146.8	6.12	0	62.1	745	100	0	1,200	3,279	0.91
8,820	147.0	6.13	0	62.1	745	100	0	1,200	2,824	0.79
8,832	147.2	6.13	0	62.1	745	100	0	1,200	2,369	0.66
8,844	147.4	6.14	0	62.1	745	100	0	1,200	1,914	0.53
8,856	147.6	6.15	0	62.1	745	100	0	1,200	1,459	0.41
8,868	147.8	6.16	0	62.1	745	0	0	0	2,204	0.61
8,880	148.0	6.17	0	62.1	745	0	0	0	2,949	0.82
8,892	148.2	6.18	0	62.1	745	0	0	0	3,694	1.03
8,904	148.4	6.18	0	62.1	745	100	0	1,200	3,239	0.90
8,916	148.6	6.19	0	62.1	745	100	0	1,200	2,784	0.78
8,928	148.8	6.20	0	62.1	745	100	0	1,200	2,329	0.65
8,940	149.0	6.21	0	62.1	745	100	0	1,200	1,874	0.52
8,952	149.2	6.22	0	62.1	745	100	0	1,200	1,419	0.40
8,964	149.4	6.23	0	62.1	745	0	0	0	2,164	0.60
8,976	149.6	6.23	0	62.1	745	0	0	0	2,909	0.81
8,988	149.8	6.24	0	62.1	745	0	0	0	3,654	1.02
9,000	150.0	6.25	0	62.1	745	100	0	1,200	3,199	0.89
9,012	150.2	6.26	0	62.1	745	100	0	1,200	2,744	0.76
9,024	150.4	6.27	0	62.1	745	100	0	1,200	2,289	0.64
9,036	150.6	6.28	0	62.1	745	100	0	1,200	1,834	0.51
9,048	150.8	6.28	0	62.1	745	100	0	1,200	1,379	0.38
9,060	151.0	6.29	0	62.1	745	0	0	0	2,124	0.59
9,072	151.2	6.30	0	62.1	745	0	0	0	2,869	0.80
9,084	151.4	6.31	0	62.1	745	0	0	0	3,614	1.01
9,096	151.6	6.32	0	62.1	745	100	0	1,200	3,159	0.88
9,108	151.8	6.33	0	62.1	745	100	0	1,200	2,704	0.75

Attachment 9 - Cell 2 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
9,120	152.0	6.33	0	62.1	745	100	0	1,200	2,249	0.63
9,132	152.2	6.34	0	62.1	745	100	0	1,200	1,794	0.50
9,144	152.4	6.35	0	62.1	745	0	0	0	2,539	0.71
9,156	152.6	6.36	0	62.1	745	0	0	0	3,284	0.91
9,168	152.8	6.37	0	62.1	745	0	0	0	4,029	1.12
9,180	153.0	6.38	0	62.1	745	100	0	1,200	3,574	1.00
9,192	153.2	6.38	0	62.1	745	100	0	1,200	3,119	0.87
9,204	153.4	6.39	0	62.1	745	100	0	1,200	2,664	0.74
9,216	153.6	6.40	0	62.1	745	100	0	1,200	2,209	0.62
9,228	153.8	6.41	0	62.1	745	100	0	1,200	1,754	0.49
9,240	154.0	6.42	0	62.1	745	0	0	0	2,499	0.70
9,252	154.2	6.43	0	62.1	745	0	0	0	3,244	0.90
9,264	154.4	6.43	0	62.1	745	0	0	0	3,989	1.11
9,276	154.6	6.44	0	62.1	745	100	0	1,200	3,534	0.98
9,288	154.8	6.45	0	62.1	745	100	0	1,200	3,079	0.86
9,300	155.0	6.46	0	62.1	745	100	0	1,200	2,624	0.73
9,312	155.2	6.47	0	62.1	745	100	0	1,200	2,169	0.60
9,324	155.4	6.48	0	62.1	745	100	0	1,200	1,714	0.48
9,336	155.6	6.48	0	62.1	745	0	0	0	2,459	0.68
9,348	155.8	6.49	0	62.1	745	0	0	0	3,204	0.89
9,360	156.0	6.50	0	62.1	745	0	0	0	3,949	1.10
9,372	156.2	6.51	0	62.1	745	100	0	1,200	3,494	0.97
9,384	156.4	6.52	0	62.1	745	100	0	1,200	3,039	0.85
9,396	156.6	6.53	0	62.1	745	100	0	1,200	2,584	0.72
9,408	156.8	6.53	0	62.1	745	100	0	1,200	2,129	0.59
9,420	157.0	6.54	0	62.1	745	100	0	1,200	1,674	0.47
9,432	157.2	6.55	0	62.1	745	0	0	0	2,419	0.67
9,444	157.4	6.56	0	62.1	745	0	0	0	3,164	0.88
9,456	157.6	6.57	0	62.1	745	0	0	0	3,909	1.09
9,468	157.8	6.58	0	62.1	745	100	0	1,200	3,454	0.96
9,480	158.0	6.58	0	62.1	745	100	0	1,200	2,998	0.84
9,492	158.2	6.59	0	62.1	745	100	0	1,200	2,543	0.71
9,504	158.4	6.60	0	62.1	745	100	0	1,200	2,088	0.58
9,516	158.6	6.61	0	62.1	745	100	0	1,200	1,633	0.45
9,528	158.8	6.62	0	62.1	745	0	0	0	2,378	0.66
9,540	159.0	6.63	0	62.1	745	0	0	0	3,123	0.87
9,552	159.2	6.63	0	62.1	745	0	0	0	3,868	1.08
9,564	159.4	6.64	0	62.1	745	100	0	1,200	3,413	0.95
9,576	159.6	6.65	0	62.1	745	100	0	1,200	2,958	0.82
9,588	159.8	6.66	0	62.1	745	100	0	1,200	2,503	0.70
9,600	160.0	6.67	0	62.1	745	100	0	1,200	2,048	0.57
9,612	160.2	6.68	0	62.1	745	100	0	1,200	1,593	0.44
9,624	160.4	6.68	0	62.1	745	0	0	0	2,338	0.65
9,636	160.6	6.69	0	62.1	745	0	0	0	3,083	0.86
9,648	160.8	6.70	0	62.1	745	0	0	0	3,828	1.07
9,660	161.0	6.71	0	62.1	745	100	0	1,200	3,373	0.94
9,672	161.2	6.72	0	62.1	745	100	0	1,200	2,918	0.81
9,684	161.4	6.73	0	62.1	745	100	0	1,200	2,463	0.69
9,696	161.6	6.73	0	62.1	745	100	0	1,200	2,008	0.56
9,708	161.8	6.74	0	62.1	745	100	0	1,200	1,553	0.43
9,720	162.0	6.75	0	62.1	745	0	0	0	2,298	0.64
9,732	162.2	6.76	0	62.1	745	0	0	0	3,043	0.85
9,744	162.4	6.77	0	62.1	745	0	0	0	3,788	1.06
9,756	162.6	6.78	0	62.1	745	100	0	1,200	3,333	0.93
9,768	162.8	6.78	0	62.1	745	100	0	1,200	2,878	0.80
9,780	163.0	6.79	0	62.1	745	100	0	1,200	2,423	0.67
9,792	163.2	6.80	0	62.1	745	100	0	1,200	1,968	0.55
9,804	163.4	6.81	0	62.1	745	100	0	1,200	1,513	0.42
9,816	163.6	6.82	0	62.1	745	0	0	0	2,258	0.63
9,828	163.8	6.83	0	62.1	745	0	0	0	3,003	0.84
9,840	164.0	6.83	0	62.1	745	0	0	0	3,748	1.04
9,852	164.2	6.84	0	62.1	745	100	0	1,200	3,293	0.92
9,864	164.4	6.85	0	62.1	745	100	0	1,200	2,838	0.79
9,876	164.6	6.86	0	62.1	745	100	0	1,200	2,383	0.66
9,888	164.8	6.87	0	62.1	745	100	0	1,200	1,928	0.54
9,900	165.0	6.88	0	62.1	745	100	0	1,200	1,473	0.41
9,912	165.2	6.88	0	62.1	745	0	0	0	2,218	0.62
9,924	165.4	6.89	0	62.1	745	0	0	0	2,963	0.83
9,936	165.6	6.90	0	62.1	745	0	0	0	3,708	1.03
9,948	165.8	6.91	0	62.1	745	100	0	1,200	3,253	0.91
9,960	166.0	6.92	0	62.1	745	100	0	1,200	2,798	0.78
9,972	166.2	6.93	0	62.1	745	100	0	1,200	2,343	0.65
9,984	166.4	6.93	0	62.1	745	100	0	1,200	1,888	0.53
9,996	166.6	6.94	0	62.1	745	100	0	1,200	1,433	0.40
10,008	166.8	6.95	0	62.1	745	0	0	0	2,178	0.61
10,020	167.0	6.96	0	62.1	745	0	0	0	2,923	0.81

Attachment 9 - Cell 2 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
10,032	167.2	6.97	0	62.1	745	0	0	0	3,668	1.02
10,044	167.4	6.98	0	62.1	745	100	0	1,200	3,213	0.89
10,056	167.6	6.98	0	62.1	745	100	0	1,200	2,758	0.77
10,068	167.8	6.99	0	62.1	745	100	0	1,200	2,303	0.64
10,080	168.0	7.00	0	62.1	745	100	0	1,200	1,848	0.51

ATTACHMENT 10

Cell 3 Leakage Detection Sump – Average Conditions

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
0	0.0	0.00	0	0.018	0.000	0	0	1,795	1.00
12	0.2	0.01	0	0.018	0.215	0	0	1,795	1.00
24	0.4	0.02	0	0.018	0.215	100	1,200	596	0.33
36	0.6	0.03	0	0.018	0.215	0	0	596	0.33
48	0.8	0.03	0	0.018	0.215	0	0	596	0.33
60	1.0	0.04	0	0.018	0.215	0	0	596	0.33
72	1.2	0.05	0	0.018	0.215	0	0	596	0.33
84	1.4	0.06	0	0.018	0.215	0	0	597	0.33
96	1.6	0.07	0	0.018	0.215	0	0	597	0.33
108	1.8	0.08	0	0.018	0.215	0	0	597	0.33
120	2.0	0.08	0	0.018	0.215	0	0	597	0.33
132	2.2	0.09	0	0.018	0.215	0	0	598	0.33
144	2.4	0.10	0	0.018	0.215	0	0	598	0.33
156	2.6	0.11	0	0.018	0.215	0	0	598	0.33
168	2.8	0.12	0	0.018	0.215	0	0	598	0.33
180	3.0	0.13	0	0.018	0.215	0	0	598	0.33
192	3.2	0.13	0	0.018	0.215	0	0	599	0.33
204	3.4	0.14	0	0.018	0.215	0	0	599	0.33
216	3.6	0.15	0	0.018	0.215	0	0	599	0.33
228	3.8	0.16	0	0.018	0.215	0	0	599	0.33
240	4.0	0.17	0	0.018	0.215	0	0	600	0.33
252	4.2	0.18	0	0.018	0.215	0	0	600	0.33
264	4.4	0.18	0	0.018	0.215	0	0	600	0.33
276	4.6	0.19	0	0.018	0.215	0	0	600	0.33
288	4.8	0.20	0	0.018	0.215	0	0	600	0.33
300	5.0	0.21	0	0.018	0.215	0	0	601	0.33
312	5.2	0.22	0	0.018	0.215	0	0	601	0.33
324	5.4	0.23	0	0.018	0.215	0	0	601	0.33
336	5.6	0.23	0	0.018	0.215	0	0	601	0.33
348	5.8	0.24	0	0.018	0.215	0	0	601	0.34
360	6.0	0.25	0	0.018	0.215	0	0	602	0.34
372	6.2	0.26	0	0.018	0.215	0	0	602	0.34
384	6.4	0.27	0	0.018	0.215	0	0	602	0.34
396	6.6	0.28	0	0.018	0.215	0	0	602	0.34
408	6.8	0.28	0	0.018	0.215	0	0	603	0.34
420	7.0	0.29	0	0.018	0.215	0	0	603	0.34
432	7.2	0.30	0	0.018	0.215	0	0	603	0.34
444	7.4	0.31	0	0.018	0.215	0	0	603	0.34
456	7.6	0.32	0	0.018	0.215	0	0	603	0.34
468	7.8	0.33	0	0.018	0.215	0	0	604	0.34
480	8.0	0.33	0	0.018	0.215	0	0	604	0.34
492	8.2	0.34	0	0.018	0.215	0	0	604	0.34
504	8.4	0.35	0	0.018	0.215	0	0	604	0.34
516	8.6	0.36	0	0.018	0.215	0	0	604	0.34
528	8.8	0.37	0	0.018	0.215	0	0	605	0.34
540	9.0	0.38	0	0.018	0.215	0	0	605	0.34
552	9.2	0.38	0	0.018	0.215	0	0	605	0.34
564	9.4	0.39	0	0.018	0.215	0	0	605	0.34
576	9.6	0.40	0	0.018	0.215	0	0	606	0.34
588	9.8	0.41	0	0.018	0.215	0	0	606	0.34
600	10.0	0.42	0	0.018	0.215	0	0	606	0.34
612	10.2	0.43	0	0.018	0.215	0	0	606	0.34
624	10.4	0.43	0	0.018	0.215	0	0	606	0.34

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
636	10.6	0.44	0	0.018	0.215	0	0	607	0.34
648	10.8	0.45	0	0.018	0.215	0	0	607	0.34
660	11.0	0.46	0	0.018	0.215	0	0	607	0.34
672	11.2	0.47	0	0.018	0.215	0	0	607	0.34
684	11.4	0.48	0	0.018	0.215	0	0	607	0.34
696	11.6	0.48	0	0.018	0.215	0	0	608	0.34
708	11.8	0.49	0	0.018	0.215	0	0	608	0.34
720	12.0	0.50	0	0.018	0.215	0	0	608	0.34
732	12.2	0.51	0	0.018	0.215	0	0	608	0.34
744	12.4	0.52	0	0.018	0.215	0	0	609	0.34
756	12.6	0.53	0	0.018	0.215	0	0	609	0.34
768	12.8	0.53	0	0.018	0.215	0	0	609	0.34
780	13.0	0.54	0	0.018	0.215	0	0	609	0.34
792	13.2	0.55	0	0.018	0.215	0	0	609	0.34
804	13.4	0.56	0	0.018	0.215	0	0	610	0.34
816	13.6	0.57	0	0.018	0.215	0	0	610	0.34
828	13.8	0.58	0	0.018	0.215	0	0	610	0.34
840	14.0	0.58	0	0.018	0.215	0	0	610	0.34
852	14.2	0.59	0	0.018	0.215	0	0	610	0.34
864	14.4	0.60	0	0.018	0.215	0	0	611	0.34
876	14.6	0.61	0	0.018	0.215	0	0	611	0.34
888	14.8	0.62	0	0.018	0.215	0	0	611	0.34
900	15.0	0.63	0	0.018	0.215	0	0	611	0.34
912	15.2	0.63	0	0.018	0.215	0	0	612	0.34
924	15.4	0.64	0	0.018	0.215	0	0	612	0.34
936	15.6	0.65	0	0.018	0.215	0	0	612	0.34
948	15.8	0.66	0	0.018	0.215	0	0	612	0.34
960	16.0	0.67	0	0.018	0.215	0	0	612	0.34
972	16.2	0.68	0	0.018	0.215	0	0	613	0.34
984	16.4	0.68	0	0.018	0.215	0	0	613	0.34
996	16.6	0.69	0	0.018	0.215	0	0	613	0.34
1,008	16.8	0.70	0	0.018	0.215	0	0	613	0.34
1,020	17.0	0.71	0	0.018	0.215	0	0	613	0.34
1,032	17.2	0.72	0	0.018	0.215	0	0	614	0.34
1,044	17.4	0.73	0	0.018	0.215	0	0	614	0.34
1,056	17.6	0.73	0	0.018	0.215	0	0	614	0.34
1,068	17.8	0.74	0	0.018	0.215	0	0	614	0.34
1,080	18.0	0.75	0	0.018	0.215	0	0	615	0.34
1,092	18.2	0.76	0	0.018	0.215	0	0	615	0.34
1,104	18.4	0.77	0	0.018	0.215	0	0	615	0.34
1,116	18.6	0.78	0	0.018	0.215	0	0	615	0.34
1,128	18.8	0.78	0	0.018	0.215	0	0	615	0.34
1,140	19.0	0.79	0	0.018	0.215	0	0	616	0.34
1,152	19.2	0.80	0	0.018	0.215	0	0	616	0.34
1,164	19.4	0.81	0	0.018	0.215	0	0	616	0.34
1,176	19.6	0.82	0	0.018	0.215	0	0	616	0.34
1,188	19.8	0.83	0	0.018	0.215	0	0	616	0.34
1,200	20.0	0.83	0	0.018	0.215	0	0	617	0.34
1,212	20.2	0.84	0	0.018	0.215	0	0	617	0.34
1,224	20.4	0.85	0	0.018	0.215	0	0	617	0.34
1,236	20.6	0.86	0	0.018	0.215	0	0	617	0.34
1,248	20.8	0.87	0	0.018	0.215	0	0	618	0.34
1,260	21.0	0.88	0	0.018	0.215	0	0	618	0.34

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,272	21.2	0.88	0	0.018	0.215	0	0	618	0.34
1,284	21.4	0.89	0	0.018	0.215	0	0	618	0.34
1,296	21.6	0.90	0	0.018	0.215	0	0	618	0.34
1,308	21.8	0.91	0	0.018	0.215	0	0	619	0.34
1,320	22.0	0.92	0	0.018	0.215	0	0	619	0.34
1,332	22.2	0.93	0	0.018	0.215	0	0	619	0.34
1,344	22.4	0.93	0	0.018	0.215	0	0	619	0.34
1,356	22.6	0.94	0	0.018	0.215	0	0	620	0.35
1,368	22.8	0.95	0	0.018	0.215	0	0	620	0.35
1,380	23.0	0.96	0	0.018	0.215	0	0	620	0.35
1,392	23.2	0.97	0	0.018	0.215	0	0	620	0.35
1,404	23.4	0.98	0	0.018	0.215	0	0	620	0.35
1,416	23.6	0.98	0	0.018	0.215	0	0	621	0.35
1,428	23.8	0.99	0	0.018	0.215	0	0	621	0.35
1,440	24.0	1.00	0	0.018	0.215	0	0	621	0.35
1,452	24.2	1.01	0	0.018	0.215	0	0	621	0.35
1,464	24.4	1.02	0	0.018	0.215	0	0	621	0.35
1,476	24.6	1.03	0	0.018	0.215	0	0	622	0.35
1,488	24.8	1.03	0	0.018	0.215	0	0	622	0.35
1,500	25.0	1.04	0	0.018	0.215	0	0	622	0.35
1,512	25.2	1.05	0	0.018	0.215	0	0	622	0.35
1,524	25.4	1.06	0	0.018	0.215	0	0	623	0.35
1,536	25.6	1.07	0	0.018	0.215	0	0	623	0.35
1,548	25.8	1.08	0	0.018	0.215	0	0	623	0.35
1,560	26.0	1.08	0	0.018	0.215	0	0	623	0.35
1,572	26.2	1.09	0	0.018	0.215	0	0	623	0.35
1,584	26.4	1.10	0	0.018	0.215	0	0	624	0.35
1,596	26.6	1.11	0	0.018	0.215	0	0	624	0.35
1,608	26.8	1.12	0	0.018	0.215	0	0	624	0.35
1,620	27.0	1.13	0	0.018	0.215	0	0	624	0.35
1,632	27.2	1.13	0	0.018	0.215	0	0	624	0.35
1,644	27.4	1.14	0	0.018	0.215	0	0	625	0.35
1,656	27.6	1.15	0	0.018	0.215	0	0	625	0.35
1,668	27.8	1.16	0	0.018	0.215	0	0	625	0.35
1,680	28.0	1.17	0	0.018	0.215	0	0	625	0.35
1,692	28.2	1.18	0	0.018	0.215	0	0	626	0.35
1,704	28.4	1.18	0	0.018	0.215	0	0	626	0.35
1,716	28.6	1.19	0	0.018	0.215	0	0	626	0.35
1,728	28.8	1.20	0	0.018	0.215	0	0	626	0.35
1,740	29.0	1.21	0	0.018	0.215	0	0	626	0.35
1,752	29.2	1.22	0	0.018	0.215	0	0	627	0.35
1,764	29.4	1.23	0	0.018	0.215	0	0	627	0.35
1,776	29.6	1.23	0	0.018	0.215	0	0	627	0.35
1,788	29.8	1.24	0	0.018	0.215	0	0	627	0.35
1,800	30.0	1.25	0	0.018	0.215	0	0	627	0.35
1,812	30.2	1.26	0	0.018	0.215	0	0	628	0.35
1,824	30.4	1.27	0	0.018	0.215	0	0	628	0.35
1,836	30.6	1.28	0	0.018	0.215	0	0	628	0.35
1,848	30.8	1.28	0	0.018	0.215	0	0	628	0.35
1,860	31.0	1.29	0	0.018	0.215	0	0	629	0.35
1,872	31.2	1.30	0	0.018	0.215	0	0	629	0.35
1,884	31.4	1.31	0	0.018	0.215	0	0	629	0.35
1,896	31.6	1.32	0	0.018	0.215	0	0	629	0.35

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,908	31.8	1.33	0	0.018	0.215	0	0	629	0.35
1,920	32.0	1.33	0	0.018	0.215	0	0	630	0.35
1,932	32.2	1.34	0	0.018	0.215	0	0	630	0.35
1,944	32.4	1.35	0	0.018	0.215	0	0	630	0.35
1,956	32.6	1.36	0	0.018	0.215	0	0	630	0.35
1,968	32.8	1.37	0	0.018	0.215	0	0	630	0.35
1,980	33.0	1.38	0	0.018	0.215	0	0	631	0.35
1,992	33.2	1.38	0	0.018	0.215	0	0	631	0.35
2,004	33.4	1.39	0	0.018	0.215	0	0	631	0.35
2,016	33.6	1.40	0	0.018	0.215	0	0	631	0.35
2,028	33.8	1.41	0	0.018	0.215	0	0	632	0.35
2,040	34.0	1.42	0	0.018	0.215	0	0	632	0.35
2,052	34.2	1.43	0	0.018	0.215	0	0	632	0.35
2,064	34.4	1.43	0	0.018	0.215	0	0	632	0.35
2,076	34.6	1.44	0	0.018	0.215	0	0	632	0.35
2,088	34.8	1.45	0	0.018	0.215	0	0	633	0.35
2,100	35.0	1.46	0	0.018	0.215	0	0	633	0.35
2,112	35.2	1.47	0	0.018	0.215	0	0	633	0.35
2,124	35.4	1.48	0	0.018	0.215	0	0	633	0.35
2,136	35.6	1.48	0	0.018	0.215	0	0	633	0.35
2,148	35.8	1.49	0	0.018	0.215	0	0	634	0.35
2,160	36.0	1.50	0	0.018	0.215	0	0	634	0.35
2,172	36.2	1.51	0	0.018	0.215	0	0	634	0.35
2,184	36.4	1.52	0	0.018	0.215	0	0	634	0.35
2,196	36.6	1.53	0	0.018	0.215	0	0	635	0.35
2,208	36.8	1.53	0	0.018	0.215	0	0	635	0.35
2,220	37.0	1.54	0	0.018	0.215	0	0	635	0.35
2,232	37.2	1.55	0	0.018	0.215	0	0	635	0.35
2,244	37.4	1.56	0	0.018	0.215	0	0	635	0.35
2,256	37.6	1.57	0	0.018	0.215	0	0	636	0.35
2,268	37.8	1.58	0	0.018	0.215	0	0	636	0.35
2,280	38.0	1.58	0	0.018	0.215	0	0	636	0.35
2,292	38.2	1.59	0	0.018	0.215	0	0	636	0.35
2,304	38.4	1.60	0	0.018	0.215	0	0	636	0.35
2,316	38.6	1.61	0	0.018	0.215	0	0	637	0.35
2,328	38.8	1.62	0	0.018	0.215	0	0	637	0.35
2,340	39.0	1.63	0	0.018	0.215	0	0	637	0.35
2,352	39.2	1.63	0	0.018	0.215	0	0	637	0.36
2,364	39.4	1.64	0	0.018	0.215	0	0	638	0.36
2,376	39.6	1.65	0	0.018	0.215	0	0	638	0.36
2,388	39.8	1.66	0	0.018	0.215	0	0	638	0.36
2,400	40.0	1.67	0	0.018	0.215	0	0	638	0.36
2,412	40.2	1.68	0	0.018	0.215	0	0	638	0.36
2,424	40.4	1.68	0	0.018	0.215	0	0	639	0.36
2,436	40.6	1.69	0	0.018	0.215	0	0	639	0.36
2,448	40.8	1.70	0	0.018	0.215	0	0	639	0.36
2,460	41.0	1.71	0	0.018	0.215	0	0	639	0.36
2,472	41.2	1.72	0	0.018	0.215	0	0	640	0.36
2,484	41.4	1.73	0	0.018	0.215	0	0	640	0.36
2,496	41.6	1.73	0	0.018	0.215	0	0	640	0.36
2,508	41.8	1.74	0	0.018	0.215	0	0	640	0.36
2,520	42.0	1.75	0	0.018	0.215	0	0	640	0.36
2,532	42.2	1.76	0	0.018	0.215	0	0	641	0.36

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
2,544	42.4	1.77	0	0.018	0.215	0	0	641	0.36
2,556	42.6	1.78	0	0.018	0.215	0	0	641	0.36
2,568	42.8	1.78	0	0.018	0.215	0	0	641	0.36
2,580	43.0	1.79	0	0.018	0.215	0	0	641	0.36
2,592	43.2	1.80	0	0.018	0.215	0	0	642	0.36
2,604	43.4	1.81	0	0.018	0.215	0	0	642	0.36
2,616	43.6	1.82	0	0.018	0.215	0	0	642	0.36
2,628	43.8	1.83	0	0.018	0.215	0	0	642	0.36
2,640	44.0	1.83	0	0.018	0.215	0	0	643	0.36
2,652	44.2	1.84	0	0.018	0.215	0	0	643	0.36
2,664	44.4	1.85	0	0.018	0.215	0	0	643	0.36
2,676	44.6	1.86	0	0.018	0.215	0	0	643	0.36
2,688	44.8	1.87	0	0.018	0.215	0	0	643	0.36
2,700	45.0	1.88	0	0.018	0.215	0	0	644	0.36
2,712	45.2	1.88	0	0.018	0.215	0	0	644	0.36
2,724	45.4	1.89	0	0.018	0.215	0	0	644	0.36
2,736	45.6	1.90	0	0.018	0.215	0	0	644	0.36
2,748	45.8	1.91	0	0.018	0.215	0	0	644	0.36
2,760	46.0	1.92	0	0.018	0.215	0	0	645	0.36
2,772	46.2	1.93	0	0.018	0.215	0	0	645	0.36
2,784	46.4	1.93	0	0.018	0.215	0	0	645	0.36
2,796	46.6	1.94	0	0.018	0.215	0	0	645	0.36
2,808	46.8	1.95	0	0.018	0.215	0	0	646	0.36
2,820	47.0	1.96	0	0.018	0.215	0	0	646	0.36
2,832	47.2	1.97	0	0.018	0.215	0	0	646	0.36
2,844	47.4	1.98	0	0.018	0.215	0	0	646	0.36
2,856	47.6	1.98	0	0.018	0.215	0	0	646	0.36
2,868	47.8	1.99	0	0.018	0.215	0	0	647	0.36
2,880	48.0	2.00	0	0.018	0.215	0	0	647	0.36
2,892	48.2	2.01	0	0.018	0.215	0	0	647	0.36
2,904	48.4	2.02	0	0.018	0.215	0	0	647	0.36
2,916	48.6	2.03	0	0.018	0.215	0	0	647	0.36
2,928	48.8	2.03	0	0.018	0.215	0	0	648	0.36
2,940	49.0	2.04	0	0.018	0.215	0	0	648	0.36
2,952	49.2	2.05	0	0.018	0.215	0	0	648	0.36
2,964	49.4	2.06	0	0.018	0.215	0	0	648	0.36
2,976	49.6	2.07	0	0.018	0.215	0	0	649	0.36
2,988	49.8	2.08	0	0.018	0.215	0	0	649	0.36
3,000	50.0	2.08	0	0.018	0.215	0	0	649	0.36
3,012	50.2	2.09	0	0.018	0.215	0	0	649	0.36
3,024	50.4	2.10	0	0.018	0.215	0	0	649	0.36
3,036	50.6	2.11	0	0.018	0.215	0	0	650	0.36
3,048	50.8	2.12	0	0.018	0.215	0	0	650	0.36
3,060	51.0	2.13	0	0.018	0.215	0	0	650	0.36
3,072	51.2	2.13	0	0.018	0.215	0	0	650	0.36
3,084	51.4	2.14	0	0.018	0.215	0	0	650	0.36
3,096	51.6	2.15	0	0.018	0.215	0	0	651	0.36
3,108	51.8	2.16	0	0.018	0.215	0	0	651	0.36
3,120	52.0	2.17	0	0.018	0.215	0	0	651	0.36
3,132	52.2	2.18	0	0.018	0.215	0	0	651	0.36
3,144	52.4	2.18	0	0.018	0.215	0	0	652	0.36
3,156	52.6	2.19	0	0.018	0.215	0	0	652	0.36
3,168	52.8	2.20	0	0.018	0.215	0	0	652	0.36

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,180	53.0	2.21	0	0.018	0.215	0	0	652	0.36
3,192	53.2	2.22	0	0.018	0.215	0	0	652	0.36
3,204	53.4	2.23	0	0.018	0.215	0	0	653	0.36
3,216	53.6	2.23	0	0.018	0.215	0	0	653	0.36
3,228	53.8	2.24	0	0.018	0.215	0	0	653	0.36
3,240	54.0	2.25	0	0.018	0.215	0	0	653	0.36
3,252	54.2	2.26	0	0.018	0.215	0	0	653	0.36
3,264	54.4	2.27	0	0.018	0.215	0	0	654	0.36
3,276	54.6	2.28	0	0.018	0.215	0	0	654	0.36
3,288	54.8	2.28	0	0.018	0.215	0	0	654	0.36
3,300	55.0	2.29	0	0.018	0.215	0	0	654	0.36
3,312	55.2	2.30	0	0.018	0.215	0	0	655	0.36
3,324	55.4	2.31	0	0.018	0.215	0	0	655	0.36
3,336	55.6	2.32	0	0.018	0.215	0	0	655	0.36
3,348	55.8	2.33	0	0.018	0.215	0	0	655	0.36
3,360	56.0	2.33	0	0.018	0.215	0	0	655	0.37
3,372	56.2	2.34	0	0.018	0.215	0	0	656	0.37
3,384	56.4	2.35	0	0.018	0.215	0	0	656	0.37
3,396	56.6	2.36	0	0.018	0.215	0	0	656	0.37
3,408	56.8	2.37	0	0.018	0.215	0	0	656	0.37
3,420	57.0	2.38	0	0.018	0.215	0	0	657	0.37
3,432	57.2	2.38	0	0.018	0.215	0	0	657	0.37
3,444	57.4	2.39	0	0.018	0.215	0	0	657	0.37
3,456	57.6	2.40	0	0.018	0.215	0	0	657	0.37
3,468	57.8	2.41	0	0.018	0.215	0	0	657	0.37
3,480	58.0	2.42	0	0.018	0.215	0	0	658	0.37
3,492	58.2	2.43	0	0.018	0.215	0	0	658	0.37
3,504	58.4	2.43	0	0.018	0.215	0	0	658	0.37
3,516	58.6	2.44	0	0.018	0.215	0	0	658	0.37
3,528	58.8	2.45	0	0.018	0.215	0	0	658	0.37
3,540	59.0	2.46	0	0.018	0.215	0	0	659	0.37
3,552	59.2	2.47	0	0.018	0.215	0	0	659	0.37
3,564	59.4	2.48	0	0.018	0.215	0	0	659	0.37
3,576	59.6	2.48	0	0.018	0.215	0	0	659	0.37
3,588	59.8	2.49	0	0.018	0.215	0	0	660	0.37
3,600	60.0	2.50	0	0.018	0.215	0	0	660	0.37
3,612	60.2	2.51	0	0.018	0.215	0	0	660	0.37
3,624	60.4	2.52	0	0.018	0.215	0	0	660	0.37
3,636	60.6	2.53	0	0.018	0.215	0	0	660	0.37
3,648	60.8	2.53	0	0.018	0.215	0	0	661	0.37
3,660	61.0	2.54	0	0.018	0.215	0	0	661	0.37
3,672	61.2	2.55	0	0.018	0.215	0	0	661	0.37
3,684	61.4	2.56	0	0.018	0.215	0	0	661	0.37
3,696	61.6	2.57	0	0.018	0.215	0	0	661	0.37
3,708	61.8	2.58	0	0.018	0.215	0	0	662	0.37
3,720	62.0	2.58	0	0.018	0.215	0	0	662	0.37
3,732	62.2	2.59	0	0.018	0.215	0	0	662	0.37
3,744	62.4	2.60	0	0.018	0.215	0	0	662	0.37
3,756	62.6	2.61	0	0.018	0.215	0	0	663	0.37
3,768	62.8	2.62	0	0.018	0.215	0	0	663	0.37
3,780	63.0	2.63	0	0.018	0.215	0	0	663	0.37
3,792	63.2	2.63	0	0.018	0.215	0	0	663	0.37
3,804	63.4	2.64	0	0.018	0.215	0	0	663	0.37

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,816	63.6	2.65	0	0.018	0.215	0	0	664	0.37
3,828	63.8	2.66	0	0.018	0.215	0	0	664	0.37
3,840	64.0	2.67	0	0.018	0.215	0	0	664	0.37
3,852	64.2	2.68	0	0.018	0.215	0	0	664	0.37
3,864	64.4	2.68	0	0.018	0.215	0	0	664	0.37
3,876	64.6	2.69	0	0.018	0.215	0	0	665	0.37
3,888	64.8	2.70	0	0.018	0.215	0	0	665	0.37
3,900	65.0	2.71	0	0.018	0.215	0	0	665	0.37
3,912	65.2	2.72	0	0.018	0.215	0	0	665	0.37
3,924	65.4	2.73	0	0.018	0.215	0	0	666	0.37
3,936	65.6	2.73	0	0.018	0.215	0	0	666	0.37
3,948	65.8	2.74	0	0.018	0.215	0	0	666	0.37
3,960	66.0	2.75	0	0.018	0.215	0	0	666	0.37
3,972	66.2	2.76	0	0.018	0.215	0	0	666	0.37
3,984	66.4	2.77	0	0.018	0.215	0	0	667	0.37
3,996	66.6	2.78	0	0.018	0.215	0	0	667	0.37
4,008	66.8	2.78	0	0.018	0.215	0	0	667	0.37
4,020	67.0	2.79	0	0.018	0.215	0	0	667	0.37
4,032	67.2	2.80	0	0.018	0.215	0	0	667	0.37
4,044	67.4	2.81	0	0.018	0.215	0	0	668	0.37
4,056	67.6	2.82	0	0.018	0.215	0	0	668	0.37
4,068	67.8	2.83	0	0.018	0.215	0	0	668	0.37
4,080	68.0	2.83	0	0.018	0.215	0	0	668	0.37
4,092	68.2	2.84	0	0.018	0.215	0	0	669	0.37
4,104	68.4	2.85	0	0.018	0.215	0	0	669	0.37
4,116	68.6	2.86	0	0.018	0.215	0	0	669	0.37
4,128	68.8	2.87	0	0.018	0.215	0	0	669	0.37
4,140	69.0	2.88	0	0.018	0.215	0	0	669	0.37
4,152	69.2	2.88	0	0.018	0.215	0	0	670	0.37
4,164	69.4	2.89	0	0.018	0.215	0	0	670	0.37
4,176	69.6	2.90	0	0.018	0.215	0	0	670	0.37
4,188	69.8	2.91	0	0.018	0.215	0	0	670	0.37
4,200	70.0	2.92	0	0.018	0.215	0	0	670	0.37
4,212	70.2	2.93	0	0.018	0.215	0	0	671	0.37
4,224	70.4	2.93	0	0.018	0.215	0	0	671	0.37
4,236	70.6	2.94	0	0.018	0.215	0	0	671	0.37
4,248	70.8	2.95	0	0.018	0.215	0	0	671	0.37
4,260	71.0	2.96	0	0.018	0.215	0	0	672	0.37
4,272	71.2	2.97	0	0.018	0.215	0	0	672	0.37
4,284	71.4	2.98	0	0.018	0.215	0	0	672	0.37
4,296	71.6	2.98	0	0.018	0.215	0	0	672	0.37
4,308	71.8	2.99	0	0.018	0.215	0	0	672	0.37
4,320	72.0	3.00	0	0.018	0.215	0	0	673	0.37
4,332	72.2	3.01	0	0.018	0.215	0	0	673	0.37
4,344	72.4	3.02	0	0.018	0.215	0	0	673	0.37
4,356	72.6	3.03	0	0.018	0.215	0	0	673	0.38
4,368	72.8	3.03	0	0.018	0.215	0	0	673	0.38
4,380	73.0	3.04	0	0.018	0.215	0	0	674	0.38
4,392	73.2	3.05	0	0.018	0.215	0	0	674	0.38
4,404	73.4	3.06	0	0.018	0.215	0	0	674	0.38
4,416	73.6	3.07	0	0.018	0.215	0	0	674	0.38
4,428	73.8	3.08	0	0.018	0.215	0	0	675	0.38
4,440	74.0	3.08	0	0.018	0.215	0	0	675	0.38

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,452	74.2	3.09	0	0.018	0.215	0	0	675	0.38
4,464	74.4	3.10	0	0.018	0.215	0	0	675	0.38
4,476	74.6	3.11	0	0.018	0.215	0	0	675	0.38
4,488	74.8	3.12	0	0.018	0.215	0	0	676	0.38
4,500	75.0	3.13	0	0.018	0.215	0	0	676	0.38
4,512	75.2	3.13	0	0.018	0.215	0	0	676	0.38
4,524	75.4	3.14	0	0.018	0.215	0	0	676	0.38
4,536	75.6	3.15	0	0.018	0.215	0	0	677	0.38
4,548	75.8	3.16	0	0.018	0.215	0	0	677	0.38
4,560	76.0	3.17	0	0.018	0.215	0	0	677	0.38
4,572	76.2	3.18	0	0.018	0.215	0	0	677	0.38
4,584	76.4	3.18	0	0.018	0.215	0	0	677	0.38
4,596	76.6	3.19	0	0.018	0.215	0	0	678	0.38
4,608	76.8	3.20	0	0.018	0.215	0	0	678	0.38
4,620	77.0	3.21	0	0.018	0.215	0	0	678	0.38
4,632	77.2	3.22	0	0.018	0.215	0	0	678	0.38
4,644	77.4	3.23	0	0.018	0.215	0	0	678	0.38
4,656	77.6	3.23	0	0.018	0.215	0	0	679	0.38
4,668	77.8	3.24	0	0.018	0.215	0	0	679	0.38
4,680	78.0	3.25	0	0.018	0.215	0	0	679	0.38
4,692	78.2	3.26	0	0.018	0.215	0	0	679	0.38
4,704	78.4	3.27	0	0.018	0.215	0	0	680	0.38
4,716	78.6	3.28	0	0.018	0.215	0	0	680	0.38
4,728	78.8	3.28	0	0.018	0.215	0	0	680	0.38
4,740	79.0	3.29	0	0.018	0.215	0	0	680	0.38
4,752	79.2	3.30	0	0.018	0.215	0	0	680	0.38
4,764	79.4	3.31	0	0.018	0.215	0	0	681	0.38
4,776	79.6	3.32	0	0.018	0.215	0	0	681	0.38
4,788	79.8	3.33	0	0.018	0.215	0	0	681	0.38
4,800	80.0	3.33	0	0.018	0.215	0	0	681	0.38
4,812	80.2	3.34	0	0.018	0.215	0	0	681	0.38
4,824	80.4	3.35	0	0.018	0.215	0	0	682	0.38
4,836	80.6	3.36	0	0.018	0.215	0	0	682	0.38
4,848	80.8	3.37	0	0.018	0.215	0	0	682	0.38
4,860	81.0	3.38	0	0.018	0.215	0	0	682	0.38
4,872	81.2	3.38	0	0.018	0.215	0	0	683	0.38
4,884	81.4	3.39	0	0.018	0.215	0	0	683	0.38
4,896	81.6	3.40	0	0.018	0.215	0	0	683	0.38
4,908	81.8	3.41	0	0.018	0.215	0	0	683	0.38
4,920	82.0	3.42	0	0.018	0.215	0	0	683	0.38
4,932	82.2	3.43	0	0.018	0.215	0	0	684	0.38
4,944	82.4	3.43	0	0.018	0.215	0	0	684	0.38
4,956	82.6	3.44	0	0.018	0.215	0	0	684	0.38
4,968	82.8	3.45	0	0.018	0.215	0	0	684	0.38
4,980	83.0	3.46	0	0.018	0.215	0	0	684	0.38
4,992	83.2	3.47	0	0.018	0.215	0	0	685	0.38
5,004	83.4	3.48	0	0.018	0.215	0	0	685	0.38
5,016	83.6	3.48	0	0.018	0.215	0	0	685	0.38
5,028	83.8	3.49	0	0.018	0.215	0	0	685	0.38
5,040	84.0	3.50	0	0.018	0.215	0	0	686	0.38
5,052	84.2	3.51	0	0.018	0.215	0	0	686	0.38
5,064	84.4	3.52	0	0.018	0.215	0	0	686	0.38
5,076	84.6	3.53	0	0.018	0.215	0	0	686	0.38

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,088	84.8	3.53	0	0.018	0.215	0	0	686	0.38
5,100	85.0	3.54	0	0.018	0.215	0	0	687	0.38
5,112	85.2	3.55	0	0.018	0.215	0	0	687	0.38
5,124	85.4	3.56	0	0.018	0.215	0	0	687	0.38
5,136	85.6	3.57	0	0.018	0.215	0	0	687	0.38
5,148	85.8	3.58	0	0.018	0.215	0	0	687	0.38
5,160	86.0	3.58	0	0.018	0.215	0	0	688	0.38
5,172	86.2	3.59	0	0.018	0.215	0	0	688	0.38
5,184	86.4	3.60	0	0.018	0.215	0	0	688	0.38
5,196	86.6	3.61	0	0.018	0.215	0	0	688	0.38
5,208	86.8	3.62	0	0.018	0.215	0	0	689	0.38
5,220	87.0	3.63	0	0.018	0.215	0	0	689	0.38
5,232	87.2	3.63	0	0.018	0.215	0	0	689	0.38
5,244	87.4	3.64	0	0.018	0.215	0	0	689	0.38
5,256	87.6	3.65	0	0.018	0.215	0	0	689	0.38
5,268	87.8	3.66	0	0.018	0.215	0	0	690	0.38
5,280	88.0	3.67	0	0.018	0.215	0	0	690	0.38
5,292	88.2	3.68	0	0.018	0.215	0	0	690	0.38
5,304	88.4	3.68	0	0.018	0.215	0	0	690	0.38
5,316	88.6	3.69	0	0.018	0.215	0	0	690	0.38
5,328	88.8	3.70	0	0.018	0.215	0	0	691	0.38
5,340	89.0	3.71	0	0.018	0.215	0	0	691	0.38
5,352	89.2	3.72	0	0.018	0.215	0	0	691	0.38
5,364	89.4	3.73	0	0.018	0.215	0	0	691	0.39
5,376	89.6	3.73	0	0.018	0.215	0	0	692	0.39
5,388	89.8	3.74	0	0.018	0.215	0	0	692	0.39
5,400	90.0	3.75	0	0.018	0.215	0	0	692	0.39
5,412	90.2	3.76	0	0.018	0.215	0	0	692	0.39
5,424	90.4	3.77	0	0.018	0.215	0	0	692	0.39
5,436	90.6	3.78	0	0.018	0.215	0	0	693	0.39
5,448	90.8	3.78	0	0.018	0.215	0	0	693	0.39
5,460	91.0	3.79	0	0.018	0.215	0	0	693	0.39
5,472	91.2	3.80	0	0.018	0.215	0	0	693	0.39
5,484	91.4	3.81	0	0.018	0.215	0	0	694	0.39
5,496	91.6	3.82	0	0.018	0.215	0	0	694	0.39
5,508	91.8	3.83	0	0.018	0.215	0	0	694	0.39
5,520	92.0	3.83	0	0.018	0.215	0	0	694	0.39
5,532	92.2	3.84	0	0.018	0.215	0	0	694	0.39
5,544	92.4	3.85	0	0.018	0.215	0	0	695	0.39
5,556	92.6	3.86	0	0.018	0.215	0	0	695	0.39
5,568	92.8	3.87	0	0.018	0.215	0	0	695	0.39
5,580	93.0	3.88	0	0.018	0.215	0	0	695	0.39
5,592	93.2	3.88	0	0.018	0.215	0	0	695	0.39
5,604	93.4	3.89	0	0.018	0.215	0	0	696	0.39
5,616	93.6	3.90	0	0.018	0.215	0	0	696	0.39
5,628	93.8	3.91	0	0.018	0.215	0	0	696	0.39
5,640	94.0	3.92	0	0.018	0.215	0	0	696	0.39
5,652	94.2	3.93	0	0.018	0.215	0	0	697	0.39
5,664	94.4	3.93	0	0.018	0.215	0	0	697	0.39
5,676	94.6	3.94	0	0.018	0.215	0	0	697	0.39
5,688	94.8	3.95	0	0.018	0.215	0	0	697	0.39
5,700	95.0	3.96	0	0.018	0.215	0	0	697	0.39
5,712	95.2	3.97	0	0.018	0.215	0	0	698	0.39

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,724	95.4	3.98	0	0.018	0.215	0	0	698	0.39
5,736	95.6	3.98	0	0.018	0.215	0	0	698	0.39
5,748	95.8	3.99	0	0.018	0.215	0	0	698	0.39
5,760	96.0	4.00	0	0.018	0.215	0	0	698	0.39
5,772	96.2	4.01	0	0.018	0.215	0	0	699	0.39
5,784	96.4	4.02	0	0.018	0.215	0	0	699	0.39
5,796	96.6	4.03	0	0.018	0.215	0	0	699	0.39
5,808	96.8	4.03	0	0.018	0.215	0	0	699	0.39
5,820	97.0	4.04	0	0.018	0.215	0	0	700	0.39
5,832	97.2	4.05	0	0.018	0.215	0	0	700	0.39
5,844	97.4	4.06	0	0.018	0.215	0	0	700	0.39
5,856	97.6	4.07	0	0.018	0.215	0	0	700	0.39
5,868	97.8	4.08	0	0.018	0.215	0	0	700	0.39
5,880	98.0	4.08	0	0.018	0.215	0	0	701	0.39
5,892	98.2	4.09	0	0.018	0.215	0	0	701	0.39
5,904	98.4	4.10	0	0.018	0.215	0	0	701	0.39
5,916	98.6	4.11	0	0.018	0.215	0	0	701	0.39
5,928	98.8	4.12	0	0.018	0.215	0	0	701	0.39
5,940	99.0	4.13	0	0.018	0.215	0	0	702	0.39
5,952	99.2	4.13	0	0.018	0.215	0	0	702	0.39
5,964	99.4	4.14	0	0.018	0.215	0	0	702	0.39
5,976	99.6	4.15	0	0.018	0.215	0	0	702	0.39
5,988	99.8	4.16	0	0.018	0.215	0	0	703	0.39
6,000	100.0	4.17	0	0.018	0.215	0	0	703	0.39
6,012	100.2	4.18	0	0.018	0.215	0	0	703	0.39
6,024	100.4	4.18	0	0.018	0.215	0	0	703	0.39
6,036	100.6	4.19	0	0.018	0.215	0	0	703	0.39
6,048	100.8	4.20	0	0.018	0.215	0	0	704	0.39
6,060	101.0	4.21	0	0.018	0.215	0	0	704	0.39
6,072	101.2	4.22	0	0.018	0.215	0	0	704	0.39
6,084	101.4	4.23	0	0.018	0.215	0	0	704	0.39
6,096	101.6	4.23	0	0.018	0.215	0	0	704	0.39
6,108	101.8	4.24	0	0.018	0.215	0	0	705	0.39
6,120	102.0	4.25	0	0.018	0.215	0	0	705	0.39
6,132	102.2	4.26	0	0.018	0.215	0	0	705	0.39
6,144	102.4	4.27	0	0.018	0.215	0	0	705	0.39
6,156	102.6	4.28	0	0.018	0.215	0	0	706	0.39
6,168	102.8	4.28	0	0.018	0.215	0	0	706	0.39
6,180	103.0	4.29	0	0.018	0.215	0	0	706	0.39
6,192	103.2	4.30	0	0.018	0.215	0	0	706	0.39
6,204	103.4	4.31	0	0.018	0.215	0	0	706	0.39
6,216	103.6	4.32	0	0.018	0.215	0	0	707	0.39
6,228	103.8	4.33	0	0.018	0.215	0	0	707	0.39
6,240	104.0	4.33	0	0.018	0.215	0	0	707	0.39
6,252	104.2	4.34	0	0.018	0.215	0	0	707	0.39
6,264	104.4	4.35	0	0.018	0.215	0	0	707	0.39
6,276	104.6	4.36	0	0.018	0.215	0	0	708	0.39
6,288	104.8	4.37	0	0.018	0.215	0	0	708	0.39
6,300	105.0	4.38	0	0.018	0.215	0	0	708	0.39
6,312	105.2	4.38	0	0.018	0.215	0	0	708	0.39
6,324	105.4	4.39	0	0.018	0.215	0	0	709	0.39
6,336	105.6	4.40	0	0.018	0.215	0	0	709	0.39
6,348	105.8	4.41	0	0.018	0.215	0	0	709	0.39

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,360	106.0	4.42	0	0.018	0.215	0	0	709	0.40
6,372	106.2	4.43	0	0.018	0.215	0	0	709	0.40
6,384	106.4	4.43	0	0.018	0.215	0	0	710	0.40
6,396	106.6	4.44	0	0.018	0.215	0	0	710	0.40
6,408	106.8	4.45	0	0.018	0.215	0	0	710	0.40
6,420	107.0	4.46	0	0.018	0.215	0	0	710	0.40
6,432	107.2	4.47	0	0.018	0.215	0	0	710	0.40
6,444	107.4	4.48	0	0.018	0.215	0	0	711	0.40
6,456	107.6	4.48	0	0.018	0.215	0	0	711	0.40
6,468	107.8	4.49	0	0.018	0.215	0	0	711	0.40
6,480	108.0	4.50	0	0.018	0.215	0	0	711	0.40
6,492	108.2	4.51	0	0.018	0.215	0	0	712	0.40
6,504	108.4	4.52	0	0.018	0.215	0	0	712	0.40
6,516	108.6	4.53	0	0.018	0.215	0	0	712	0.40
6,528	108.8	4.53	0	0.018	0.215	0	0	712	0.40
6,540	109.0	4.54	0	0.018	0.215	0	0	712	0.40
6,552	109.2	4.55	0	0.018	0.215	0	0	713	0.40
6,564	109.4	4.56	0	0.018	0.215	0	0	713	0.40
6,576	109.6	4.57	0	0.018	0.215	0	0	713	0.40
6,588	109.8	4.58	0	0.018	0.215	0	0	713	0.40
6,600	110.0	4.58	0	0.018	0.215	0	0	714	0.40
6,612	110.2	4.59	0	0.018	0.215	0	0	714	0.40
6,624	110.4	4.60	0	0.018	0.215	0	0	714	0.40
6,636	110.6	4.61	0	0.018	0.215	0	0	714	0.40
6,648	110.8	4.62	0	0.018	0.215	0	0	714	0.40
6,660	111.0	4.63	0	0.018	0.215	0	0	715	0.40
6,672	111.2	4.63	0	0.018	0.215	0	0	715	0.40
6,684	111.4	4.64	0	0.018	0.215	0	0	715	0.40
6,696	111.6	4.65	0	0.018	0.215	0	0	715	0.40
6,708	111.8	4.66	0	0.018	0.215	0	0	715	0.40
6,720	112.0	4.67	0	0.018	0.215	0	0	716	0.40
6,732	112.2	4.68	0	0.018	0.215	0	0	716	0.40
6,744	112.4	4.68	0	0.018	0.215	0	0	716	0.40
6,756	112.6	4.69	0	0.018	0.215	0	0	716	0.40
6,768	112.8	4.70	0	0.018	0.215	0	0	717	0.40
6,780	113.0	4.71	0	0.018	0.215	0	0	717	0.40
6,792	113.2	4.72	0	0.018	0.215	0	0	717	0.40
6,804	113.4	4.73	0	0.018	0.215	0	0	717	0.40
6,816	113.6	4.73	0	0.018	0.215	0	0	717	0.40
6,828	113.8	4.74	0	0.018	0.215	0	0	718	0.40
6,840	114.0	4.75	0	0.018	0.215	0	0	718	0.40
6,852	114.2	4.76	0	0.018	0.215	0	0	718	0.40
6,864	114.4	4.77	0	0.018	0.215	0	0	718	0.40
6,876	114.6	4.78	0	0.018	0.215	0	0	718	0.40
6,888	114.8	4.78	0	0.018	0.215	0	0	719	0.40
6,900	115.0	4.79	0	0.018	0.215	0	0	719	0.40
6,912	115.2	4.80	0	0.018	0.215	0	0	719	0.40
6,924	115.4	4.81	0	0.018	0.215	0	0	719	0.40
6,936	115.6	4.82	0	0.018	0.215	0	0	720	0.40
6,948	115.8	4.83	0	0.018	0.215	0	0	720	0.40
6,960	116.0	4.83	0	0.018	0.215	0	0	720	0.40
6,972	116.2	4.84	0	0.018	0.215	0	0	720	0.40
6,984	116.4	4.85	0	0.018	0.215	0	0	720	0.40

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,996	116.6	4.86	0	0.018	0.215	0	0	721	0.40
7,008	116.8	4.87	0	0.018	0.215	0	0	721	0.40
7,020	117.0	4.88	0	0.018	0.215	0	0	721	0.40
7,032	117.2	4.88	0	0.018	0.215	0	0	721	0.40
7,044	117.4	4.89	0	0.018	0.215	0	0	721	0.40
7,056	117.6	4.90	0	0.018	0.215	0	0	722	0.40
7,068	117.8	4.91	0	0.018	0.215	0	0	722	0.40
7,080	118.0	4.92	0	0.018	0.215	0	0	722	0.40
7,092	118.2	4.93	0	0.018	0.215	0	0	722	0.40
7,104	118.4	4.93	0	0.018	0.215	0	0	723	0.40
7,116	118.6	4.94	0	0.018	0.215	0	0	723	0.40
7,128	118.8	4.95	0	0.018	0.215	0	0	723	0.40
7,140	119.0	4.96	0	0.018	0.215	0	0	723	0.40
7,152	119.2	4.97	0	0.018	0.215	0	0	723	0.40
7,164	119.4	4.98	0	0.018	0.215	0	0	724	0.40
7,176	119.6	4.98	0	0.018	0.215	0	0	724	0.40
7,188	119.8	4.99	0	0.018	0.215	0	0	724	0.40
7,200	120.0	5.00	0	0.018	0.215	0	0	724	0.40
7,212	120.2	5.01	0	0.018	0.215	0	0	724	0.40
7,224	120.4	5.02	0	0.018	0.215	0	0	725	0.40
7,236	120.6	5.03	0	0.018	0.215	0	0	725	0.40
7,248	120.8	5.03	0	0.018	0.215	0	0	725	0.40
7,260	121.0	5.04	0	0.018	0.215	0	0	725	0.40
7,272	121.2	5.05	0	0.018	0.215	0	0	726	0.40
7,284	121.4	5.06	0	0.018	0.215	0	0	726	0.40
7,296	121.6	5.07	0	0.018	0.215	0	0	726	0.40
7,308	121.8	5.08	0	0.018	0.215	0	0	726	0.40
7,320	122.0	5.08	0	0.018	0.215	0	0	726	0.40
7,332	122.2	5.09	0	0.018	0.215	0	0	727	0.40
7,344	122.4	5.10	0	0.018	0.215	0	0	727	0.40
7,356	122.6	5.11	0	0.018	0.215	0	0	727	0.41
7,368	122.8	5.12	0	0.018	0.215	0	0	727	0.41
7,380	123.0	5.13	0	0.018	0.215	0	0	727	0.41
7,392	123.2	5.13	0	0.018	0.215	0	0	728	0.41
7,404	123.4	5.14	0	0.018	0.215	0	0	728	0.41
7,416	123.6	5.15	0	0.018	0.215	0	0	728	0.41
7,428	123.8	5.16	0	0.018	0.215	0	0	728	0.41
7,440	124.0	5.17	0	0.018	0.215	0	0	729	0.41
7,452	124.2	5.18	0	0.018	0.215	0	0	729	0.41
7,464	124.4	5.18	0	0.018	0.215	0	0	729	0.41
7,476	124.6	5.19	0	0.018	0.215	0	0	729	0.41
7,488	124.8	5.20	0	0.018	0.215	0	0	729	0.41
7,500	125.0	5.21	0	0.018	0.215	0	0	730	0.41
7,512	125.2	5.22	0	0.018	0.215	0	0	730	0.41
7,524	125.4	5.23	0	0.018	0.215	0	0	730	0.41
7,536	125.6	5.23	0	0.018	0.215	0	0	730	0.41
7,548	125.8	5.24	0	0.018	0.215	0	0	730	0.41
7,560	126.0	5.25	0	0.018	0.215	0	0	731	0.41
7,572	126.2	5.26	0	0.018	0.215	0	0	731	0.41
7,584	126.4	5.27	0	0.018	0.215	0	0	731	0.41
7,596	126.6	5.28	0	0.018	0.215	0	0	731	0.41
7,608	126.8	5.28	0	0.018	0.215	0	0	732	0.41
7,620	127.0	5.29	0	0.018	0.215	0	0	732	0.41

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,632	127.2	5.30	0	0.018	0.215	0	0	732	0.41
7,644	127.4	5.31	0	0.018	0.215	0	0	732	0.41
7,656	127.6	5.32	0	0.018	0.215	0	0	732	0.41
7,668	127.8	5.33	0	0.018	0.215	0	0	733	0.41
7,680	128.0	5.33	0	0.018	0.215	0	0	733	0.41
7,692	128.2	5.34	0	0.018	0.215	0	0	733	0.41
7,704	128.4	5.35	0	0.018	0.215	0	0	733	0.41
7,716	128.6	5.36	0	0.018	0.215	0	0	734	0.41
7,728	128.8	5.37	0	0.018	0.215	0	0	734	0.41
7,740	129.0	5.38	0	0.018	0.215	0	0	734	0.41
7,752	129.2	5.38	0	0.018	0.215	0	0	734	0.41
7,764	129.4	5.39	0	0.018	0.215	0	0	734	0.41
7,776	129.6	5.40	0	0.018	0.215	0	0	735	0.41
7,788	129.8	5.41	0	0.018	0.215	0	0	735	0.41
7,800	130.0	5.42	0	0.018	0.215	0	0	735	0.41
7,812	130.2	5.43	0	0.018	0.215	0	0	735	0.41
7,824	130.4	5.43	0	0.018	0.215	0	0	735	0.41
7,836	130.6	5.44	0	0.018	0.215	0	0	736	0.41
7,848	130.8	5.45	0	0.018	0.215	0	0	736	0.41
7,860	131.0	5.46	0	0.018	0.215	0	0	736	0.41
7,872	131.2	5.47	0	0.018	0.215	0	0	736	0.41
7,884	131.4	5.48	0	0.018	0.215	0	0	737	0.41
7,896	131.6	5.48	0	0.018	0.215	0	0	737	0.41
7,908	131.8	5.49	0	0.018	0.215	0	0	737	0.41
7,920	132.0	5.50	0	0.018	0.215	0	0	737	0.41
7,932	132.2	5.51	0	0.018	0.215	0	0	737	0.41
7,944	132.4	5.52	0	0.018	0.215	0	0	738	0.41
7,956	132.6	5.53	0	0.018	0.215	0	0	738	0.41
7,968	132.8	5.53	0	0.018	0.215	0	0	738	0.41
7,980	133.0	5.54	0	0.018	0.215	0	0	738	0.41
7,992	133.2	5.55	0	0.018	0.215	0	0	738	0.41
8,004	133.4	5.56	0	0.018	0.215	0	0	739	0.41
8,016	133.6	5.57	0	0.018	0.215	0	0	739	0.41
8,028	133.8	5.58	0	0.018	0.215	0	0	739	0.41
8,040	134.0	5.58	0	0.018	0.215	0	0	739	0.41
8,052	134.2	5.59	0	0.018	0.215	0	0	740	0.41
8,064	134.4	5.60	0	0.018	0.215	0	0	740	0.41
8,076	134.6	5.61	0	0.018	0.215	0	0	740	0.41
8,088	134.8	5.62	0	0.018	0.215	0	0	740	0.41
8,100	135.0	5.63	0	0.018	0.215	0	0	740	0.41
8,112	135.2	5.63	0	0.018	0.215	0	0	741	0.41
8,124	135.4	5.64	0	0.018	0.215	0	0	741	0.41
8,136	135.6	5.65	0	0.018	0.215	0	0	741	0.41
8,148	135.8	5.66	0	0.018	0.215	0	0	741	0.41
8,160	136.0	5.67	0	0.018	0.215	0	0	741	0.41
8,172	136.2	5.68	0	0.018	0.215	0	0	742	0.41
8,184	136.4	5.68	0	0.018	0.215	0	0	742	0.41
8,196	136.6	5.69	0	0.018	0.215	0	0	742	0.41
8,208	136.8	5.70	0	0.018	0.215	0	0	742	0.41
8,220	137.0	5.71	0	0.018	0.215	0	0	743	0.41
8,232	137.2	5.72	0	0.018	0.215	0	0	743	0.41
8,244	137.4	5.73	0	0.018	0.215	0	0	743	0.41
8,256	137.6	5.73	0	0.018	0.215	0	0	743	0.41

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,268	137.8	5.74	0	0.018	0.215	0	0	743	0.41
8,280	138.0	5.75	0	0.018	0.215	0	0	744	0.41
8,292	138.2	5.76	0	0.018	0.215	0	0	744	0.41
8,304	138.4	5.77	0	0.018	0.215	0	0	744	0.41
8,316	138.6	5.78	0	0.018	0.215	0	0	744	0.41
8,328	138.8	5.78	0	0.018	0.215	0	0	744	0.41
8,340	139.0	5.79	0	0.018	0.215	0	0	745	0.41
8,352	139.2	5.80	0	0.018	0.215	0	0	745	0.41
8,364	139.4	5.81	0	0.018	0.215	0	0	745	0.42
8,376	139.6	5.82	0	0.018	0.215	0	0	745	0.42
8,388	139.8	5.83	0	0.018	0.215	0	0	746	0.42
8,400	140.0	5.83	0	0.018	0.215	0	0	746	0.42
8,412	140.2	5.84	0	0.018	0.215	0	0	746	0.42
8,424	140.4	5.85	0	0.018	0.215	0	0	746	0.42
8,436	140.6	5.86	0	0.018	0.215	0	0	746	0.42
8,448	140.8	5.87	0	0.018	0.215	0	0	747	0.42
8,460	141.0	5.88	0	0.018	0.215	0	0	747	0.42
8,472	141.2	5.88	0	0.018	0.215	0	0	747	0.42
8,484	141.4	5.89	0	0.018	0.215	0	0	747	0.42
8,496	141.6	5.90	0	0.018	0.215	0	0	747	0.42
8,508	141.8	5.91	0	0.018	0.215	0	0	748	0.42
8,520	142.0	5.92	0	0.018	0.215	0	0	748	0.42
8,532	142.2	5.93	0	0.018	0.215	0	0	748	0.42
8,544	142.4	5.93	0	0.018	0.215	0	0	748	0.42
8,556	142.6	5.94	0	0.018	0.215	0	0	749	0.42
8,568	142.8	5.95	0	0.018	0.215	0	0	749	0.42
8,580	143.0	5.96	0	0.018	0.215	0	0	749	0.42
8,592	143.2	5.97	0	0.018	0.215	0	0	749	0.42
8,604	143.4	5.98	0	0.018	0.215	0	0	749	0.42
8,616	143.6	5.98	0	0.018	0.215	0	0	750	0.42
8,628	143.8	5.99	0	0.018	0.215	0	0	750	0.42
8,640	144.0	6.00	0	0.018	0.215	0	0	750	0.42
8,652	144.2	6.01	0	0.018	0.215	0	0	750	0.42
8,664	144.4	6.02	0	0.018	0.215	0	0	751	0.42
8,676	144.6	6.03	0	0.018	0.215	0	0	751	0.42
8,688	144.8	6.03	0	0.018	0.215	0	0	751	0.42
8,700	145.0	6.04	0	0.018	0.215	0	0	751	0.42
8,712	145.2	6.05	0	0.018	0.215	0	0	751	0.42
8,724	145.4	6.06	0	0.018	0.215	0	0	752	0.42
8,736	145.6	6.07	0	0.018	0.215	0	0	752	0.42
8,748	145.8	6.08	0	0.018	0.215	0	0	752	0.42
8,760	146.0	6.08	0	0.018	0.215	0	0	752	0.42
8,772	146.2	6.09	0	0.018	0.215	0	0	752	0.42
8,784	146.4	6.10	0	0.018	0.215	0	0	753	0.42
8,796	146.6	6.11	0	0.018	0.215	0	0	753	0.42
8,808	146.8	6.12	0	0.018	0.215	0	0	753	0.42
8,820	147.0	6.13	0	0.018	0.215	0	0	753	0.42
8,832	147.2	6.13	0	0.018	0.215	0	0	754	0.42
8,844	147.4	6.14	0	0.018	0.215	0	0	754	0.42
8,856	147.6	6.15	0	0.018	0.215	0	0	754	0.42
8,868	147.8	6.16	0	0.018	0.215	0	0	754	0.42
8,880	148.0	6.17	0	0.018	0.215	0	0	754	0.42
8,892	148.2	6.18	0	0.018	0.215	0	0	755	0.42

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,904	148.4	6.18	0	0.018	0.215	0	0	755	0.42
8,916	148.6	6.19	0	0.018	0.215	0	0	755	0.42
8,928	148.8	6.20	0	0.018	0.215	0	0	755	0.42
8,940	149.0	6.21	0	0.018	0.215	0	0	755	0.42
8,952	149.2	6.22	0	0.018	0.215	0	0	756	0.42
8,964	149.4	6.23	0	0.018	0.215	0	0	756	0.42
8,976	149.6	6.23	0	0.018	0.215	0	0	756	0.42
8,988	149.8	6.24	0	0.018	0.215	0	0	756	0.42
9,000	150.0	6.25	0	0.018	0.215	0	0	757	0.42
9,012	150.2	6.26	0	0.018	0.215	0	0	757	0.42
9,024	150.4	6.27	0	0.018	0.215	0	0	757	0.42
9,036	150.6	6.28	0	0.018	0.215	0	0	757	0.42
9,048	150.8	6.28	0	0.018	0.215	0	0	757	0.42
9,060	151.0	6.29	0	0.018	0.215	0	0	758	0.42
9,072	151.2	6.30	0	0.018	0.215	0	0	758	0.42
9,084	151.4	6.31	0	0.018	0.215	0	0	758	0.42
9,096	151.6	6.32	0	0.018	0.215	0	0	758	0.42
9,108	151.8	6.33	0	0.018	0.215	0	0	758	0.42
9,120	152.0	6.33	0	0.018	0.215	0	0	759	0.42
9,132	152.2	6.34	0	0.018	0.215	0	0	759	0.42
9,144	152.4	6.35	0	0.018	0.215	0	0	759	0.42
9,156	152.6	6.36	0	0.018	0.215	0	0	759	0.42
9,168	152.8	6.37	0	0.018	0.215	0	0	760	0.42
9,180	153.0	6.38	0	0.018	0.215	0	0	760	0.42
9,192	153.2	6.38	0	0.018	0.215	0	0	760	0.42
9,204	153.4	6.39	0	0.018	0.215	0	0	760	0.42
9,216	153.6	6.40	0	0.018	0.215	0	0	760	0.42
9,228	153.8	6.41	0	0.018	0.215	0	0	761	0.42
9,240	154.0	6.42	0	0.018	0.215	0	0	761	0.42
9,252	154.2	6.43	0	0.018	0.215	0	0	761	0.42
9,264	154.4	6.43	0	0.018	0.215	0	0	761	0.42
9,276	154.6	6.44	0	0.018	0.215	0	0	761	0.42
9,288	154.8	6.45	0	0.018	0.215	0	0	762	0.42
9,300	155.0	6.46	0	0.018	0.215	0	0	762	0.42
9,312	155.2	6.47	0	0.018	0.215	0	0	762	0.42
9,324	155.4	6.48	0	0.018	0.215	0	0	762	0.42
9,336	155.6	6.48	0	0.018	0.215	0	0	763	0.42
9,348	155.8	6.49	0	0.018	0.215	0	0	763	0.42
9,360	156.0	6.50	0	0.018	0.215	0	0	763	0.43
9,372	156.2	6.51	0	0.018	0.215	0	0	763	0.43
9,384	156.4	6.52	0	0.018	0.215	0	0	763	0.43
9,396	156.6	6.53	0	0.018	0.215	0	0	764	0.43
9,408	156.8	6.53	0	0.018	0.215	0	0	764	0.43
9,420	157.0	6.54	0	0.018	0.215	0	0	764	0.43
9,432	157.2	6.55	0	0.018	0.215	0	0	764	0.43
9,444	157.4	6.56	0	0.018	0.215	0	0	764	0.43
9,456	157.6	6.57	0	0.018	0.215	0	0	765	0.43
9,468	157.8	6.58	0	0.018	0.215	0	0	765	0.43
9,480	158.0	6.58	0	0.018	0.215	0	0	765	0.43
9,492	158.2	6.59	0	0.018	0.215	0	0	765	0.43
9,504	158.4	6.60	0	0.018	0.215	0	0	766	0.43
9,516	158.6	6.61	0	0.018	0.215	0	0	766	0.43
9,528	158.8	6.62	0	0.018	0.215	0	0	766	0.43

Attachment 10 - Cell 3 Leakage Detection Sump - Average Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
9,540	159.0	6.63	0	0.018	0.215	0	0	766	0.43
9,552	159.2	6.63	0	0.018	0.215	0	0	766	0.43
9,564	159.4	6.64	0	0.018	0.215	0	0	767	0.43
9,576	159.6	6.65	0	0.018	0.215	0	0	767	0.43
9,588	159.8	6.66	0	0.018	0.215	0	0	767	0.43
9,600	160.0	6.67	0	0.018	0.215	0	0	767	0.43
9,612	160.2	6.68	0	0.018	0.215	0	0	767	0.43
9,624	160.4	6.68	0	0.018	0.215	0	0	768	0.43
9,636	160.6	6.69	0	0.018	0.215	0	0	768	0.43
9,648	160.8	6.70	0	0.018	0.215	0	0	768	0.43
9,660	161.0	6.71	0	0.018	0.215	0	0	768	0.43
9,672	161.2	6.72	0	0.018	0.215	0	0	769	0.43
9,684	161.4	6.73	0	0.018	0.215	0	0	769	0.43
9,696	161.6	6.73	0	0.018	0.215	0	0	769	0.43
9,708	161.8	6.74	0	0.018	0.215	0	0	769	0.43
9,720	162.0	6.75	0	0.018	0.215	0	0	769	0.43
9,732	162.2	6.76	0	0.018	0.215	0	0	770	0.43
9,744	162.4	6.77	0	0.018	0.215	0	0	770	0.43
9,756	162.6	6.78	0	0.018	0.215	0	0	770	0.43
9,768	162.8	6.78	0	0.018	0.215	0	0	770	0.43
9,780	163.0	6.79	0	0.018	0.215	0	0	771	0.43
9,792	163.2	6.80	0	0.018	0.215	0	0	771	0.43
9,804	163.4	6.81	0	0.018	0.215	0	0	771	0.43
9,816	163.6	6.82	0	0.018	0.215	0	0	771	0.43
9,828	163.8	6.83	0	0.018	0.215	0	0	771	0.43
9,840	164.0	6.83	0	0.018	0.215	0	0	772	0.43
9,852	164.2	6.84	0	0.018	0.215	0	0	772	0.43
9,864	164.4	6.85	0	0.018	0.215	0	0	772	0.43
9,876	164.6	6.86	0	0.018	0.215	0	0	772	0.43
9,888	164.8	6.87	0	0.018	0.215	0	0	772	0.43
9,900	165.0	6.88	0	0.018	0.215	0	0	773	0.43
9,912	165.2	6.88	0	0.018	0.215	0	0	773	0.43
9,924	165.4	6.89	0	0.018	0.215	0	0	773	0.43
9,936	165.6	6.90	0	0.018	0.215	0	0	773	0.43
9,948	165.8	6.91	0	0.018	0.215	0	0	774	0.43
9,960	166.0	6.92	0	0.018	0.215	0	0	774	0.43
9,972	166.2	6.93	0	0.018	0.215	0	0	774	0.43
9,984	166.4	6.93	0	0.018	0.215	0	0	774	0.43
9,996	166.6	6.94	0	0.018	0.215	0	0	774	0.43
10,008	166.8	6.95	0	0.018	0.215	0	0	775	0.43
10,020	167.0	6.96	0	0.018	0.215	0	0	775	0.43
10,032	167.2	6.97	0	0.018	0.215	0	0	775	0.43
10,044	167.4	6.98	0	0.018	0.215	0	0	775	0.43
10,056	167.6	6.98	0	0.018	0.215	0	0	775	0.43
10,068	167.8	6.99	0	0.018	0.215	0	0	776	0.43
10,080	168.0	7.00	0	0.018	0.215	0	0	776	0.43

ATTACHMENT 11

Cell 3 Leakage Detection Sump – Peak Conditions

Attachment 11 - Cell 3 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
0	0.0	0.00	0	7.5	0.0	0	0	1795	1.0
12	0.2	0.01	0	7.5	90.0	0	0	1885	1.1
24	0.4	0.02	0	7.5	90.0	100	1,200	775	0.4
36	0.6	0.03	0	7.5	90.0	0	0	865	0.5
48	0.8	0.03	0	7.5	90.0	0	0	955	0.5
60	1.0	0.04	0	7.5	90.0	0	0	1045	0.6
72	1.2	0.05	0	7.5	90.0	0	0	1135	0.6
84	1.4	0.06	0	7.5	90.0	0	0	1225	0.7
96	1.6	0.07	0	7.5	90.0	0	0	1315	0.7
108	1.8	0.08	0	7.5	90.0	0	0	1405	0.8
120	2.0	0.08	0	7.5	90.0	0	0	1495	0.8
132	2.2	0.09	0	7.5	90.0	0	0	1585	0.9
144	2.4	0.10	0	7.5	90.0	0	0	1675	0.9
156	2.6	0.11	0	7.5	90.0	0	0	1765	1.0
168	2.8	0.12	0	7.5	90.0	0	0	1855	1.0
180	3.0	0.13	0	7.5	90.0	100	1,200	745	0.4
192	3.2	0.13	0	7.5	90.0	0	0	835	0.5
204	3.4	0.14	0	7.5	90.0	0	0	925	0.5
216	3.6	0.15	0	7.5	90.0	0	0	1015	0.6
228	3.8	0.16	0	7.5	90.0	0	0	1105	0.6
240	4.0	0.17	0	7.5	90.0	0	0	1195	0.7
252	4.2	0.18	0	7.5	90.0	0	0	1285	0.7
264	4.4	0.18	0	7.5	90.0	0	0	1375	0.8
276	4.6	0.19	0	7.5	90.0	0	0	1465	0.8
288	4.8	0.20	0	7.5	90.0	0	0	1555	0.9
300	5.0	0.21	0	7.5	90.0	0	0	1645	0.9
312	5.2	0.22	0	7.5	90.0	0	0	1735	1.0
324	5.4	0.23	0	7.5	90.0	0	0	1825	1.0
336	5.6	0.23	0	7.5	90.0	100	1,200	715	0.4
348	5.8	0.24	0	7.5	90.0	0	0	805	0.4
360	6.0	0.25	0	7.5	90.0	0	0	895	0.5
372	6.2	0.26	0	7.5	90.0	0	0	985	0.5
384	6.4	0.27	0	7.5	90.0	0	0	1075	0.6
396	6.6	0.28	0	7.5	90.0	0	0	1165	0.6
408	6.8	0.28	0	7.5	90.0	0	0	1255	0.7
420	7.0	0.29	0	7.5	90.0	0	0	1345	0.7
432	7.2	0.30	0	7.5	90.0	0	0	1435	0.8
444	7.4	0.31	0	7.5	90.0	0	0	1525	0.8
456	7.6	0.32	0	7.5	90.0	0	0	1615	0.9
468	7.8	0.33	0	7.5	90.0	0	0	1705	0.9
480	8.0	0.33	0	7.5	90.0	0	0	1795	1.0
492	8.2	0.34	0	7.5	90.0	0	0	1885	1.1
504	8.4	0.35	0	7.5	90.0	100	1,200	775	0.4
516	8.6	0.36	0	7.5	90.0	0	0	865	0.5
528	8.8	0.37	0	7.5	90.0	0	0	955	0.5
540	9.0	0.38	0	7.5	90.0	0	0	1045	0.6
552	9.2	0.38	0	7.5	90.0	0	0	1135	0.6
564	9.4	0.39	0	7.5	90.0	0	0	1225	0.7
576	9.6	0.40	0	7.5	90.0	0	0	1315	0.7
588	9.8	0.41	0	7.5	90.0	0	0	1405	0.8
600	10.0	0.42	0	7.5	90.0	0	0	1495	0.8
612	10.2	0.43	0	7.5	90.0	0	0	1585	0.9
624	10.4	0.43	0	7.5	90.0	0	0	1675	0.9
636	10.6	0.44	0	7.5	90.0	0	0	1765	1.0
648	10.8	0.45	0	7.5	90.0	0	0	1855	1.0
660	11.0	0.46	0	7.5	90.0	100	1,200	745	0.4
672	11.2	0.47	0	7.5	90.0	0	0	835	0.5
684	11.4	0.48	0	7.5	90.0	0	0	925	0.5
696	11.6	0.48	0	7.5	90.0	0	0	1015	0.6
708	11.8	0.49	0	7.5	90.0	0	0	1105	0.6
720	12.0	0.50	0	7.5	90.0	0	0	1195	0.7
732	12.2	0.51	0	7.5	90.0	0	0	1285	0.7
744	12.4	0.52	0	7.5	90.0	0	0	1375	0.8
756	12.6	0.53	0	7.5	90.0	0	0	1465	0.8
768	12.8	0.53	0	7.5	90.0	0	0	1555	0.9
780	13.0	0.54	0	7.5	90.0	0	0	1645	0.9
792	13.2	0.55	0	7.5	90.0	0	0	1735	1.0

Attachment 11 - Cell 3 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
804	13.4	0.56	0	7.5	90.0	0	0	1825	1.0
816	13.6	0.57	0	7.5	90.0	100	1,200	715	0.4
828	13.8	0.58	0	7.5	90.0	0	0	805	0.4
840	14.0	0.58	0	7.5	90.0	0	0	895	0.5
852	14.2	0.59	0	7.5	90.0	0	0	985	0.5
864	14.4	0.60	0	7.5	90.0	0	0	1075	0.6
876	14.6	0.61	0	7.5	90.0	0	0	1165	0.6
888	14.8	0.62	0	7.5	90.0	0	0	1255	0.7
900	15.0	0.63	0	7.5	90.0	0	0	1345	0.7
912	15.2	0.63	0	7.5	90.0	0	0	1435	0.8
924	15.4	0.64	0	7.5	90.0	0	0	1525	0.8
936	15.6	0.65	0	7.5	90.0	0	0	1615	0.9
948	15.8	0.66	0	7.5	90.0	0	0	1705	0.9
960	16.0	0.67	0	7.5	90.0	0	0	1795	1.0
972	16.2	0.68	0	7.5	90.0	0	0	1885	1.1
984	16.4	0.68	0	7.5	90.0	100	1,200	775	0.4
996	16.6	0.69	0	7.5	90.0	0	0	865	0.5
1,008	16.8	0.70	0	7.5	90.0	0	0	955	0.5
1,020	17.0	0.71	0	7.5	90.0	0	0	1045	0.6
1,032	17.2	0.72	0	7.5	90.0	0	0	1135	0.6
1,044	17.4	0.73	0	7.5	90.0	0	0	1225	0.7
1,056	17.6	0.73	0	7.5	90.0	0	0	1315	0.7
1,068	17.8	0.74	0	7.5	90.0	0	0	1405	0.8
1,080	18.0	0.75	0	7.5	90.0	0	0	1495	0.8
1,092	18.2	0.76	0	7.5	90.0	0	0	1585	0.9
1,104	18.4	0.77	0	7.5	90.0	0	0	1675	0.9
1,116	18.6	0.78	0	7.5	90.0	0	0	1765	1.0
1,128	18.8	0.78	0	7.5	90.0	0	0	1855	1.0
1,140	19.0	0.79	0	7.5	90.0	100	1,200	745	0.4
1,152	19.2	0.80	0	7.5	90.0	0	0	835	0.5
1,164	19.4	0.81	0	7.5	90.0	0	0	925	0.5
1,176	19.6	0.82	0	7.5	90.0	0	0	1015	0.6
1,188	19.8	0.83	0	7.5	90.0	0	0	1105	0.6
1,200	20.0	0.83	0	7.5	90.0	0	0	1195	0.7
1,212	20.2	0.84	0	7.5	90.0	0	0	1285	0.7
1,224	20.4	0.85	0	7.5	90.0	0	0	1375	0.8
1,236	20.6	0.86	0	7.5	90.0	0	0	1465	0.8
1,248	20.8	0.87	0	7.5	90.0	0	0	1555	0.9
1,260	21.0	0.88	0	7.5	90.0	0	0	1645	0.9
1,272	21.2	0.88	0	7.5	90.0	0	0	1735	1.0
1,284	21.4	0.89	0	7.5	90.0	0	0	1825	1.0
1,296	21.6	0.90	0	7.5	90.0	100	1,200	715	0.4
1,308	21.8	0.91	0	7.5	90.0	0	0	805	0.4
1,320	22.0	0.92	0	7.5	90.0	0	0	895	0.5
1,332	22.2	0.93	0	7.5	90.0	0	0	985	0.5
1,344	22.4	0.93	0	7.5	90.0	0	0	1075	0.6
1,356	22.6	0.94	0	7.5	90.0	0	0	1165	0.6
1,368	22.8	0.95	0	7.5	90.0	0	0	1255	0.7
1,380	23.0	0.96	0	7.5	90.0	0	0	1345	0.7
1,392	23.2	0.97	0	7.5	90.0	0	0	1435	0.8
1,404	23.4	0.98	0	7.5	90.0	0	0	1525	0.8
1,416	23.6	0.98	0	7.5	90.0	0	0	1615	0.9
1,428	23.8	0.99	0	7.5	90.0	0	0	1705	0.9
1,440	24.0	1.00	0	7.5	90.0	0	0	1795	1.0
1,452	24.2	1.01	0	7.5	90.0	0	0	1885	1.1
1,464	24.4	1.02	0	7.5	90.0	100	1,200	775	0.4
1,476	24.6	1.03	0	7.5	90.0	0	0	865	0.5
1,488	24.8	1.03	0	7.5	90.0	0	0	955	0.5
1,500	25.0	1.04	0	7.5	90.0	0	0	1045	0.6
1,512	25.2	1.05	0	7.5	90.0	0	0	1135	0.6
1,524	25.4	1.06	0	7.5	90.0	0	0	1225	0.7
1,536	25.6	1.07	0	7.5	90.0	0	0	1315	0.7
1,548	25.8	1.08	0	7.5	90.0	0	0	1405	0.8
1,560	26.0	1.08	0	7.5	90.0	0	0	1495	0.8
1,572	26.2	1.09	0	7.5	90.0	0	0	1585	0.9
1,584	26.4	1.10	0	7.5	90.0	0	0	1675	0.9
1,596	26.6	1.11	0	7.5	90.0	0	0	1765	1.0

Attachment 11 - Cell 3 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,608	26.8	1.12	0	7.5	90.0	0	0	1855	1.0
1,620	27.0	1.13	0	7.5	90.0	100	1,200	745	0.4
1,632	27.2	1.13	0	7.5	90.0	0	0	835	0.5
1,644	27.4	1.14	0	7.5	90.0	0	0	925	0.5
1,656	27.6	1.15	0	7.5	90.0	0	0	1015	0.6
1,668	27.8	1.16	0	7.5	90.0	0	0	1105	0.6
1,680	28.0	1.17	0	7.5	90.0	0	0	1195	0.7
1,692	28.2	1.18	0	7.5	90.0	0	0	1285	0.7
1,704	28.4	1.18	0	7.5	90.0	0	0	1375	0.8
1,716	28.6	1.19	0	7.5	90.0	0	0	1465	0.8
1,728	28.8	1.20	0	7.5	90.0	0	0	1555	0.9
1,740	29.0	1.21	0	7.5	90.0	0	0	1645	0.9
1,752	29.2	1.22	0	7.5	90.0	0	0	1735	1.0
1,764	29.4	1.23	0	7.5	90.0	0	0	1825	1.0
1,776	29.6	1.23	0	7.5	90.0	100	1,200	715	0.4
1,788	29.8	1.24	0	7.5	90.0	0	0	805	0.4
1,800	30.0	1.25	0	7.5	90.0	0	0	895	0.5
1,812	30.2	1.26	0	7.5	90.0	0	0	985	0.5
1,824	30.4	1.27	0	7.5	90.0	0	0	1075	0.6
1,836	30.6	1.28	0	7.5	90.0	0	0	1165	0.6
1,848	30.8	1.28	0	7.5	90.0	0	0	1255	0.7
1,860	31.0	1.29	0	7.5	90.0	0	0	1345	0.7
1,872	31.2	1.30	0	7.5	90.0	0	0	1435	0.8
1,884	31.4	1.31	0	7.5	90.0	0	0	1525	0.8
1,896	31.6	1.32	0	7.5	90.0	0	0	1615	0.9
1,908	31.8	1.33	0	7.5	90.0	0	0	1705	0.9
1,920	32.0	1.33	0	7.5	90.0	0	0	1795	1.0
1,932	32.2	1.34	0	7.5	90.0	0	0	1885	1.1
1,944	32.4	1.35	0	7.5	90.0	100	1,200	775	0.4
1,956	32.6	1.36	0	7.5	90.0	0	0	865	0.5
1,968	32.8	1.37	0	7.5	90.0	0	0	955	0.5
1,980	33.0	1.38	0	7.5	90.0	0	0	1045	0.6
1,992	33.2	1.38	0	7.5	90.0	0	0	1135	0.6
2,004	33.4	1.39	0	7.5	90.0	0	0	1225	0.7
2,016	33.6	1.40	0	7.5	90.0	0	0	1315	0.7
2,028	33.8	1.41	0	7.5	90.0	0	0	1405	0.8
2,040	34.0	1.42	0	7.5	90.0	0	0	1495	0.8
2,052	34.2	1.43	0	7.5	90.0	0	0	1585	0.9
2,064	34.4	1.43	0	7.5	90.0	0	0	1675	0.9
2,076	34.6	1.44	0	7.5	90.0	0	0	1765	1.0
2,088	34.8	1.45	0	7.5	90.0	0	0	1855	1.0
2,100	35.0	1.46	0	7.5	90.0	100	1,200	745	0.4
2,112	35.2	1.47	0	7.5	90.0	0	0	835	0.5
2,124	35.4	1.48	0	7.5	90.0	0	0	925	0.5
2,136	35.6	1.48	0	7.5	90.0	0	0	1015	0.6
2,148	35.8	1.49	0	7.5	90.0	0	0	1105	0.6
2,160	36.0	1.50	0	7.5	90.0	0	0	1195	0.7
2,172	36.2	1.51	0	7.5	90.0	0	0	1285	0.7
2,184	36.4	1.52	0	7.5	90.0	0	0	1375	0.8
2,196	36.6	1.53	0	7.5	90.0	0	0	1465	0.8
2,208	36.8	1.53	0	7.5	90.0	0	0	1555	0.9
2,220	37.0	1.54	0	7.5	90.0	0	0	1645	0.9
2,232	37.2	1.55	0	7.5	90.0	0	0	1735	1.0
2,244	37.4	1.56	0	7.5	90.0	0	0	1825	1.0
2,256	37.6	1.57	0	7.5	90.0	100	1,200	715	0.4
2,268	37.8	1.58	0	7.5	90.0	0	0	805	0.4
2,280	38.0	1.58	0	7.5	90.0	0	0	895	0.5
2,292	38.2	1.59	0	7.5	90.0	0	0	985	0.5
2,304	38.4	1.60	0	7.5	90.0	0	0	1075	0.6
2,316	38.6	1.61	0	7.5	90.0	0	0	1165	0.6
2,328	38.8	1.62	0	7.5	90.0	0	0	1255	0.7
2,340	39.0	1.63	0	7.5	90.0	0	0	1345	0.7
2,352	39.2	1.63	0	7.5	90.0	0	0	1435	0.8
2,364	39.4	1.64	0	7.5	90.0	0	0	1525	0.8
2,376	39.6	1.65	0	7.5	90.0	0	0	1615	0.9
2,388	39.8	1.66	0	7.5	90.0	0	0	1705	0.9
2,400	40.0	1.67	0	7.5	90.0	0	0	1795	1.0

Attachment 11 - Cell 3 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
2,412	40.2	1.68	0	7.5	90.0	0	0	1885	1.1
2,424	40.4	1.68	0	7.5	90.0	100	1,200	775	0.4
2,436	40.6	1.69	0	7.5	90.0	0	0	865	0.5
2,448	40.8	1.70	0	7.5	90.0	0	0	955	0.5
2,460	41.0	1.71	0	7.5	90.0	0	0	1045	0.6
2,472	41.2	1.72	0	7.5	90.0	0	0	1135	0.6
2,484	41.4	1.73	0	7.5	90.0	0	0	1225	0.7
2,496	41.6	1.73	0	7.5	90.0	0	0	1315	0.7
2,508	41.8	1.74	0	7.5	90.0	0	0	1405	0.8
2,520	42.0	1.75	0	7.5	90.0	0	0	1495	0.8
2,532	42.2	1.76	0	7.5	90.0	0	0	1585	0.9
2,544	42.4	1.77	0	7.5	90.0	0	0	1675	0.9
2,556	42.6	1.78	0	7.5	90.0	0	0	1765	1.0
2,568	42.8	1.78	0	7.5	90.0	0	0	1855	1.0
2,580	43.0	1.79	0	7.5	90.0	100	1,200	745	0.4
2,592	43.2	1.80	0	7.5	90.0	0	0	835	0.5
2,604	43.4	1.81	0	7.5	90.0	0	0	925	0.5
2,616	43.6	1.82	0	7.5	90.0	0	0	1015	0.6
2,628	43.8	1.83	0	7.5	90.0	0	0	1105	0.6
2,640	44.0	1.83	0	7.5	90.0	0	0	1195	0.7
2,652	44.2	1.84	0	7.5	90.0	0	0	1285	0.7
2,664	44.4	1.85	0	7.5	90.0	0	0	1375	0.8
2,676	44.6	1.86	0	7.5	90.0	0	0	1465	0.8
2,688	44.8	1.87	0	7.5	90.0	0	0	1555	0.9
2,700	45.0	1.88	0	7.5	90.0	0	0	1645	0.9
2,712	45.2	1.88	0	7.5	90.0	0	0	1735	1.0
2,724	45.4	1.89	0	7.5	90.0	0	0	1825	1.0
2,736	45.6	1.90	0	7.5	90.0	100	1,200	715	0.4
2,748	45.8	1.91	0	7.5	90.0	0	0	805	0.4
2,760	46.0	1.92	0	7.5	90.0	0	0	895	0.5
2,772	46.2	1.93	0	7.5	90.0	0	0	985	0.5
2,784	46.4	1.93	0	7.5	90.0	0	0	1075	0.6
2,796	46.6	1.94	0	7.5	90.0	0	0	1165	0.6
2,808	46.8	1.95	0	7.5	90.0	0	0	1255	0.7
2,820	47.0	1.96	0	7.5	90.0	0	0	1345	0.7
2,832	47.2	1.97	0	7.5	90.0	0	0	1435	0.8
2,844	47.4	1.98	0	7.5	90.0	0	0	1525	0.8
2,856	47.6	1.98	0	7.5	90.0	0	0	1615	0.9
2,868	47.8	1.99	0	7.5	90.0	0	0	1705	0.9
2,880	48.0	2.00	0	7.5	90.0	0	0	1795	1.0
2,892	48.2	2.01	0	7.5	90.0	0	0	1885	1.1
2,904	48.4	2.02	0	7.5	90.0	100	1,200	775	0.4
2,916	48.6	2.03	0	7.5	90.0	0	0	865	0.5
2,928	48.8	2.03	0	7.5	90.0	0	0	955	0.5
2,940	49.0	2.04	0	7.5	90.0	0	0	1045	0.6
2,952	49.2	2.05	0	7.5	90.0	0	0	1135	0.6
2,964	49.4	2.06	0	7.5	90.0	0	0	1225	0.7
2,976	49.6	2.07	0	7.5	90.0	0	0	1315	0.7
2,988	49.8	2.08	0	7.5	90.0	0	0	1405	0.8
3,000	50.0	2.08	0	7.5	90.0	0	0	1495	0.8
3,012	50.2	2.09	0	7.5	90.0	0	0	1585	0.9
3,024	50.4	2.10	0	7.5	90.0	0	0	1675	0.9
3,036	50.6	2.11	0	7.5	90.0	0	0	1765	1.0
3,048	50.8	2.12	0	7.5	90.0	0	0	1855	1.0
3,060	51.0	2.13	0	7.5	90.0	100	1,200	745	0.4
3,072	51.2	2.13	0	7.5	90.0	0	0	835	0.5
3,084	51.4	2.14	0	7.5	90.0	0	0	925	0.5
3,096	51.6	2.15	0	7.5	90.0	0	0	1015	0.6
3,108	51.8	2.16	0	7.5	90.0	0	0	1105	0.6
3,120	52.0	2.17	0	7.5	90.0	0	0	1195	0.7
3,132	52.2	2.18	0	7.5	90.0	0	0	1285	0.7
3,144	52.4	2.18	0	7.5	90.0	0	0	1375	0.8
3,156	52.6	2.19	0	7.5	90.0	0	0	1465	0.8
3,168	52.8	2.20	0	7.5	90.0	0	0	1555	0.9
3,180	53.0	2.21	0	7.5	90.0	0	0	1645	0.9
3,192	53.2	2.22	0	7.5	90.0	0	0	1735	1.0
3,204	53.4	2.23	0	7.5	90.0	0	0	1825	1.0

Attachment 11 - Cell 3 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,216	53.6	2.23	0	7.5	90.0	100	1,200	715	0.4
3,228	53.8	2.24	0	7.5	90.0	0	0	805	0.4
3,240	54.0	2.25	0	7.5	90.0	0	0	895	0.5
3,252	54.2	2.26	0	7.5	90.0	0	0	985	0.5
3,264	54.4	2.27	0	7.5	90.0	0	0	1075	0.6
3,276	54.6	2.28	0	7.5	90.0	0	0	1165	0.6
3,288	54.8	2.28	0	7.5	90.0	0	0	1255	0.7
3,300	55.0	2.29	0	7.5	90.0	0	0	1345	0.7
3,312	55.2	2.30	0	7.5	90.0	0	0	1435	0.8
3,324	55.4	2.31	0	7.5	90.0	0	0	1525	0.8
3,336	55.6	2.32	0	7.5	90.0	0	0	1615	0.9
3,348	55.8	2.33	0	7.5	90.0	0	0	1705	0.9
3,360	56.0	2.33	0	7.5	90.0	0	0	1795	1.0
3,372	56.2	2.34	0	7.5	90.0	0	0	1885	1.1
3,384	56.4	2.35	0	7.5	90.0	100	1,200	775	0.4
3,396	56.6	2.36	0	7.5	90.0	0	0	865	0.5
3,408	56.8	2.37	0	7.5	90.0	0	0	955	0.5
3,420	57.0	2.38	0	7.5	90.0	0	0	1045	0.6
3,432	57.2	2.38	0	7.5	90.0	0	0	1135	0.6
3,444	57.4	2.39	0	7.5	90.0	0	0	1225	0.7
3,456	57.6	2.40	0	7.5	90.0	0	0	1315	0.7
3,468	57.8	2.41	0	7.5	90.0	0	0	1405	0.8
3,480	58.0	2.42	0	7.5	90.0	0	0	1495	0.8
3,492	58.2	2.43	0	7.5	90.0	0	0	1585	0.9
3,504	58.4	2.43	0	7.5	90.0	0	0	1675	0.9
3,516	58.6	2.44	0	7.5	90.0	0	0	1765	1.0
3,528	58.8	2.45	0	7.5	90.0	0	0	1855	1.0
3,540	59.0	2.46	0	7.5	90.0	100	1,200	745	0.4
3,552	59.2	2.47	0	7.5	90.0	0	0	835	0.5
3,564	59.4	2.48	0	7.5	90.0	0	0	925	0.5
3,576	59.6	2.48	0	7.5	90.0	0	0	1015	0.6
3,588	59.8	2.49	0	7.5	90.0	0	0	1105	0.6
3,600	60.0	2.50	0	7.5	90.0	0	0	1195	0.7
3,612	60.2	2.51	0	7.5	90.0	0	0	1285	0.7
3,624	60.4	2.52	0	7.5	90.0	0	0	1375	0.8
3,636	60.6	2.53	0	7.5	90.0	0	0	1465	0.8
3,648	60.8	2.53	0	7.5	90.0	0	0	1555	0.9
3,660	61.0	2.54	0	7.5	90.0	0	0	1645	0.9
3,672	61.2	2.55	0	7.5	90.0	0	0	1735	1.0
3,684	61.4	2.56	0	7.5	90.0	0	0	1825	1.0
3,696	61.6	2.57	0	7.5	90.0	100	1,200	715	0.4
3,708	61.8	2.58	0	7.5	90.0	0	0	805	0.4
3,720	62.0	2.58	0	7.5	90.0	0	0	895	0.5
3,732	62.2	2.59	0	7.5	90.0	0	0	985	0.5
3,744	62.4	2.60	0	7.5	90.0	0	0	1075	0.6
3,756	62.6	2.61	0	7.5	90.0	0	0	1165	0.6
3,768	62.8	2.62	0	7.5	90.0	0	0	1255	0.7
3,780	63.0	2.63	0	7.5	90.0	0	0	1345	0.7
3,792	63.2	2.63	0	7.5	90.0	0	0	1435	0.8
3,804	63.4	2.64	0	7.5	90.0	0	0	1525	0.8
3,816	63.6	2.65	0	7.5	90.0	0	0	1615	0.9
3,828	63.8	2.66	0	7.5	90.0	0	0	1705	0.9
3,840	64.0	2.67	0	7.5	90.0	0	0	1795	1.0
3,852	64.2	2.68	0	7.5	90.0	0	0	1885	1.1
3,864	64.4	2.68	0	7.5	90.0	100	1,200	775	0.4
3,876	64.6	2.69	0	7.5	90.0	0	0	865	0.5
3,888	64.8	2.70	0	7.5	90.0	0	0	955	0.5
3,900	65.0	2.71	0	7.5	90.0	0	0	1045	0.6
3,912	65.2	2.72	0	7.5	90.0	0	0	1135	0.6
3,924	65.4	2.73	0	7.5	90.0	0	0	1225	0.7
3,936	65.6	2.73	0	7.5	90.0	0	0	1315	0.7
3,948	65.8	2.74	0	7.5	90.0	0	0	1405	0.8
3,960	66.0	2.75	0	7.5	90.0	0	0	1495	0.8
3,972	66.2	2.76	0	7.5	90.0	0	0	1585	0.9
3,984	66.4	2.77	0	7.5	90.0	0	0	1675	0.9
3,996	66.6	2.78	0	7.5	90.0	0	0	1765	1.0
4,008	66.8	2.78	0	7.5	90.0	0	0	1855	1.0

Attachment 11 - Cell 3 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,020	67.0	2.79	0	7.5	90.0	100	1,200	745	0.4
4,032	67.2	2.80	0	7.5	90.0	0	0	835	0.5
4,044	67.4	2.81	0	7.5	90.0	0	0	925	0.5
4,056	67.6	2.82	0	7.5	90.0	0	0	1015	0.6
4,068	67.8	2.83	0	7.5	90.0	0	0	1105	0.6
4,080	68.0	2.83	0	7.5	90.0	0	0	1195	0.7
4,092	68.2	2.84	0	7.5	90.0	0	0	1285	0.7
4,104	68.4	2.85	0	7.5	90.0	0	0	1375	0.8
4,116	68.6	2.86	0	7.5	90.0	0	0	1465	0.8
4,128	68.8	2.87	0	7.5	90.0	0	0	1555	0.9
4,140	69.0	2.88	0	7.5	90.0	0	0	1645	0.9
4,152	69.2	2.88	0	7.5	90.0	0	0	1735	1.0
4,164	69.4	2.89	0	7.5	90.0	0	0	1825	1.0
4,176	69.6	2.90	0	7.5	90.0	100	1,200	715	0.4
4,188	69.8	2.91	0	7.5	90.0	0	0	805	0.4
4,200	70.0	2.92	0	7.5	90.0	0	0	895	0.5
4,212	70.2	2.93	0	7.5	90.0	0	0	985	0.5
4,224	70.4	2.93	0	7.5	90.0	0	0	1075	0.6
4,236	70.6	2.94	0	7.5	90.0	0	0	1165	0.6
4,248	70.8	2.95	0	7.5	90.0	0	0	1255	0.7
4,260	71.0	2.96	0	7.5	90.0	0	0	1345	0.7
4,272	71.2	2.97	0	7.5	90.0	0	0	1435	0.8
4,284	71.4	2.98	0	7.5	90.0	0	0	1525	0.8
4,296	71.6	2.98	0	7.5	90.0	0	0	1615	0.9
4,308	71.8	2.99	0	7.5	90.0	0	0	1705	0.9
4,320	72.0	3.00	0	7.5	90.0	0	0	1795	1.0
4,332	72.2	3.01	0	7.5	90.0	0	0	1885	1.1
4,344	72.4	3.02	0	7.5	90.0	100	1,200	775	0.4
4,356	72.6	3.03	0	7.5	90.0	0	0	865	0.5
4,368	72.8	3.03	0	7.5	90.0	0	0	955	0.5
4,380	73.0	3.04	0	7.5	90.0	0	0	1045	0.6
4,392	73.2	3.05	0	7.5	90.0	0	0	1135	0.6
4,404	73.4	3.06	0	7.5	90.0	0	0	1225	0.7
4,416	73.6	3.07	0	7.5	90.0	0	0	1315	0.7
4,428	73.8	3.08	0	7.5	90.0	0	0	1405	0.8
4,440	74.0	3.08	0	7.5	90.0	0	0	1495	0.8
4,452	74.2	3.09	0	7.5	90.0	0	0	1585	0.9
4,464	74.4	3.10	0	7.5	90.0	0	0	1675	0.9
4,476	74.6	3.11	0	7.5	90.0	0	0	1765	1.0
4,488	74.8	3.12	0	7.5	90.0	0	0	1855	1.0
4,500	75.0	3.13	0	7.5	90.0	100	1,200	745	0.4
4,512	75.2	3.13	0	7.5	90.0	0	0	835	0.5
4,524	75.4	3.14	0	7.5	90.0	0	0	925	0.5
4,536	75.6	3.15	0	7.5	90.0	0	0	1015	0.6
4,548	75.8	3.16	0	7.5	90.0	0	0	1105	0.6
4,560	76.0	3.17	0	7.5	90.0	0	0	1195	0.7
4,572	76.2	3.18	0	7.5	90.0	0	0	1285	0.7
4,584	76.4	3.18	0	7.5	90.0	0	0	1375	0.8
4,596	76.6	3.19	0	7.5	90.0	0	0	1465	0.8
4,608	76.8	3.20	0	7.5	90.0	0	0	1555	0.9
4,620	77.0	3.21	0	7.5	90.0	0	0	1645	0.9
4,632	77.2	3.22	0	7.5	90.0	0	0	1735	1.0
4,644	77.4	3.23	0	7.5	90.0	0	0	1825	1.0
4,656	77.6	3.23	0	7.5	90.0	100	1,200	715	0.4
4,668	77.8	3.24	0	7.5	90.0	0	0	805	0.4
4,680	78.0	3.25	0	7.5	90.0	0	0	895	0.5
4,692	78.2	3.26	0	7.5	90.0	0	0	985	0.5
4,704	78.4	3.27	0	7.5	90.0	0	0	1075	0.6
4,716	78.6	3.28	0	7.5	90.0	0	0	1165	0.6
4,728	78.8	3.28	0	7.5	90.0	0	0	1255	0.7
4,740	79.0	3.29	0	7.5	90.0	0	0	1345	0.7
4,752	79.2	3.30	0	7.5	90.0	0	0	1435	0.8
4,764	79.4	3.31	0	7.5	90.0	0	0	1525	0.8
4,776	79.6	3.32	0	7.5	90.0	0	0	1615	0.9
4,788	79.8	3.33	0	7.5	90.0	0	0	1705	0.9
4,800	80.0	3.33	0	7.5	90.0	0	0	1795	1.0
4,812	80.2	3.34	0	7.5	90.0	0	0	1885	1.1

Attachment 11 - Cell 3 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,824	80.4	3.35	0	7.5	90.0	100	1,200	775	0.4
4,836	80.6	3.36	0	7.5	90.0	0	0	865	0.5
4,848	80.8	3.37	0	7.5	90.0	0	0	955	0.5
4,860	81.0	3.38	0	7.5	90.0	0	0	1045	0.6
4,872	81.2	3.38	0	7.5	90.0	0	0	1135	0.6
4,884	81.4	3.39	0	7.5	90.0	0	0	1225	0.7
4,896	81.6	3.40	0	7.5	90.0	0	0	1315	0.7
4,908	81.8	3.41	0	7.5	90.0	0	0	1405	0.8
4,920	82.0	3.42	0	7.5	90.0	0	0	1495	0.8
4,932	82.2	3.43	0	7.5	90.0	0	0	1585	0.9
4,944	82.4	3.43	0	7.5	90.0	0	0	1675	0.9
4,956	82.6	3.44	0	7.5	90.0	0	0	1765	1.0
4,968	82.8	3.45	0	7.5	90.0	0	0	1855	1.0
4,980	83.0	3.46	0	7.5	90.0	100	1,200	745	0.4
4,992	83.2	3.47	0	7.5	90.0	0	0	835	0.5
5,004	83.4	3.48	0	7.5	90.0	0	0	925	0.5
5,016	83.6	3.48	0	7.5	90.0	0	0	1015	0.6
5,028	83.8	3.49	0	7.5	90.0	0	0	1105	0.6
5,040	84.0	3.50	0	7.5	90.0	0	0	1195	0.7
5,052	84.2	3.51	0	7.5	90.0	0	0	1285	0.7
5,064	84.4	3.52	0	7.5	90.0	0	0	1375	0.8
5,076	84.6	3.53	0	7.5	90.0	0	0	1465	0.8
5,088	84.8	3.53	0	7.5	90.0	0	0	1555	0.9
5,100	85.0	3.54	0	7.5	90.0	0	0	1645	0.9
5,112	85.2	3.55	0	7.5	90.0	0	0	1735	1.0
5,124	85.4	3.56	0	7.5	90.0	0	0	1825	1.0
5,136	85.6	3.57	0	7.5	90.0	100	1,200	715	0.4
5,148	85.8	3.58	0	7.5	90.0	0	0	805	0.4
5,160	86.0	3.58	0	7.5	90.0	0	0	895	0.5
5,172	86.2	3.59	0	7.5	90.0	0	0	985	0.5
5,184	86.4	3.60	0	7.5	90.0	0	0	1075	0.6
5,196	86.6	3.61	0	7.5	90.0	0	0	1165	0.6
5,208	86.8	3.62	0	7.5	90.0	0	0	1255	0.7
5,220	87.0	3.63	0	7.5	90.0	0	0	1345	0.7
5,232	87.2	3.63	0	7.5	90.0	0	0	1435	0.8
5,244	87.4	3.64	0	7.5	90.0	0	0	1525	0.8
5,256	87.6	3.65	0	7.5	90.0	0	0	1615	0.9
5,268	87.8	3.66	0	7.5	90.0	0	0	1705	0.9
5,280	88.0	3.67	0	7.5	90.0	0	0	1795	1.0
5,292	88.2	3.68	0	7.5	90.0	0	0	1885	1.1
5,304	88.4	3.68	0	7.5	90.0	100	1,200	775	0.4
5,316	88.6	3.69	0	7.5	90.0	0	0	865	0.5
5,328	88.8	3.70	0	7.5	90.0	0	0	955	0.5
5,340	89.0	3.71	0	7.5	90.0	0	0	1045	0.6
5,352	89.2	3.72	0	7.5	90.0	0	0	1135	0.6
5,364	89.4	3.73	0	7.5	90.0	0	0	1225	0.7
5,376	89.6	3.73	0	7.5	90.0	0	0	1315	0.7
5,388	89.8	3.74	0	7.5	90.0	0	0	1405	0.8
5,400	90.0	3.75	0	7.5	90.0	0	0	1495	0.8
5,412	90.2	3.76	0	7.5	90.0	0	0	1585	0.9
5,424	90.4	3.77	0	7.5	90.0	0	0	1675	0.9
5,436	90.6	3.78	0	7.5	90.0	0	0	1765	1.0
5,448	90.8	3.78	0	7.5	90.0	0	0	1855	1.0
5,460	91.0	3.79	0	7.5	90.0	100	1,200	745	0.4
5,472	91.2	3.80	0	7.5	90.0	0	0	835	0.5
5,484	91.4	3.81	0	7.5	90.0	0	0	925	0.5
5,496	91.6	3.82	0	7.5	90.0	0	0	1015	0.6
5,508	91.8	3.83	0	7.5	90.0	0	0	1105	0.6
5,520	92.0	3.83	0	7.5	90.0	0	0	1195	0.7
5,532	92.2	3.84	0	7.5	90.0	0	0	1285	0.7
5,544	92.4	3.85	0	7.5	90.0	0	0	1375	0.8
5,556	92.6	3.86	0	7.5	90.0	0	0	1465	0.8
5,568	92.8	3.87	0	7.5	90.0	0	0	1555	0.9
5,580	93.0	3.88	0	7.5	90.0	0	0	1645	0.9
5,592	93.2	3.88	0	7.5	90.0	0	0	1735	1.0
5,604	93.4	3.89	0	7.5	90.0	0	0	1825	1.0
5,616	93.6	3.90	0	7.5	90.0	100	1,200	715	0.4

Attachment 11 - Cell 3 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,628	93.8	3.91	0	7.5	90.0	0	0	805	0.4
5,640	94.0	3.92	0	7.5	90.0	0	0	895	0.5
5,652	94.2	3.93	0	7.5	90.0	0	0	985	0.5
5,664	94.4	3.93	0	7.5	90.0	0	0	1075	0.6
5,676	94.6	3.94	0	7.5	90.0	0	0	1165	0.6
5,688	94.8	3.95	0	7.5	90.0	0	0	1255	0.7
5,700	95.0	3.96	0	7.5	90.0	0	0	1345	0.7
5,712	95.2	3.97	0	7.5	90.0	0	0	1435	0.8
5,724	95.4	3.98	0	7.5	90.0	0	0	1525	0.8
5,736	95.6	3.98	0	7.5	90.0	0	0	1615	0.9
5,748	95.8	3.99	0	7.5	90.0	0	0	1705	0.9
5,760	96.0	4.00	0	7.5	90.0	0	0	1795	1.0
5,772	96.2	4.01	0	7.5	90.0	0	0	1885	1.1
5,784	96.4	4.02	0	7.5	90.0	100	1,200	775	0.4
5,796	96.6	4.03	0	7.5	90.0	0	0	865	0.5
5,808	96.8	4.03	0	7.5	90.0	0	0	955	0.5
5,820	97.0	4.04	0	7.5	90.0	0	0	1045	0.6
5,832	97.2	4.05	0	7.5	90.0	0	0	1135	0.6
5,844	97.4	4.06	0	7.5	90.0	0	0	1225	0.7
5,856	97.6	4.07	0	7.5	90.0	0	0	1315	0.7
5,868	97.8	4.08	0	7.5	90.0	0	0	1405	0.8
5,880	98.0	4.08	0	7.5	90.0	0	0	1495	0.8
5,892	98.2	4.09	0	7.5	90.0	0	0	1585	0.9
5,904	98.4	4.10	0	7.5	90.0	0	0	1675	0.9
5,916	98.6	4.11	0	7.5	90.0	0	0	1765	1.0
5,928	98.8	4.12	0	7.5	90.0	0	0	1855	1.0
5,940	99.0	4.13	0	7.5	90.0	100	1,200	745	0.4
5,952	99.2	4.13	0	7.5	90.0	0	0	835	0.5
5,964	99.4	4.14	0	7.5	90.0	0	0	925	0.5
5,976	99.6	4.15	0	7.5	90.0	0	0	1015	0.6
5,988	99.8	4.16	0	7.5	90.0	0	0	1105	0.6
6,000	100.0	4.17	0	7.5	90.0	0	0	1195	0.7
6,012	100.2	4.18	0	7.5	90.0	0	0	1285	0.7
6,024	100.4	4.18	0	7.5	90.0	0	0	1375	0.8
6,036	100.6	4.19	0	7.5	90.0	0	0	1465	0.8
6,048	100.8	4.20	0	7.5	90.0	0	0	1555	0.9
6,060	101.0	4.21	0	7.5	90.0	0	0	1645	0.9
6,072	101.2	4.22	0	7.5	90.0	0	0	1735	1.0
6,084	101.4	4.23	0	7.5	90.0	0	0	1825	1.0
6,096	101.6	4.23	0	7.5	90.0	100	1,200	715	0.4
6,108	101.8	4.24	0	7.5	90.0	0	0	805	0.4
6,120	102.0	4.25	0	7.5	90.0	0	0	895	0.5
6,132	102.2	4.26	0	7.5	90.0	0	0	985	0.5
6,144	102.4	4.27	0	7.5	90.0	0	0	1075	0.6
6,156	102.6	4.28	0	7.5	90.0	0	0	1165	0.6
6,168	102.8	4.28	0	7.5	90.0	0	0	1255	0.7
6,180	103.0	4.29	0	7.5	90.0	0	0	1345	0.7
6,192	103.2	4.30	0	7.5	90.0	0	0	1435	0.8
6,204	103.4	4.31	0	7.5	90.0	0	0	1525	0.8
6,216	103.6	4.32	0	7.5	90.0	0	0	1615	0.9
6,228	103.8	4.33	0	7.5	90.0	0	0	1705	0.9
6,240	104.0	4.33	0	7.5	90.0	0	0	1795	1.0
6,252	104.2	4.34	0	7.5	90.0	0	0	1885	1.1
6,264	104.4	4.35	0	7.5	90.0	100	1,200	775	0.4
6,276	104.6	4.36	0	7.5	90.0	0	0	865	0.5
6,288	104.8	4.37	0	7.5	90.0	0	0	955	0.5
6,300	105.0	4.38	0	7.5	90.0	0	0	1045	0.6
6,312	105.2	4.38	0	7.5	90.0	0	0	1135	0.6
6,324	105.4	4.39	0	7.5	90.0	0	0	1225	0.7
6,336	105.6	4.40	0	7.5	90.0	0	0	1315	0.7
6,348	105.8	4.41	0	7.5	90.0	0	0	1405	0.8
6,360	106.0	4.42	0	7.5	90.0	0	0	1495	0.8
6,372	106.2	4.43	0	7.5	90.0	0	0	1585	0.9
6,384	106.4	4.43	0	7.5	90.0	0	0	1675	0.9
6,396	106.6	4.44	0	7.5	90.0	0	0	1765	1.0
6,408	106.8	4.45	0	7.5	90.0	0	0	1855	1.0
6,420	107.0	4.46	0	7.5	90.0	100	1,200	745	0.4

Attachment 11 - Cell 3 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,432	107.2	4.47	0	7.5	90.0	0	0	835	0.5
6,444	107.4	4.48	0	7.5	90.0	0	0	925	0.5
6,456	107.6	4.48	0	7.5	90.0	0	0	1015	0.6
6,468	107.8	4.49	0	7.5	90.0	0	0	1105	0.6
6,480	108.0	4.50	0	7.5	90.0	0	0	1195	0.7
6,492	108.2	4.51	0	7.5	90.0	0	0	1285	0.7
6,504	108.4	4.52	0	7.5	90.0	0	0	1375	0.8
6,516	108.6	4.53	0	7.5	90.0	0	0	1465	0.8
6,528	108.8	4.53	0	7.5	90.0	0	0	1555	0.9
6,540	109.0	4.54	0	7.5	90.0	0	0	1645	0.9
6,552	109.2	4.55	0	7.5	90.0	0	0	1735	1.0
6,564	109.4	4.56	0	7.5	90.0	0	0	1825	1.0
6,576	109.6	4.57	0	7.5	90.0	100	1,200	715	0.4
6,588	109.8	4.58	0	7.5	90.0	0	0	805	0.4
6,600	110.0	4.58	0	7.5	90.0	0	0	895	0.5
6,612	110.2	4.59	0	7.5	90.0	0	0	985	0.5
6,624	110.4	4.60	0	7.5	90.0	0	0	1075	0.6
6,636	110.6	4.61	0	7.5	90.0	0	0	1165	0.6
6,648	110.8	4.62	0	7.5	90.0	0	0	1255	0.7
6,660	111.0	4.63	0	7.5	90.0	0	0	1345	0.7
6,672	111.2	4.63	0	7.5	90.0	0	0	1435	0.8
6,684	111.4	4.64	0	7.5	90.0	0	0	1525	0.8
6,696	111.6	4.65	0	7.5	90.0	0	0	1615	0.9
6,708	111.8	4.66	0	7.5	90.0	0	0	1705	0.9
6,720	112.0	4.67	0	7.5	90.0	0	0	1795	1.0
6,732	112.2	4.68	0	7.5	90.0	0	0	1885	1.1
6,744	112.4	4.68	0	7.5	90.0	100	1,200	775	0.4
6,756	112.6	4.69	0	7.5	90.0	0	0	865	0.5
6,768	112.8	4.70	0	7.5	90.0	0	0	955	0.5
6,780	113.0	4.71	0	7.5	90.0	0	0	1045	0.6
6,792	113.2	4.72	0	7.5	90.0	0	0	1135	0.6
6,804	113.4	4.73	0	7.5	90.0	0	0	1225	0.7
6,816	113.6	4.73	0	7.5	90.0	0	0	1315	0.7
6,828	113.8	4.74	0	7.5	90.0	0	0	1405	0.8
6,840	114.0	4.75	0	7.5	90.0	0	0	1495	0.8
6,852	114.2	4.76	0	7.5	90.0	0	0	1585	0.9
6,864	114.4	4.77	0	7.5	90.0	0	0	1675	0.9
6,876	114.6	4.78	0	7.5	90.0	0	0	1765	1.0
6,888	114.8	4.78	0	7.5	90.0	0	0	1855	1.0
6,900	115.0	4.79	0	7.5	90.0	100	1,200	745	0.4
6,912	115.2	4.80	0	7.5	90.0	0	0	835	0.5
6,924	115.4	4.81	0	7.5	90.0	0	0	925	0.5
6,936	115.6	4.82	0	7.5	90.0	0	0	1015	0.6
6,948	115.8	4.83	0	7.5	90.0	0	0	1105	0.6
6,960	116.0	4.83	0	7.5	90.0	0	0	1195	0.7
6,972	116.2	4.84	0	7.5	90.0	0	0	1285	0.7
6,984	116.4	4.85	0	7.5	90.0	0	0	1375	0.8
6,996	116.6	4.86	0	7.5	90.0	0	0	1465	0.8
7,008	116.8	4.87	0	7.5	90.0	0	0	1555	0.9
7,020	117.0	4.88	0	7.5	90.0	0	0	1645	0.9
7,032	117.2	4.88	0	7.5	90.0	0	0	1735	1.0
7,044	117.4	4.89	0	7.5	90.0	0	0	1825	1.0
7,056	117.6	4.90	0	7.5	90.0	100	1,200	715	0.4
7,068	117.8	4.91	0	7.5	90.0	0	0	805	0.4
7,080	118.0	4.92	0	7.5	90.0	0	0	895	0.5
7,092	118.2	4.93	0	7.5	90.0	0	0	985	0.5
7,104	118.4	4.93	0	7.5	90.0	0	0	1075	0.6
7,116	118.6	4.94	0	7.5	90.0	0	0	1165	0.6
7,128	118.8	4.95	0	7.5	90.0	0	0	1255	0.7
7,140	119.0	4.96	0	7.5	90.0	0	0	1345	0.7
7,152	119.2	4.97	0	7.5	90.0	0	0	1435	0.8
7,164	119.4	4.98	0	7.5	90.0	0	0	1525	0.8
7,176	119.6	4.98	0	7.5	90.0	0	0	1615	0.9
7,188	119.8	4.99	0	7.5	90.0	0	0	1705	0.9
7,200	120.0	5.00	0	7.5	90.0	0	0	1795	1.0
7,212	120.2	5.01	0	7.5	90.0	0	0	1885	1.1
7,224	120.4	5.02	0	7.5	90.0	100	1,200	775	0.4

Attachment 11 - Cell 3 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,236	120.6	5.03	0	7.5	90.0	0	0	865	0.5
7,248	120.8	5.03	0	7.5	90.0	0	0	955	0.5
7,260	121.0	5.04	0	7.5	90.0	0	0	1045	0.6
7,272	121.2	5.05	0	7.5	90.0	0	0	1135	0.6
7,284	121.4	5.06	0	7.5	90.0	0	0	1225	0.7
7,296	121.6	5.07	0	7.5	90.0	0	0	1315	0.7
7,308	121.8	5.08	0	7.5	90.0	0	0	1405	0.8
7,320	122.0	5.08	0	7.5	90.0	0	0	1495	0.8
7,332	122.2	5.09	0	7.5	90.0	0	0	1585	0.9
7,344	122.4	5.10	0	7.5	90.0	0	0	1675	0.9
7,356	122.6	5.11	0	7.5	90.0	0	0	1765	1.0
7,368	122.8	5.12	0	7.5	90.0	0	0	1855	1.0
7,380	123.0	5.13	0	7.5	90.0	100	1,200	745	0.4
7,392	123.2	5.13	0	7.5	90.0	0	0	835	0.5
7,404	123.4	5.14	0	7.5	90.0	0	0	925	0.5
7,416	123.6	5.15	0	7.5	90.0	0	0	1015	0.6
7,428	123.8	5.16	0	7.5	90.0	0	0	1105	0.6
7,440	124.0	5.17	0	7.5	90.0	0	0	1195	0.7
7,452	124.2	5.18	0	7.5	90.0	0	0	1285	0.7
7,464	124.4	5.18	0	7.5	90.0	0	0	1375	0.8
7,476	124.6	5.19	0	7.5	90.0	0	0	1465	0.8
7,488	124.8	5.20	0	7.5	90.0	0	0	1555	0.9
7,500	125.0	5.21	0	7.5	90.0	0	0	1645	0.9
7,512	125.2	5.22	0	7.5	90.0	0	0	1735	1.0
7,524	125.4	5.23	0	7.5	90.0	0	0	1825	1.0
7,536	125.6	5.23	0	7.5	90.0	100	1,200	715	0.4
7,548	125.8	5.24	0	7.5	90.0	0	0	805	0.4
7,560	126.0	5.25	0	7.5	90.0	0	0	895	0.5
7,572	126.2	5.26	0	7.5	90.0	0	0	985	0.5
7,584	126.4	5.27	0	7.5	90.0	0	0	1075	0.6
7,596	126.6	5.28	0	7.5	90.0	0	0	1165	0.6
7,608	126.8	5.28	0	7.5	90.0	0	0	1255	0.7
7,620	127.0	5.29	0	7.5	90.0	0	0	1345	0.7
7,632	127.2	5.30	0	7.5	90.0	0	0	1435	0.8
7,644	127.4	5.31	0	7.5	90.0	0	0	1525	0.8
7,656	127.6	5.32	0	7.5	90.0	0	0	1615	0.9
7,668	127.8	5.33	0	7.5	90.0	0	0	1705	0.9
7,680	128.0	5.33	0	7.5	90.0	0	0	1795	1.0
7,692	128.2	5.34	0	7.5	90.0	0	0	1885	1.1
7,704	128.4	5.35	0	7.5	90.0	100	1,200	775	0.4
7,716	128.6	5.36	0	7.5	90.0	0	0	865	0.5
7,728	128.8	5.37	0	7.5	90.0	0	0	955	0.5
7,740	129.0	5.38	0	7.5	90.0	0	0	1045	0.6
7,752	129.2	5.38	0	7.5	90.0	0	0	1135	0.6
7,764	129.4	5.39	0	7.5	90.0	0	0	1225	0.7
7,776	129.6	5.40	0	7.5	90.0	0	0	1315	0.7
7,788	129.8	5.41	0	7.5	90.0	0	0	1405	0.8
7,800	130.0	5.42	0	7.5	90.0	0	0	1495	0.8
7,812	130.2	5.43	0	7.5	90.0	0	0	1585	0.9
7,824	130.4	5.43	0	7.5	90.0	0	0	1675	0.9
7,836	130.6	5.44	0	7.5	90.0	0	0	1765	1.0
7,848	130.8	5.45	0	7.5	90.0	0	0	1855	1.0
7,860	131.0	5.46	0	7.5	90.0	100	1,200	745	0.4
7,872	131.2	5.47	0	7.5	90.0	0	0	835	0.5
7,884	131.4	5.48	0	7.5	90.0	0	0	925	0.5
7,896	131.6	5.48	0	7.5	90.0	0	0	1015	0.6
7,908	131.8	5.49	0	7.5	90.0	0	0	1105	0.6
7,920	132.0	5.50	0	7.5	90.0	0	0	1195	0.7
7,932	132.2	5.51	0	7.5	90.0	0	0	1285	0.7
7,944	132.4	5.52	0	7.5	90.0	0	0	1375	0.8
7,956	132.6	5.53	0	7.5	90.0	0	0	1465	0.8
7,968	132.8	5.53	0	7.5	90.0	0	0	1555	0.9
7,980	133.0	5.54	0	7.5	90.0	0	0	1645	0.9
7,992	133.2	5.55	0	7.5	90.0	0	0	1735	1.0
8,004	133.4	5.56	0	7.5	90.0	0	0	1825	1.0
8,016	133.6	5.57	0	7.5	90.0	100	1,200	715	0.4
8,028	133.8	5.58	0	7.5	90.0	0	0	805	0.4

Attachment 11 - Cell 3 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,040	134.0	5.58	0	7.5	90.0	0	0	895	0.5
8,052	134.2	5.59	0	7.5	90.0	0	0	985	0.5
8,064	134.4	5.60	0	7.5	90.0	0	0	1075	0.6
8,076	134.6	5.61	0	7.5	90.0	0	0	1165	0.6
8,088	134.8	5.62	0	7.5	90.0	0	0	1255	0.7
8,100	135.0	5.63	0	7.5	90.0	0	0	1345	0.7
8,112	135.2	5.63	0	7.5	90.0	0	0	1435	0.8
8,124	135.4	5.64	0	7.5	90.0	0	0	1525	0.8
8,136	135.6	5.65	0	7.5	90.0	0	0	1615	0.9
8,148	135.8	5.66	0	7.5	90.0	0	0	1705	0.9
8,160	136.0	5.67	0	7.5	90.0	0	0	1795	1.0
8,172	136.2	5.68	0	7.5	90.0	0	0	1885	1.1
8,184	136.4	5.68	0	7.5	90.0	100	1,200	775	0.4
8,196	136.6	5.69	0	7.5	90.0	0	0	865	0.5
8,208	136.8	5.70	0	7.5	90.0	0	0	955	0.5
8,220	137.0	5.71	0	7.5	90.0	0	0	1045	0.6
8,232	137.2	5.72	0	7.5	90.0	0	0	1135	0.6
8,244	137.4	5.73	0	7.5	90.0	0	0	1225	0.7
8,256	137.6	5.73	0	7.5	90.0	0	0	1315	0.7
8,268	137.8	5.74	0	7.5	90.0	0	0	1405	0.8
8,280	138.0	5.75	0	7.5	90.0	0	0	1495	0.8
8,292	138.2	5.76	0	7.5	90.0	0	0	1585	0.9
8,304	138.4	5.77	0	7.5	90.0	0	0	1675	0.9
8,316	138.6	5.78	0	7.5	90.0	0	0	1765	1.0
8,328	138.8	5.78	0	7.5	90.0	0	0	1855	1.0
8,340	139.0	5.79	0	7.5	90.0	100	1,200	745	0.4
8,352	139.2	5.80	0	7.5	90.0	0	0	835	0.5
8,364	139.4	5.81	0	7.5	90.0	0	0	925	0.5
8,376	139.6	5.82	0	7.5	90.0	0	0	1015	0.6
8,388	139.8	5.83	0	7.5	90.0	0	0	1105	0.6
8,400	140.0	5.83	0	7.5	90.0	0	0	1195	0.7
8,412	140.2	5.84	0	7.5	90.0	0	0	1285	0.7
8,424	140.4	5.85	0	7.5	90.0	0	0	1375	0.8
8,436	140.6	5.86	0	7.5	90.0	0	0	1465	0.8
8,448	140.8	5.87	0	7.5	90.0	0	0	1555	0.9
8,460	141.0	5.88	0	7.5	90.0	0	0	1645	0.9
8,472	141.2	5.88	0	7.5	90.0	0	0	1735	1.0
8,484	141.4	5.89	0	7.5	90.0	0	0	1825	1.0
8,496	141.6	5.90	0	7.5	90.0	100	1,200	715	0.4
8,508	141.8	5.91	0	7.5	90.0	0	0	805	0.4
8,520	142.0	5.92	0	7.5	90.0	0	0	895	0.5
8,532	142.2	5.93	0	7.5	90.0	0	0	985	0.5
8,544	142.4	5.93	0	7.5	90.0	0	0	1075	0.6
8,556	142.6	5.94	0	7.5	90.0	0	0	1165	0.6
8,568	142.8	5.95	0	7.5	90.0	0	0	1255	0.7
8,580	143.0	5.96	0	7.5	90.0	0	0	1345	0.7
8,592	143.2	5.97	0	7.5	90.0	0	0	1435	0.8
8,604	143.4	5.98	0	7.5	90.0	0	0	1525	0.8
8,616	143.6	5.98	0	7.5	90.0	0	0	1615	0.9
8,628	143.8	5.99	0	7.5	90.0	0	0	1705	0.9
8,640	144.0	6.00	0	7.5	90.0	0	0	1795	1.0
8,652	144.2	6.01	0	7.5	90.0	0	0	1885	1.1
8,664	144.4	6.02	0	7.5	90.0	100	1,200	775	0.4
8,676	144.6	6.03	0	7.5	90.0	0	0	865	0.5
8,688	144.8	6.03	0	7.5	90.0	0	0	955	0.5
8,700	145.0	6.04	0	7.5	90.0	0	0	1045	0.6
8,712	145.2	6.05	0	7.5	90.0	0	0	1135	0.6
8,724	145.4	6.06	0	7.5	90.0	0	0	1225	0.7
8,736	145.6	6.07	0	7.5	90.0	0	0	1315	0.7
8,748	145.8	6.08	0	7.5	90.0	0	0	1405	0.8
8,760	146.0	6.08	0	7.5	90.0	0	0	1495	0.8
8,772	146.2	6.09	0	7.5	90.0	0	0	1585	0.9
8,784	146.4	6.10	0	7.5	90.0	0	0	1675	0.9
8,796	146.6	6.11	0	7.5	90.0	0	0	1765	1.0
8,808	146.8	6.12	0	7.5	90.0	0	0	1855	1.0
8,820	147.0	6.13	0	7.5	90.0	100	1,200	745	0.4
8,832	147.2	6.13	0	7.5	90.0	0	0	835	0.5

Attachment 11 - Cell 3 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,844	147.4	6.14	0	7.5	90.0	0	0	925	0.5
8,856	147.6	6.15	0	7.5	90.0	0	0	1015	0.6
8,868	147.8	6.16	0	7.5	90.0	0	0	1105	0.6
8,880	148.0	6.17	0	7.5	90.0	0	0	1195	0.7
8,892	148.2	6.18	0	7.5	90.0	0	0	1285	0.7
8,904	148.4	6.18	0	7.5	90.0	0	0	1375	0.8
8,916	148.6	6.19	0	7.5	90.0	0	0	1465	0.8
8,928	148.8	6.20	0	7.5	90.0	0	0	1555	0.9
8,940	149.0	6.21	0	7.5	90.0	0	0	1645	0.9
8,952	149.2	6.22	0	7.5	90.0	0	0	1735	1.0
8,964	149.4	6.23	0	7.5	90.0	0	0	1825	1.0
8,976	149.6	6.23	0	7.5	90.0	100	1,200	715	0.4
8,988	149.8	6.24	0	7.5	90.0	0	0	805	0.4
9,000	150.0	6.25	0	7.5	90.0	0	0	895	0.5
9,012	150.2	6.26	0	7.5	90.0	0	0	985	0.5
9,024	150.4	6.27	0	7.5	90.0	0	0	1075	0.6
9,036	150.6	6.28	0	7.5	90.0	0	0	1165	0.6
9,048	150.8	6.28	0	7.5	90.0	0	0	1255	0.7
9,060	151.0	6.29	0	7.5	90.0	0	0	1345	0.7
9,072	151.2	6.30	0	7.5	90.0	0	0	1435	0.8
9,084	151.4	6.31	0	7.5	90.0	0	0	1525	0.8
9,096	151.6	6.32	0	7.5	90.0	0	0	1615	0.9
9,108	151.8	6.33	0	7.5	90.0	0	0	1705	0.9
9,120	152.0	6.33	0	7.5	90.0	0	0	1795	1.0
9,132	152.2	6.34	0	7.5	90.0	0	0	1885	1.1
9,144	152.4	6.35	0	7.5	90.0	100	1,200	775	0.4
9,156	152.6	6.36	0	7.5	90.0	0	0	865	0.5
9,168	152.8	6.37	0	7.5	90.0	0	0	955	0.5
9,180	153.0	6.38	0	7.5	90.0	0	0	1045	0.6
9,192	153.2	6.38	0	7.5	90.0	0	0	1135	0.6
9,204	153.4	6.39	0	7.5	90.0	0	0	1225	0.7
9,216	153.6	6.40	0	7.5	90.0	0	0	1315	0.7
9,228	153.8	6.41	0	7.5	90.0	0	0	1405	0.8
9,240	154.0	6.42	0	7.5	90.0	0	0	1495	0.8
9,252	154.2	6.43	0	7.5	90.0	0	0	1585	0.9
9,264	154.4	6.43	0	7.5	90.0	0	0	1675	0.9
9,276	154.6	6.44	0	7.5	90.0	0	0	1765	1.0
9,288	154.8	6.45	0	7.5	90.0	0	0	1855	1.0
9,300	155.0	6.46	0	7.5	90.0	100	1,200	745	0.4
9,312	155.2	6.47	0	7.5	90.0	0	0	835	0.5
9,324	155.4	6.48	0	7.5	90.0	0	0	925	0.5
9,336	155.6	6.48	0	7.5	90.0	0	0	1015	0.6
9,348	155.8	6.49	0	7.5	90.0	0	0	1105	0.6
9,360	156.0	6.50	0	7.5	90.0	0	0	1195	0.7
9,372	156.2	6.51	0	7.5	90.0	0	0	1285	0.7
9,384	156.4	6.52	0	7.5	90.0	0	0	1375	0.8
9,396	156.6	6.53	0	7.5	90.0	0	0	1465	0.8
9,408	156.8	6.53	0	7.5	90.0	0	0	1555	0.9
9,420	157.0	6.54	0	7.5	90.0	0	0	1645	0.9
9,432	157.2	6.55	0	7.5	90.0	0	0	1735	1.0
9,444	157.4	6.56	0	7.5	90.0	0	0	1825	1.0
9,456	157.6	6.57	0	7.5	90.0	100	1,200	715	0.4
9,468	157.8	6.58	0	7.5	90.0	0	0	805	0.4
9,480	158.0	6.58	0	7.5	90.0	0	0	895	0.5
9,492	158.2	6.59	0	7.5	90.0	0	0	985	0.5
9,504	158.4	6.60	0	7.5	90.0	0	0	1075	0.6
9,516	158.6	6.61	0	7.5	90.0	0	0	1165	0.6
9,528	158.8	6.62	0	7.5	90.0	0	0	1255	0.7
9,540	159.0	6.63	0	7.5	90.0	0	0	1345	0.7
9,552	159.2	6.63	0	7.5	90.0	0	0	1435	0.8
9,564	159.4	6.64	0	7.5	90.0	0	0	1525	0.8
9,576	159.6	6.65	0	7.5	90.0	0	0	1615	0.9
9,588	159.8	6.66	0	7.5	90.0	0	0	1705	0.9
9,600	160.0	6.67	0	7.5	90.0	0	0	1795	1.0
9,612	160.2	6.68	0	7.5	90.0	0	0	1885	1.1
9,624	160.4	6.68	0	7.5	90.0	100	1,200	775	0.4
9,636	160.6	6.69	0	7.5	90.0	0	0	865	0.5

Attachment 11 - Cell 3 Leakage Detection Sump - Peak Conditions									
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	Incremental Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
9,648	160.8	6.70	0	7.5	90.0	0	0	955	0.5
9,660	161.0	6.71	0	7.5	90.0	0	0	1045	0.6
9,672	161.2	6.72	0	7.5	90.0	0	0	1135	0.6
9,684	161.4	6.73	0	7.5	90.0	0	0	1225	0.7
9,696	161.6	6.73	0	7.5	90.0	0	0	1315	0.7
9,708	161.8	6.74	0	7.5	90.0	0	0	1405	0.8
9,720	162.0	6.75	0	7.5	90.0	0	0	1495	0.8
9,732	162.2	6.76	0	7.5	90.0	0	0	1585	0.9
9,744	162.4	6.77	0	7.5	90.0	0	0	1675	0.9
9,756	162.6	6.78	0	7.5	90.0	0	0	1765	1.0
9,768	162.8	6.78	0	7.5	90.0	0	0	1855	1.0
9,780	163.0	6.79	0	7.5	90.0	100	1,200	745	0.4
9,792	163.2	6.80	0	7.5	90.0	0	0	835	0.5
9,804	163.4	6.81	0	7.5	90.0	0	0	925	0.5
9,816	163.6	6.82	0	7.5	90.0	0	0	1015	0.6
9,828	163.8	6.83	0	7.5	90.0	0	0	1105	0.6
9,840	164.0	6.83	0	7.5	90.0	0	0	1195	0.7
9,852	164.2	6.84	0	7.5	90.0	0	0	1285	0.7
9,864	164.4	6.85	0	7.5	90.0	0	0	1375	0.8
9,876	164.6	6.86	0	7.5	90.0	0	0	1465	0.8
9,888	164.8	6.87	0	7.5	90.0	0	0	1555	0.9
9,900	165.0	6.88	0	7.5	90.0	0	0	1645	0.9
9,912	165.2	6.88	0	7.5	90.0	0	0	1735	1.0
9,924	165.4	6.89	0	7.5	90.0	0	0	1825	1.0
9,936	165.6	6.90	0	7.5	90.0	100	1,200	715	0.4
9,948	165.8	6.91	0	7.5	90.0	0	0	805	0.4
9,960	166.0	6.92	0	7.5	90.0	0	0	895	0.5
9,972	166.2	6.93	0	7.5	90.0	0	0	985	0.5
9,984	166.4	6.93	0	7.5	90.0	0	0	1075	0.6
9,996	166.6	6.94	0	7.5	90.0	0	0	1165	0.6
10,008	166.8	6.95	0	7.5	90.0	0	0	1255	0.7
10,020	167.0	6.96	0	7.5	90.0	0	0	1345	0.7
10,032	167.2	6.97	0	7.5	90.0	0	0	1435	0.8
10,044	167.4	6.98	0	7.5	90.0	0	0	1525	0.8
10,056	167.6	6.98	0	7.5	90.0	0	0	1615	0.9
10,068	167.8	6.99	0	7.5	90.0	0	0	1705	0.9
10,080	168.0	7.00	0	7.5	90.0	0	0	1795	1.0

ATTACHMENT 12

Cell 3 Leachate Collection Sump – Average Conditions

Attachment 12 - Cell 3 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
0	0.0	0.00	0	8.7	0.0	0	0	0	3,590	1.00
12	0.2	0.01	0	8.7	104.0	0	0	0	3,694	1.03
24	0.4	0.02	0	8.7	104.0	100	0	1,200	2,598	0.72
36	0.6	0.03	0	8.7	104.0	100	0	1,200	1,502	0.42
48	0.8	0.03	0	8.7	104.0	0	0	0	1,606	0.45
60	1.0	0.04	0	8.7	104.0	0	0	0	1,710	0.48
72	1.2	0.05	0	8.7	104.0	0	0	0	1,814	0.51
84	1.4	0.06	0	8.7	104.0	0	0	0	1,918	0.53
96	1.6	0.07	0	8.7	104.0	0	0	0	2,022	0.56
108	1.8	0.08	0	8.7	104.0	0	0	0	2,126	0.59
120	2.0	0.08	0	8.7	104.0	0	0	0	2,230	0.62
132	2.2	0.09	0	8.7	104.0	0	0	0	2,334	0.65
144	2.4	0.10	0	8.7	104.0	0	0	0	2,438	0.68
156	2.6	0.11	0	8.7	104.0	0	0	0	2,542	0.71
168	2.8	0.12	0	8.7	104.0	0	0	0	2,646	0.74
180	3.0	0.13	0	8.7	104.0	0	0	0	2,750	0.77
192	3.2	0.13	0	8.7	104.0	0	0	0	2,854	0.79
204	3.4	0.14	0	8.7	104.0	0	0	0	2,958	0.82
216	3.6	0.15	0	8.7	104.0	0	0	0	3,062	0.85
228	3.8	0.16	0	8.7	104.0	0	0	0	3,165	0.88
240	4.0	0.17	0	8.7	104.0	0	0	0	3,269	0.91
252	4.2	0.18	0	8.7	104.0	0	0	0	3,373	0.94
264	4.4	0.18	0	8.7	104.0	0	0	0	3,477	0.97
276	4.6	0.19	0	8.7	104.0	0	0	0	3,581	1.00
288	4.8	0.20	0	8.7	104.0	0	0	0	3,685	1.03
300	5.0	0.21	0	8.7	104.0	100	0	1,200	2,589	0.72
312	5.2	0.22	0	8.7	104.0	100	0	1,200	1,493	0.42
324	5.4	0.23	0	8.7	104.0	0	0	0	1,597	0.44
336	5.6	0.23	0	8.7	104.0	0	0	0	1,701	0.47
348	5.8	0.24	0	8.7	104.0	0	0	0	1,805	0.50
360	6.0	0.25	0	8.7	104.0	0	0	0	1,909	0.53
372	6.2	0.26	0	8.7	104.0	0	0	0	2,013	0.56
384	6.4	0.27	0	8.7	104.0	0	0	0	2,117	0.59
396	6.6	0.28	0	8.7	104.0	0	0	0	2,221	0.62
408	6.8	0.28	0	8.7	104.0	0	0	0	2,325	0.65
420	7.0	0.29	0	8.7	104.0	0	0	0	2,429	0.68
432	7.2	0.30	0	8.7	104.0	0	0	0	2,533	0.71
444	7.4	0.31	0	8.7	104.0	0	0	0	2,637	0.73
456	7.6	0.32	0	8.7	104.0	0	0	0	2,741	0.76
468	7.8	0.33	0	8.7	104.0	0	0	0	2,844	0.79
480	8.0	0.33	0	8.7	104.0	0	0	0	2,948	0.82
492	8.2	0.34	0	8.7	104.0	0	0	0	3,052	0.85
504	8.4	0.35	0	8.7	104.0	0	0	0	3,156	0.88
516	8.6	0.36	0	8.7	104.0	0	0	0	3,260	0.91
528	8.8	0.37	0	8.7	104.0	0	0	0	3,364	0.94
540	9.0	0.38	0	8.7	104.0	0	0	0	3,468	0.97
552	9.2	0.38	0	8.7	104.0	0	0	0	3,572	0.99
564	9.4	0.39	0	8.7	104.0	0	0	0	3,676	1.02
576	9.6	0.40	0	8.7	104.0	100	0	1,200	2,580	0.72
588	9.8	0.41	0	8.7	104.0	100	0	1,200	1,484	0.41
600	10.0	0.42	0	8.7	104.0	0	0	0	1,588	0.44
612	10.2	0.43	0	8.7	104.0	0	0	0	1,692	0.47
624	10.4	0.43	0	8.7	104.0	0	0	0	1,796	0.50
636	10.6	0.44	0	8.7	104.0	0	0	0	1,900	0.53
648	10.8	0.45	0	8.7	104.0	0	0	0	2,004	0.56
660	11.0	0.46	0	8.7	104.0	0	0	0	2,108	0.59
672	11.2	0.47	0	8.7	104.0	0	0	0	2,212	0.62
684	11.4	0.48	0	8.7	104.0	0	0	0	2,316	0.64
696	11.6	0.48	0	8.7	104.0	0	0	0	2,419	0.67
708	11.8	0.49	0	8.7	104.0	0	0	0	2,523	0.70
720	12.0	0.50	0	8.7	104.0	0	0	0	2,627	0.73
732	12.2	0.51	0	8.7	104.0	0	0	0	2,731	0.76
744	12.4	0.52	0	8.7	104.0	0	0	0	2,835	0.79
756	12.6	0.53	0	8.7	104.0	0	0	0	2,939	0.82
768	12.8	0.53	0	8.7	104.0	0	0	0	3,043	0.85
780	13.0	0.54	0	8.7	104.0	0	0	0	3,147	0.88
792	13.2	0.55	0	8.7	104.0	0	0	0	3,251	0.91
804	13.4	0.56	0	8.7	104.0	0	0	0	3,355	0.93
816	13.6	0.57	0	8.7	104.0	0	0	0	3,459	0.96
828	13.8	0.58	0	8.7	104.0	0	0	0	3,563	0.99
840	14.0	0.58	0	8.7	104.0	0	0	0	3,667	1.02
852	14.2	0.59	0	8.7	104.0	100	0	1,200	2,571	0.72
864	14.4	0.60	0	8.7	104.0	100	0	1,200	1,475	0.41
876	14.6	0.61	0	8.7	104.0	0	0	0	1,579	0.44
888	14.8	0.62	0	8.7	104.0	0	0	0	1,683	0.47
900	15.0	0.63	0	8.7	104.0	0	0	0	1,787	0.50

Attachment 12 - Cell 3 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
912	15.2	0.63	0	8.7	104.0	0	0	0	1,891	0.53
924	15.4	0.64	0	8.7	104.0	0	0	0	1,995	0.56
936	15.6	0.65	0	8.7	104.0	0	0	0	2,098	0.58
948	15.8	0.66	0	8.7	104.0	0	0	0	2,202	0.61
960	16.0	0.67	0	8.7	104.0	0	0	0	2,306	0.64
972	16.2	0.68	0	8.7	104.0	0	0	0	2,410	0.67
984	16.4	0.68	0	8.7	104.0	0	0	0	2,514	0.70
996	16.6	0.69	0	8.7	104.0	0	0	0	2,618	0.73
1,008	16.8	0.70	0	8.7	104.0	0	0	0	2,722	0.76
1,020	17.0	0.71	0	8.7	104.0	0	0	0	2,826	0.79
1,032	17.2	0.72	0	8.7	104.0	0	0	0	2,930	0.82
1,044	17.4	0.73	0	8.7	104.0	0	0	0	3,034	0.85
1,056	17.6	0.73	0	8.7	104.0	0	0	0	3,138	0.87
1,068	17.8	0.74	0	8.7	104.0	0	0	0	3,242	0.90
1,080	18.0	0.75	0	8.7	104.0	0	0	0	3,346	0.93
1,092	18.2	0.76	0	8.7	104.0	0	0	0	3,450	0.96
1,104	18.4	0.77	0	8.7	104.0	0	0	0	3,554	0.99
1,116	18.6	0.78	0	8.7	104.0	0	0	0	3,658	1.02
1,128	18.8	0.78	0	8.7	104.0	100	0	1,200	2,562	0.71
1,140	19.0	0.79	0	8.7	104.0	100	0	1,200	1,466	0.41
1,152	19.2	0.80	0	8.7	104.0	0	0	0	1,570	0.44
1,164	19.4	0.81	0	8.7	104.0	0	0	0	1,674	0.47
1,176	19.6	0.82	0	8.7	104.0	0	0	0	1,777	0.50
1,188	19.8	0.83	0	8.7	104.0	0	0	0	1,881	0.52
1,200	20.0	0.83	0	8.7	104.0	0	0	0	1,985	0.55
1,212	20.2	0.84	0	8.7	104.0	0	0	0	2,089	0.58
1,224	20.4	0.85	0	8.7	104.0	0	0	0	2,193	0.61
1,236	20.6	0.86	0	8.7	104.0	0	0	0	2,297	0.64
1,248	20.8	0.87	0	8.7	104.0	0	0	0	2,401	0.67
1,260	21.0	0.88	0	8.7	104.0	0	0	0	2,505	0.70
1,272	21.2	0.88	0	8.7	104.0	0	0	0	2,609	0.73
1,284	21.4	0.89	0	8.7	104.0	0	0	0	2,713	0.76
1,296	21.6	0.90	0	8.7	104.0	0	0	0	2,817	0.78
1,308	21.8	0.91	0	8.7	104.0	0	0	0	2,921	0.81
1,320	22.0	0.92	0	8.7	104.0	0	0	0	3,025	0.84
1,332	22.2	0.93	0	8.7	104.0	0	0	0	3,129	0.87
1,344	22.4	0.93	0	8.7	104.0	0	0	0	3,233	0.90
1,356	22.6	0.94	0	8.7	104.0	0	0	0	3,337	0.93
1,368	22.8	0.95	0	8.7	104.0	0	0	0	3,441	0.96
1,380	23.0	0.96	0	8.7	104.0	0	0	0	3,545	0.99
1,392	23.2	0.97	0	8.7	104.0	0	0	0	3,649	1.02
1,404	23.4	0.98	0	8.7	104.0	100	0	1,200	2,553	0.71
1,416	23.6	0.98	0	8.7	104.0	100	0	1,200	1,456	0.41
1,428	23.8	0.99	0	8.7	104.0	0	0	0	1,560	0.43
1,440	24.0	1.00	0	8.7	104.0	0	0	0	1,664	0.46
1,452	24.2	1.01	0	8.7	104.0	0	0	0	1,768	0.49
1,464	24.4	1.02	0	8.7	104.0	0	0	0	1,872	0.52
1,476	24.6	1.03	0	8.7	104.0	0	0	0	1,976	0.55
1,488	24.8	1.03	0	8.7	104.0	0	0	0	2,080	0.58
1,500	25.0	1.04	0	8.7	104.0	0	0	0	2,184	0.61
1,512	25.2	1.05	0	8.7	104.0	0	0	0	2,288	0.64
1,524	25.4	1.06	0	8.7	104.0	0	0	0	2,392	0.67
1,536	25.6	1.07	0	8.7	104.0	0	0	0	2,496	0.70
1,548	25.8	1.08	0	8.7	104.0	0	0	0	2,600	0.72
1,560	26.0	1.08	0	8.7	104.0	0	0	0	2,704	0.75
1,572	26.2	1.09	0	8.7	104.0	0	0	0	2,808	0.78
1,584	26.4	1.10	0	8.7	104.0	0	0	0	2,912	0.81
1,596	26.6	1.11	0	8.7	104.0	0	0	0	3,016	0.84
1,608	26.8	1.12	0	8.7	104.0	0	0	0	3,120	0.87
1,620	27.0	1.13	0	8.7	104.0	0	0	0	3,224	0.90
1,632	27.2	1.13	0	8.7	104.0	0	0	0	3,328	0.93
1,644	27.4	1.14	0	8.7	104.0	0	0	0	3,432	0.96
1,656	27.6	1.15	0	8.7	104.0	0	0	0	3,535	0.98
1,668	27.8	1.16	0	8.7	104.0	0	0	0	3,639	1.01
1,680	28.0	1.17	0	8.7	104.0	100	0	1,200	2,543	0.71
1,692	28.2	1.18	0	8.7	104.0	100	0	1,200	1,447	0.40
1,704	28.4	1.18	0	8.7	104.0	0	0	0	1,551	0.43
1,716	28.6	1.19	0	8.7	104.0	0	0	0	1,655	0.46
1,728	28.8	1.20	0	8.7	104.0	0	0	0	1,759	0.49
1,740	29.0	1.21	0	8.7	104.0	0	0	0	1,863	0.52
1,752	29.2	1.22	0	8.7	104.0	0	0	0	1,967	0.55
1,764	29.4	1.23	0	8.7	104.0	0	0	0	2,071	0.58
1,776	29.6	1.23	0	8.7	104.0	0	0	0	2,175	0.61
1,788	29.8	1.24	0	8.7	104.0	0	0	0	2,279	0.63
1,800	30.0	1.25	0	8.7	104.0	0	0	0	2,383	0.66
1,812	30.2	1.26	0	8.7	104.0	0	0	0	2,487	0.69

Attachment 12 - Cell 3 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,824	30.4	1.27	0	8.7	104.0	0	0	0	2,591	0.72
1,836	30.6	1.28	0	8.7	104.0	0	0	0	2,695	0.75
1,848	30.8	1.28	0	8.7	104.0	0	0	0	2,799	0.78
1,860	31.0	1.29	0	8.7	104.0	0	0	0	2,903	0.81
1,872	31.2	1.30	0	8.7	104.0	0	0	0	3,007	0.84
1,884	31.4	1.31	0	8.7	104.0	0	0	0	3,111	0.87
1,896	31.6	1.32	0	8.7	104.0	0	0	0	3,214	0.90
1,908	31.8	1.33	0	8.7	104.0	0	0	0	3,318	0.92
1,920	32.0	1.33	0	8.7	104.0	0	0	0	3,422	0.95
1,932	32.2	1.34	0	8.7	104.0	0	0	0	3,526	0.98
1,944	32.4	1.35	0	8.7	104.0	0	0	0	3,630	1.01
1,956	32.6	1.36	0	8.7	104.0	100	0	1,200	2,534	0.71
1,968	32.8	1.37	0	8.7	104.0	100	0	1,200	1,438	0.40
1,980	33.0	1.38	0	8.7	104.0	0	0	0	1,542	0.43
1,992	33.2	1.38	0	8.7	104.0	0	0	0	1,646	0.46
2,004	33.4	1.39	0	8.7	104.0	0	0	0	1,750	0.49
2,016	33.6	1.40	0	8.7	104.0	0	0	0	1,854	0.52
2,028	33.8	1.41	0	8.7	104.0	0	0	0	1,958	0.55
2,040	34.0	1.42	0	8.7	104.0	0	0	0	2,062	0.57
2,052	34.2	1.43	0	8.7	104.0	0	0	0	2,166	0.60
2,064	34.4	1.43	0	8.7	104.0	0	0	0	2,270	0.63
2,076	34.6	1.44	0	8.7	104.0	0	0	0	2,374	0.66
2,088	34.8	1.45	0	8.7	104.0	0	0	0	2,478	0.69
2,100	35.0	1.46	0	8.7	104.0	0	0	0	2,582	0.72
2,112	35.2	1.47	0	8.7	104.0	0	0	0	2,686	0.75
2,124	35.4	1.48	0	8.7	104.0	0	0	0	2,790	0.78
2,136	35.6	1.48	0	8.7	104.0	0	0	0	2,893	0.81
2,148	35.8	1.49	0	8.7	104.0	0	0	0	2,997	0.83
2,160	36.0	1.50	0	8.7	104.0	0	0	0	3,101	0.86
2,172	36.2	1.51	0	8.7	104.0	0	0	0	3,205	0.89
2,184	36.4	1.52	0	8.7	104.0	0	0	0	3,309	0.92
2,196	36.6	1.53	0	8.7	104.0	0	0	0	3,413	0.95
2,208	36.8	1.53	0	8.7	104.0	0	0	0	3,517	0.98
2,220	37.0	1.54	0	8.7	104.0	0	0	0	3,621	1.01
2,232	37.2	1.55	0	8.7	104.0	100	0	1,200	2,525	0.70
2,244	37.4	1.56	0	8.7	104.0	100	0	1,200	1,429	0.40
2,256	37.6	1.57	0	8.7	104.0	0	0	0	1,533	0.43
2,268	37.8	1.58	0	8.7	104.0	0	0	0	1,637	0.46
2,280	38.0	1.58	0	8.7	104.0	0	0	0	1,741	0.48
2,292	38.2	1.59	0	8.7	104.0	0	0	0	1,845	0.51
2,304	38.4	1.60	0	8.7	104.0	0	0	0	1,949	0.54
2,316	38.6	1.61	0	8.7	104.0	0	0	0	2,053	0.57
2,328	38.8	1.62	0	8.7	104.0	0	0	0	2,157	0.60
2,340	39.0	1.63	0	8.7	104.0	0	0	0	2,261	0.63
2,352	39.2	1.63	0	8.7	104.0	0	0	0	2,365	0.66
2,364	39.4	1.64	0	8.7	104.0	0	0	0	2,469	0.69
2,376	39.6	1.65	0	8.7	104.0	0	0	0	2,572	0.72
2,388	39.8	1.66	0	8.7	104.0	0	0	0	2,676	0.75
2,400	40.0	1.67	0	8.7	104.0	0	0	0	2,780	0.77
2,412	40.2	1.68	0	8.7	104.0	0	0	0	2,884	0.80
2,424	40.4	1.68	0	8.7	104.0	0	0	0	2,988	0.83
2,436	40.6	1.69	0	8.7	104.0	0	0	0	3,092	0.86
2,448	40.8	1.70	0	8.7	104.0	0	0	0	3,196	0.89
2,460	41.0	1.71	0	8.7	104.0	0	0	0	3,300	0.92
2,472	41.2	1.72	0	8.7	104.0	0	0	0	3,404	0.95
2,484	41.4	1.73	0	8.7	104.0	0	0	0	3,508	0.98
2,496	41.6	1.73	0	8.7	104.0	0	0	0	3,612	1.01
2,508	41.8	1.74	0	8.7	104.0	100	0	1,200	2,516	0.70
2,520	42.0	1.75	0	8.7	104.0	100	0	1,200	1,420	0.40
2,532	42.2	1.76	0	8.7	104.0	0	0	0	1,524	0.42
2,544	42.4	1.77	0	8.7	104.0	0	0	0	1,628	0.45
2,556	42.6	1.78	0	8.7	104.0	0	0	0	1,732	0.48
2,568	42.8	1.78	0	8.7	104.0	0	0	0	1,836	0.51
2,580	43.0	1.79	0	8.7	104.0	0	0	0	1,940	0.54
2,592	43.2	1.80	0	8.7	104.0	0	0	0	2,044	0.57
2,604	43.4	1.81	0	8.7	104.0	0	0	0	2,148	0.60
2,616	43.6	1.82	0	8.7	104.0	0	0	0	2,251	0.63
2,628	43.8	1.83	0	8.7	104.0	0	0	0	2,355	0.66
2,640	44.0	1.83	0	8.7	104.0	0	0	0	2,459	0.68
2,652	44.2	1.84	0	8.7	104.0	0	0	0	2,563	0.71
2,664	44.4	1.85	0	8.7	104.0	0	0	0	2,667	0.74
2,676	44.6	1.86	0	8.7	104.0	0	0	0	2,771	0.77
2,688	44.8	1.87	0	8.7	104.0	0	0	0	2,875	0.80
2,700	45.0	1.88	0	8.7	104.0	0	0	0	2,979	0.83
2,712	45.2	1.88	0	8.7	104.0	0	0	0	3,083	0.86
2,724	45.4	1.89	0	8.7	104.0	0	0	0	3,187	0.89

Attachment 12 - Cell 3 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
2,736	45.6	1.90	0	8.7	104.0	0	0	0	3,291	0.92
2,748	45.8	1.91	0	8.7	104.0	0	0	0	3,395	0.95
2,760	46.0	1.92	0	8.7	104.0	0	0	0	3,499	0.97
2,772	46.2	1.93	0	8.7	104.0	0	0	0	3,603	1.00
2,784	46.4	1.93	0	8.7	104.0	100	0	1,200	2,507	0.70
2,796	46.6	1.94	0	8.7	104.0	100	0	1,200	1,411	0.39
2,808	46.8	1.95	0	8.7	104.0	0	0	0	1,515	0.42
2,820	47.0	1.96	0	8.7	104.0	0	0	0	1,619	0.45
2,832	47.2	1.97	0	8.7	104.0	0	0	0	1,723	0.48
2,844	47.4	1.98	0	8.7	104.0	0	0	0	1,827	0.51
2,856	47.6	1.98	0	8.7	104.0	0	0	0	1,930	0.54
2,868	47.8	1.99	0	8.7	104.0	0	0	0	2,034	0.57
2,880	48.0	2.00	0	8.7	104.0	0	0	0	2,138	0.60
2,892	48.2	2.01	0	8.7	104.0	0	0	0	2,242	0.62
2,904	48.4	2.02	0	8.7	104.0	0	0	0	2,346	0.65
2,916	48.6	2.03	0	8.7	104.0	0	0	0	2,450	0.68
2,928	48.8	2.03	0	8.7	104.0	0	0	0	2,554	0.71
2,940	49.0	2.04	0	8.7	104.0	0	0	0	2,658	0.74
2,952	49.2	2.05	0	8.7	104.0	0	0	0	2,762	0.77
2,964	49.4	2.06	0	8.7	104.0	0	0	0	2,866	0.80
2,976	49.6	2.07	0	8.7	104.0	0	0	0	2,970	0.83
2,988	49.8	2.08	0	8.7	104.0	0	0	0	3,074	0.86
3,000	50.0	2.08	0	8.7	104.0	0	0	0	3,178	0.89
3,012	50.2	2.09	0	8.7	104.0	0	0	0	3,282	0.91
3,024	50.4	2.10	0	8.7	104.0	0	0	0	3,386	0.94
3,036	50.6	2.11	0	8.7	104.0	0	0	0	3,490	0.97
3,048	50.8	2.12	0	8.7	104.0	0	0	0	3,594	1.00
3,060	51.0	2.13	0	8.7	104.0	100	0	1,200	2,498	0.70
3,072	51.2	2.13	0	8.7	104.0	100	0	1,200	1,402	0.39
3,084	51.4	2.14	0	8.7	104.0	0	0	0	1,506	0.42
3,096	51.6	2.15	0	8.7	104.0	0	0	0	1,609	0.45
3,108	51.8	2.16	0	8.7	104.0	0	0	0	1,713	0.48
3,120	52.0	2.17	0	8.7	104.0	0	0	0	1,817	0.51
3,132	52.2	2.18	0	8.7	104.0	0	0	0	1,921	0.54
3,144	52.4	2.18	0	8.7	104.0	0	0	0	2,025	0.56
3,156	52.6	2.19	0	8.7	104.0	0	0	0	2,129	0.59
3,168	52.8	2.20	0	8.7	104.0	0	0	0	2,233	0.62
3,180	53.0	2.21	0	8.7	104.0	0	0	0	2,337	0.65
3,192	53.2	2.22	0	8.7	104.0	0	0	0	2,441	0.68
3,204	53.4	2.23	0	8.7	104.0	0	0	0	2,545	0.71
3,216	53.6	2.23	0	8.7	104.0	0	0	0	2,649	0.74
3,228	53.8	2.24	0	8.7	104.0	0	0	0	2,753	0.77
3,240	54.0	2.25	0	8.7	104.0	0	0	0	2,857	0.80
3,252	54.2	2.26	0	8.7	104.0	0	0	0	2,961	0.82
3,264	54.4	2.27	0	8.7	104.0	0	0	0	3,065	0.85
3,276	54.6	2.28	0	8.7	104.0	0	0	0	3,169	0.88
3,288	54.8	2.28	0	8.7	104.0	0	0	0	3,273	0.91
3,300	55.0	2.29	0	8.7	104.0	0	0	0	3,377	0.94
3,312	55.2	2.30	0	8.7	104.0	0	0	0	3,481	0.97
3,324	55.4	2.31	0	8.7	104.0	0	0	0	3,585	1.00
3,336	55.6	2.32	0	8.7	104.0	0	0	0	3,688	1.03
3,348	55.8	2.33	0	8.7	104.0	100	0	1,200	2,592	0.72
3,360	56.0	2.33	0	8.7	104.0	100	0	1,200	1,496	0.42
3,372	56.2	2.34	0	8.7	104.0	0	0	0	1,600	0.45
3,384	56.4	2.35	0	8.7	104.0	0	0	0	1,704	0.47
3,396	56.6	2.36	0	8.7	104.0	0	0	0	1,808	0.50
3,408	56.8	2.37	0	8.7	104.0	0	0	0	1,912	0.53
3,420	57.0	2.38	0	8.7	104.0	0	0	0	2,016	0.56
3,432	57.2	2.38	0	8.7	104.0	0	0	0	2,120	0.59
3,444	57.4	2.39	0	8.7	104.0	0	0	0	2,224	0.62
3,456	57.6	2.40	0	8.7	104.0	0	0	0	2,328	0.65
3,468	57.8	2.41	0	8.7	104.0	0	0	0	2,432	0.68
3,480	58.0	2.42	0	8.7	104.0	0	0	0	2,536	0.71
3,492	58.2	2.43	0	8.7	104.0	0	0	0	2,640	0.74
3,504	58.4	2.43	0	8.7	104.0	0	0	0	2,744	0.76
3,516	58.6	2.44	0	8.7	104.0	0	0	0	2,848	0.79
3,528	58.8	2.45	0	8.7	104.0	0	0	0	2,952	0.82
3,540	59.0	2.46	0	8.7	104.0	0	0	0	3,056	0.85
3,552	59.2	2.47	0	8.7	104.0	0	0	0	3,160	0.88
3,564	59.4	2.48	0	8.7	104.0	0	0	0	3,264	0.91
3,576	59.6	2.48	0	8.7	104.0	0	0	0	3,367	0.94
3,588	59.8	2.49	0	8.7	104.0	0	0	0	3,471	0.97
3,600	60.0	2.50	0	8.7	104.0	0	0	0	3,575	1.00
3,612	60.2	2.51	0	8.7	104.0	0	0	0	3,679	1.02
3,624	60.4	2.52	0	8.7	104.0	100	0	1,200	2,583	0.72
3,636	60.6	2.53	0	8.7	104.0	100	0	1,200	1,487	0.41

Attachment 12 - Cell 3 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,648	60.8	2.53	0	8.7	104.0	0	0	0	1,591	0.44
3,660	61.0	2.54	0	8.7	104.0	0	0	0	1,695	0.47
3,672	61.2	2.55	0	8.7	104.0	0	0	0	1,799	0.50
3,684	61.4	2.56	0	8.7	104.0	0	0	0	1,903	0.53
3,696	61.6	2.57	0	8.7	104.0	0	0	0	2,007	0.56
3,708	61.8	2.58	0	8.7	104.0	0	0	0	2,111	0.59
3,720	62.0	2.58	0	8.7	104.0	0	0	0	2,215	0.62
3,732	62.2	2.59	0	8.7	104.0	0	0	0	2,319	0.65
3,744	62.4	2.60	0	8.7	104.0	0	0	0	2,423	0.67
3,756	62.6	2.61	0	8.7	104.0	0	0	0	2,527	0.70
3,768	62.8	2.62	0	8.7	104.0	0	0	0	2,631	0.73
3,780	63.0	2.63	0	8.7	104.0	0	0	0	2,735	0.76
3,792	63.2	2.63	0	8.7	104.0	0	0	0	2,839	0.79
3,804	63.4	2.64	0	8.7	104.0	0	0	0	2,943	0.82
3,816	63.6	2.65	0	8.7	104.0	0	0	0	3,046	0.85
3,828	63.8	2.66	0	8.7	104.0	0	0	0	3,150	0.88
3,840	64.0	2.67	0	8.7	104.0	0	0	0	3,254	0.91
3,852	64.2	2.68	0	8.7	104.0	0	0	0	3,358	0.94
3,864	64.4	2.68	0	8.7	104.0	0	0	0	3,462	0.96
3,876	64.6	2.69	0	8.7	104.0	0	0	0	3,566	0.99
3,888	64.8	2.70	0	8.7	104.0	0	0	0	3,670	1.02
3,900	65.0	2.71	0	8.7	104.0	100	0	1,200	2,574	0.72
3,912	65.2	2.72	0	8.7	104.0	100	0	1,200	1,478	0.41
3,924	65.4	2.73	0	8.7	104.0	0	0	0	1,582	0.44
3,936	65.6	2.73	0	8.7	104.0	0	0	0	1,686	0.47
3,948	65.8	2.74	0	8.7	104.0	0	0	0	1,790	0.50
3,960	66.0	2.75	0	8.7	104.0	0	0	0	1,894	0.53
3,972	66.2	2.76	0	8.7	104.0	0	0	0	1,998	0.56
3,984	66.4	2.77	0	8.7	104.0	0	0	0	2,102	0.59
3,996	66.6	2.78	0	8.7	104.0	0	0	0	2,206	0.61
4,008	66.8	2.78	0	8.7	104.0	0	0	0	2,310	0.64
4,020	67.0	2.79	0	8.7	104.0	0	0	0	2,414	0.67
4,032	67.2	2.80	0	8.7	104.0	0	0	0	2,518	0.70
4,044	67.4	2.81	0	8.7	104.0	0	0	0	2,622	0.73
4,056	67.6	2.82	0	8.7	104.0	0	0	0	2,725	0.76
4,068	67.8	2.83	0	8.7	104.0	0	0	0	2,829	0.79
4,080	68.0	2.83	0	8.7	104.0	0	0	0	2,933	0.82
4,092	68.2	2.84	0	8.7	104.0	0	0	0	3,037	0.85
4,104	68.4	2.85	0	8.7	104.0	0	0	0	3,141	0.87
4,116	68.6	2.86	0	8.7	104.0	0	0	0	3,245	0.90
4,128	68.8	2.87	0	8.7	104.0	0	0	0	3,349	0.93
4,140	69.0	2.88	0	8.7	104.0	0	0	0	3,453	0.96
4,152	69.2	2.88	0	8.7	104.0	0	0	0	3,557	0.99
4,164	69.4	2.89	0	8.7	104.0	0	0	0	3,661	1.02
4,176	69.6	2.90	0	8.7	104.0	100	0	1,200	2,565	0.71
4,188	69.8	2.91	0	8.7	104.0	100	0	1,200	1,469	0.41
4,200	70.0	2.92	0	8.7	104.0	0	0	0	1,573	0.44
4,212	70.2	2.93	0	8.7	104.0	0	0	0	1,677	0.47
4,224	70.4	2.93	0	8.7	104.0	0	0	0	1,781	0.50
4,236	70.6	2.94	0	8.7	104.0	0	0	0	1,885	0.52
4,248	70.8	2.95	0	8.7	104.0	0	0	0	1,989	0.55
4,260	71.0	2.96	0	8.7	104.0	0	0	0	2,093	0.58
4,272	71.2	2.97	0	8.7	104.0	0	0	0	2,197	0.61
4,284	71.4	2.98	0	8.7	104.0	0	0	0	2,301	0.64
4,296	71.6	2.98	0	8.7	104.0	0	0	0	2,404	0.67
4,308	71.8	2.99	0	8.7	104.0	0	0	0	2,508	0.70
4,320	72.0	3.00	0	8.7	104.0	0	0	0	2,612	0.73
4,332	72.2	3.01	0	8.7	104.0	0	0	0	2,716	0.76
4,344	72.4	3.02	0	8.7	104.0	0	0	0	2,820	0.79
4,356	72.6	3.03	0	8.7	104.0	0	0	0	2,924	0.81
4,368	72.8	3.03	0	8.7	104.0	0	0	0	3,028	0.84
4,380	73.0	3.04	0	8.7	104.0	0	0	0	3,132	0.87
4,392	73.2	3.05	0	8.7	104.0	0	0	0	3,236	0.90
4,404	73.4	3.06	0	8.7	104.0	0	0	0	3,340	0.93
4,416	73.6	3.07	0	8.7	104.0	0	0	0	3,444	0.96
4,428	73.8	3.08	0	8.7	104.0	0	0	0	3,548	0.99
4,440	74.0	3.08	0	8.7	104.0	0	0	0	3,652	1.02
4,452	74.2	3.09	0	8.7	104.0	100	0	1,200	2,556	0.71
4,464	74.4	3.10	0	8.7	104.0	100	0	1,200	1,460	0.41
4,476	74.6	3.11	0	8.7	104.0	0	0	0	1,564	0.44
4,488	74.8	3.12	0	8.7	104.0	0	0	0	1,668	0.46
4,500	75.0	3.13	0	8.7	104.0	0	0	0	1,772	0.49
4,512	75.2	3.13	0	8.7	104.0	0	0	0	1,876	0.52
4,524	75.4	3.14	0	8.7	104.0	0	0	0	1,980	0.55
4,536	75.6	3.15	0	8.7	104.0	0	0	0	2,083	0.58
4,548	75.8	3.16	0	8.7	104.0	0	0	0	2,187	0.61

Attachment 12 - Cell 3 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,560	76.0	3.17	0	8.7	104.0	0	0	0	2,291	0.64
4,572	76.2	3.18	0	8.7	104.0	0	0	0	2,395	0.67
4,584	76.4	3.18	0	8.7	104.0	0	0	0	2,499	0.70
4,596	76.6	3.19	0	8.7	104.0	0	0	0	2,603	0.73
4,608	76.8	3.20	0	8.7	104.0	0	0	0	2,707	0.75
4,620	77.0	3.21	0	8.7	104.0	0	0	0	2,811	0.78
4,632	77.2	3.22	0	8.7	104.0	0	0	0	2,915	0.81
4,644	77.4	3.23	0	8.7	104.0	0	0	0	3,019	0.84
4,656	77.6	3.23	0	8.7	104.0	0	0	0	3,123	0.87
4,668	77.8	3.24	0	8.7	104.0	0	0	0	3,227	0.90
4,680	78.0	3.25	0	8.7	104.0	0	0	0	3,331	0.93
4,692	78.2	3.26	0	8.7	104.0	0	0	0	3,435	0.96
4,704	78.4	3.27	0	8.7	104.0	0	0	0	3,539	0.99
4,716	78.6	3.28	0	8.7	104.0	0	0	0	3,643	1.01
4,728	78.8	3.28	0	8.7	104.0	100	0	1,200	2,547	0.71
4,740	79.0	3.29	0	8.7	104.0	100	0	1,200	1,451	0.40
4,752	79.2	3.30	0	8.7	104.0	0	0	0	1,555	0.43
4,764	79.4	3.31	0	8.7	104.0	0	0	0	1,659	0.46
4,776	79.6	3.32	0	8.7	104.0	0	0	0	1,762	0.49
4,788	79.8	3.33	0	8.7	104.0	0	0	0	1,866	0.52
4,800	80.0	3.33	0	8.7	104.0	0	0	0	1,970	0.55
4,812	80.2	3.34	0	8.7	104.0	0	0	0	2,074	0.58
4,824	80.4	3.35	0	8.7	104.0	0	0	0	2,178	0.61
4,836	80.6	3.36	0	8.7	104.0	0	0	0	2,282	0.64
4,848	80.8	3.37	0	8.7	104.0	0	0	0	2,386	0.66
4,860	81.0	3.38	0	8.7	104.0	0	0	0	2,490	0.69
4,872	81.2	3.38	0	8.7	104.0	0	0	0	2,594	0.72
4,884	81.4	3.39	0	8.7	104.0	0	0	0	2,698	0.75
4,896	81.6	3.40	0	8.7	104.0	0	0	0	2,802	0.78
4,908	81.8	3.41	0	8.7	104.0	0	0	0	2,906	0.81
4,920	82.0	3.42	0	8.7	104.0	0	0	0	3,010	0.84
4,932	82.2	3.43	0	8.7	104.0	0	0	0	3,114	0.87
4,944	82.4	3.43	0	8.7	104.0	0	0	0	3,218	0.90
4,956	82.6	3.44	0	8.7	104.0	0	0	0	3,322	0.93
4,968	82.8	3.45	0	8.7	104.0	0	0	0	3,426	0.95
4,980	83.0	3.46	0	8.7	104.0	0	0	0	3,530	0.98
4,992	83.2	3.47	0	8.7	104.0	0	0	0	3,634	1.01
5,004	83.4	3.48	0	8.7	104.0	100	0	1,200	2,538	0.71
5,016	83.6	3.48	0	8.7	104.0	100	0	1,200	1,441	0.40
5,028	83.8	3.49	0	8.7	104.0	0	0	0	1,545	0.43
5,040	84.0	3.50	0	8.7	104.0	0	0	0	1,649	0.46
5,052	84.2	3.51	0	8.7	104.0	0	0	0	1,753	0.49
5,064	84.4	3.52	0	8.7	104.0	0	0	0	1,857	0.52
5,076	84.6	3.53	0	8.7	104.0	0	0	0	1,961	0.55
5,088	84.8	3.53	0	8.7	104.0	0	0	0	2,065	0.58
5,100	85.0	3.54	0	8.7	104.0	0	0	0	2,169	0.60
5,112	85.2	3.55	0	8.7	104.0	0	0	0	2,273	0.63
5,124	85.4	3.56	0	8.7	104.0	0	0	0	2,377	0.66
5,136	85.6	3.57	0	8.7	104.0	0	0	0	2,481	0.69
5,148	85.8	3.58	0	8.7	104.0	0	0	0	2,585	0.72
5,160	86.0	3.58	0	8.7	104.0	0	0	0	2,689	0.75
5,172	86.2	3.59	0	8.7	104.0	0	0	0	2,793	0.78
5,184	86.4	3.60	0	8.7	104.0	0	0	0	2,897	0.81
5,196	86.6	3.61	0	8.7	104.0	0	0	0	3,001	0.84
5,208	86.8	3.62	0	8.7	104.0	0	0	0	3,105	0.86
5,220	87.0	3.63	0	8.7	104.0	0	0	0	3,209	0.89
5,232	87.2	3.63	0	8.7	104.0	0	0	0	3,313	0.92
5,244	87.4	3.64	0	8.7	104.0	0	0	0	3,417	0.95
5,256	87.6	3.65	0	8.7	104.0	0	0	0	3,520	0.98
5,268	87.8	3.66	0	8.7	104.0	0	0	0	3,624	1.01
5,280	88.0	3.67	0	8.7	104.0	100	0	1,200	2,528	0.70
5,292	88.2	3.68	0	8.7	104.0	100	0	1,200	1,432	0.40
5,304	88.4	3.68	0	8.7	104.0	0	0	0	1,536	0.43
5,316	88.6	3.69	0	8.7	104.0	0	0	0	1,640	0.46
5,328	88.8	3.70	0	8.7	104.0	0	0	0	1,744	0.49
5,340	89.0	3.71	0	8.7	104.0	0	0	0	1,848	0.51
5,352	89.2	3.72	0	8.7	104.0	0	0	0	1,952	0.54
5,364	89.4	3.73	0	8.7	104.0	0	0	0	2,056	0.57
5,376	89.6	3.73	0	8.7	104.0	0	0	0	2,160	0.60
5,388	89.8	3.74	0	8.7	104.0	0	0	0	2,264	0.63
5,400	90.0	3.75	0	8.7	104.0	0	0	0	2,368	0.66
5,412	90.2	3.76	0	8.7	104.0	0	0	0	2,472	0.69
5,424	90.4	3.77	0	8.7	104.0	0	0	0	2,576	0.72
5,436	90.6	3.78	0	8.7	104.0	0	0	0	2,680	0.75
5,448	90.8	3.78	0	8.7	104.0	0	0	0	2,784	0.78
5,460	91.0	3.79	0	8.7	104.0	0	0	0	2,888	0.80

Attachment 12 - Cell 3 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,472	91.2	3.80	0	8.7	104.0	0	0	0	2,992	0.83
5,484	91.4	3.81	0	8.7	104.0	0	0	0	3,096	0.86
5,496	91.6	3.82	0	8.7	104.0	0	0	0	3,199	0.89
5,508	91.8	3.83	0	8.7	104.0	0	0	0	3,303	0.92
5,520	92.0	3.83	0	8.7	104.0	0	0	0	3,407	0.95
5,532	92.2	3.84	0	8.7	104.0	0	0	0	3,511	0.98
5,544	92.4	3.85	0	8.7	104.0	0	0	0	3,615	1.01
5,556	92.6	3.86	0	8.7	104.0	100	0	1,200	2,519	0.70
5,568	92.8	3.87	0	8.7	104.0	100	0	1,200	1,423	0.40
5,580	93.0	3.88	0	8.7	104.0	0	0	0	1,527	0.43
5,592	93.2	3.88	0	8.7	104.0	0	0	0	1,631	0.45
5,604	93.4	3.89	0	8.7	104.0	0	0	0	1,735	0.48
5,616	93.6	3.90	0	8.7	104.0	0	0	0	1,839	0.51
5,628	93.8	3.91	0	8.7	104.0	0	0	0	1,943	0.54
5,640	94.0	3.92	0	8.7	104.0	0	0	0	2,047	0.57
5,652	94.2	3.93	0	8.7	104.0	0	0	0	2,151	0.60
5,664	94.4	3.93	0	8.7	104.0	0	0	0	2,255	0.63
5,676	94.6	3.94	0	8.7	104.0	0	0	0	2,359	0.66
5,688	94.8	3.95	0	8.7	104.0	0	0	0	2,463	0.69
5,700	95.0	3.96	0	8.7	104.0	0	0	0	2,567	0.71
5,712	95.2	3.97	0	8.7	104.0	0	0	0	2,671	0.74
5,724	95.4	3.98	0	8.7	104.0	0	0	0	2,775	0.77
5,736	95.6	3.98	0	8.7	104.0	0	0	0	2,878	0.80
5,748	95.8	3.99	0	8.7	104.0	0	0	0	2,982	0.83
5,760	96.0	4.00	0	8.7	104.0	0	0	0	3,086	0.86
5,772	96.2	4.01	0	8.7	104.0	0	0	0	3,190	0.89
5,784	96.4	4.02	0	8.7	104.0	0	0	0	3,294	0.92
5,796	96.6	4.03	0	8.7	104.0	0	0	0	3,398	0.95
5,808	96.8	4.03	0	8.7	104.0	0	0	0	3,502	0.98
5,820	97.0	4.04	0	8.7	104.0	0	0	0	3,606	1.00
5,832	97.2	4.05	0	8.7	104.0	100	0	1,200	2,510	0.70
5,844	97.4	4.06	0	8.7	104.0	100	0	1,200	1,414	0.39
5,856	97.6	4.07	0	8.7	104.0	0	0	0	1,518	0.42
5,868	97.8	4.08	0	8.7	104.0	0	0	0	1,622	0.45
5,880	98.0	4.08	0	8.7	104.0	0	0	0	1,726	0.48
5,892	98.2	4.09	0	8.7	104.0	0	0	0	1,830	0.51
5,904	98.4	4.10	0	8.7	104.0	0	0	0	1,934	0.54
5,916	98.6	4.11	0	8.7	104.0	0	0	0	2,038	0.57
5,928	98.8	4.12	0	8.7	104.0	0	0	0	2,142	0.60
5,940	99.0	4.13	0	8.7	104.0	0	0	0	2,246	0.63
5,952	99.2	4.13	0	8.7	104.0	0	0	0	2,350	0.65
5,964	99.4	4.14	0	8.7	104.0	0	0	0	2,454	0.68
5,976	99.6	4.15	0	8.7	104.0	0	0	0	2,557	0.71
5,988	99.8	4.16	0	8.7	104.0	0	0	0	2,661	0.74
6,000	100.0	4.17	0	8.7	104.0	0	0	0	2,765	0.77
6,012	100.2	4.18	0	8.7	104.0	0	0	0	2,869	0.80
6,024	100.4	4.18	0	8.7	104.0	0	0	0	2,973	0.83
6,036	100.6	4.19	0	8.7	104.0	0	0	0	3,077	0.86
6,048	100.8	4.20	0	8.7	104.0	0	0	0	3,181	0.89
6,060	101.0	4.21	0	8.7	104.0	0	0	0	3,285	0.91
6,072	101.2	4.22	0	8.7	104.0	0	0	0	3,389	0.94
6,084	101.4	4.23	0	8.7	104.0	0	0	0	3,493	0.97
6,096	101.6	4.23	0	8.7	104.0	0	0	0	3,597	1.00
6,108	101.8	4.24	0	8.7	104.0	100	0	1,200	2,501	0.70
6,120	102.0	4.25	0	8.7	104.0	100	0	1,200	1,405	0.39
6,132	102.2	4.26	0	8.7	104.0	0	0	0	1,509	0.42
6,144	102.4	4.27	0	8.7	104.0	0	0	0	1,613	0.45
6,156	102.6	4.28	0	8.7	104.0	0	0	0	1,717	0.48
6,168	102.8	4.28	0	8.7	104.0	0	0	0	1,821	0.51
6,180	103.0	4.29	0	8.7	104.0	0	0	0	1,925	0.54
6,192	103.2	4.30	0	8.7	104.0	0	0	0	2,029	0.57
6,204	103.4	4.31	0	8.7	104.0	0	0	0	2,133	0.59
6,216	103.6	4.32	0	8.7	104.0	0	0	0	2,236	0.62
6,228	103.8	4.33	0	8.7	104.0	0	0	0	2,340	0.65
6,240	104.0	4.33	0	8.7	104.0	0	0	0	2,444	0.68
6,252	104.2	4.34	0	8.7	104.0	0	0	0	2,548	0.71
6,264	104.4	4.35	0	8.7	104.0	0	0	0	2,652	0.74
6,276	104.6	4.36	0	8.7	104.0	0	0	0	2,756	0.77
6,288	104.8	4.37	0	8.7	104.0	0	0	0	2,860	0.80
6,300	105.0	4.38	0	8.7	104.0	0	0	0	2,964	0.83
6,312	105.2	4.38	0	8.7	104.0	0	0	0	3,068	0.85
6,324	105.4	4.39	0	8.7	104.0	0	0	0	3,172	0.88
6,336	105.6	4.40	0	8.7	104.0	0	0	0	3,276	0.91
6,348	105.8	4.41	0	8.7	104.0	0	0	0	3,380	0.94
6,360	106.0	4.42	0	8.7	104.0	0	0	0	3,484	0.97
6,372	106.2	4.43	0	8.7	104.0	0	0	0	3,588	1.00

Attachment 12 - Cell 3 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,384	106.4	4.43	0	8.7	104.0	0	0	0	3,692	1.03
6,396	106.6	4.44	0	8.7	104.0	100	0	1,200	2,596	0.72
6,408	106.8	4.45	0	8.7	104.0	100	0	1,200	1,500	0.42
6,420	107.0	4.46	0	8.7	104.0	0	0	0	1,604	0.45
6,432	107.2	4.47	0	8.7	104.0	0	0	0	1,708	0.48
6,444	107.4	4.48	0	8.7	104.0	0	0	0	1,812	0.50
6,456	107.6	4.48	0	8.7	104.0	0	0	0	1,915	0.53
6,468	107.8	4.49	0	8.7	104.0	0	0	0	2,019	0.56
6,480	108.0	4.50	0	8.7	104.0	0	0	0	2,123	0.59
6,492	108.2	4.51	0	8.7	104.0	0	0	0	2,227	0.62
6,504	108.4	4.52	0	8.7	104.0	0	0	0	2,331	0.65
6,516	108.6	4.53	0	8.7	104.0	0	0	0	2,435	0.68
6,528	108.8	4.53	0	8.7	104.0	0	0	0	2,539	0.71
6,540	109.0	4.54	0	8.7	104.0	0	0	0	2,643	0.74
6,552	109.2	4.55	0	8.7	104.0	0	0	0	2,747	0.77
6,564	109.4	4.56	0	8.7	104.0	0	0	0	2,851	0.79
6,576	109.6	4.57	0	8.7	104.0	0	0	0	2,955	0.82
6,588	109.8	4.58	0	8.7	104.0	0	0	0	3,059	0.85
6,600	110.0	4.58	0	8.7	104.0	0	0	0	3,163	0.88
6,612	110.2	4.59	0	8.7	104.0	0	0	0	3,267	0.91
6,624	110.4	4.60	0	8.7	104.0	0	0	0	3,371	0.94
6,636	110.6	4.61	0	8.7	104.0	0	0	0	3,475	0.97
6,648	110.8	4.62	0	8.7	104.0	0	0	0	3,579	1.00
6,660	111.0	4.63	0	8.7	104.0	0	0	0	3,683	1.03
6,672	111.2	4.63	0	8.7	104.0	100	0	1,200	2,587	0.72
6,684	111.4	4.64	0	8.7	104.0	100	0	1,200	1,491	0.42
6,696	111.6	4.65	0	8.7	104.0	0	0	0	1,594	0.44
6,708	111.8	4.66	0	8.7	104.0	0	0	0	1,698	0.47
6,720	112.0	4.67	0	8.7	104.0	0	0	0	1,802	0.50
6,732	112.2	4.68	0	8.7	104.0	0	0	0	1,906	0.53
6,744	112.4	4.68	0	8.7	104.0	0	0	0	2,010	0.56
6,756	112.6	4.69	0	8.7	104.0	0	0	0	2,114	0.59
6,768	112.8	4.70	0	8.7	104.0	0	0	0	2,218	0.62
6,780	113.0	4.71	0	8.7	104.0	0	0	0	2,322	0.65
6,792	113.2	4.72	0	8.7	104.0	0	0	0	2,426	0.68
6,804	113.4	4.73	0	8.7	104.0	0	0	0	2,530	0.70
6,816	113.6	4.73	0	8.7	104.0	0	0	0	2,634	0.73
6,828	113.8	4.74	0	8.7	104.0	0	0	0	2,738	0.76
6,840	114.0	4.75	0	8.7	104.0	0	0	0	2,842	0.79
6,852	114.2	4.76	0	8.7	104.0	0	0	0	2,946	0.82
6,864	114.4	4.77	0	8.7	104.0	0	0	0	3,050	0.85
6,876	114.6	4.78	0	8.7	104.0	0	0	0	3,154	0.88
6,888	114.8	4.78	0	8.7	104.0	0	0	0	3,258	0.91
6,900	115.0	4.79	0	8.7	104.0	0	0	0	3,362	0.94
6,912	115.2	4.80	0	8.7	104.0	0	0	0	3,466	0.97
6,924	115.4	4.81	0	8.7	104.0	0	0	0	3,570	0.99
6,936	115.6	4.82	0	8.7	104.0	0	0	0	3,673	1.02
6,948	115.8	4.83	0	8.7	104.0	100	0	1,200	2,577	0.72
6,960	116.0	4.83	0	8.7	104.0	100	0	1,200	1,481	0.41
6,972	116.2	4.84	0	8.7	104.0	0	0	0	1,585	0.44
6,984	116.4	4.85	0	8.7	104.0	0	0	0	1,689	0.47
6,996	116.6	4.86	0	8.7	104.0	0	0	0	1,793	0.50
7,008	116.8	4.87	0	8.7	104.0	0	0	0	1,897	0.53
7,020	117.0	4.88	0	8.7	104.0	0	0	0	2,001	0.56
7,032	117.2	4.88	0	8.7	104.0	0	0	0	2,105	0.59
7,044	117.4	4.89	0	8.7	104.0	0	0	0	2,209	0.62
7,056	117.6	4.90	0	8.7	104.0	0	0	0	2,313	0.64
7,068	117.8	4.91	0	8.7	104.0	0	0	0	2,417	0.67
7,080	118.0	4.92	0	8.7	104.0	0	0	0	2,521	0.70
7,092	118.2	4.93	0	8.7	104.0	0	0	0	2,625	0.73
7,104	118.4	4.93	0	8.7	104.0	0	0	0	2,729	0.76
7,116	118.6	4.94	0	8.7	104.0	0	0	0	2,833	0.79
7,128	118.8	4.95	0	8.7	104.0	0	0	0	2,937	0.82
7,140	119.0	4.96	0	8.7	104.0	0	0	0	3,041	0.85
7,152	119.2	4.97	0	8.7	104.0	0	0	0	3,145	0.88
7,164	119.4	4.98	0	8.7	104.0	0	0	0	3,249	0.90
7,176	119.6	4.98	0	8.7	104.0	0	0	0	3,352	0.93
7,188	119.8	4.99	0	8.7	104.0	0	0	0	3,456	0.96
7,200	120.0	5.00	0	8.7	104.0	0	0	0	3,560	0.99
7,212	120.2	5.01	0	8.7	104.0	0	0	0	3,664	1.02
7,224	120.4	5.02	0	8.7	104.0	100	0	1,200	2,568	0.72
7,236	120.6	5.03	0	8.7	104.0	100	0	1,200	1,472	0.41
7,248	120.8	5.03	0	8.7	104.0	0	0	0	1,576	0.44
7,260	121.0	5.04	0	8.7	104.0	0	0	0	1,680	0.47
7,272	121.2	5.05	0	8.7	104.0	0	0	0	1,784	0.50
7,284	121.4	5.06	0	8.7	104.0	0	0	0	1,888	0.53

Attachment 12 - Cell 3 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,296	121.6	5.07	0	8.7	104.0	0	0	0	1,992	0.55
7,308	121.8	5.08	0	8.7	104.0	0	0	0	2,096	0.58
7,320	122.0	5.08	0	8.7	104.0	0	0	0	2,200	0.61
7,332	122.2	5.09	0	8.7	104.0	0	0	0	2,304	0.64
7,344	122.4	5.10	0	8.7	104.0	0	0	0	2,408	0.67
7,356	122.6	5.11	0	8.7	104.0	0	0	0	2,512	0.70
7,368	122.8	5.12	0	8.7	104.0	0	0	0	2,616	0.73
7,380	123.0	5.13	0	8.7	104.0	0	0	0	2,720	0.76
7,392	123.2	5.13	0	8.7	104.0	0	0	0	2,824	0.79
7,404	123.4	5.14	0	8.7	104.0	0	0	0	2,928	0.82
7,416	123.6	5.15	0	8.7	104.0	0	0	0	3,031	0.84
7,428	123.8	5.16	0	8.7	104.0	0	0	0	3,135	0.87
7,440	124.0	5.17	0	8.7	104.0	0	0	0	3,239	0.90
7,452	124.2	5.18	0	8.7	104.0	0	0	0	3,343	0.93
7,464	124.4	5.18	0	8.7	104.0	0	0	0	3,447	0.96
7,476	124.6	5.19	0	8.7	104.0	0	0	0	3,551	0.99
7,488	124.8	5.20	0	8.7	104.0	0	0	0	3,655	1.02
7,500	125.0	5.21	0	8.7	104.0	100	0	1,200	2,559	0.71
7,512	125.2	5.22	0	8.7	104.0	100	0	1,200	1,463	0.41
7,524	125.4	5.23	0	8.7	104.0	0	0	0	1,567	0.44
7,536	125.6	5.23	0	8.7	104.0	0	0	0	1,671	0.47
7,548	125.8	5.24	0	8.7	104.0	0	0	0	1,775	0.49
7,560	126.0	5.25	0	8.7	104.0	0	0	0	1,879	0.52
7,572	126.2	5.26	0	8.7	104.0	0	0	0	1,983	0.55
7,584	126.4	5.27	0	8.7	104.0	0	0	0	2,087	0.58
7,596	126.6	5.28	0	8.7	104.0	0	0	0	2,191	0.61
7,608	126.8	5.28	0	8.7	104.0	0	0	0	2,295	0.64
7,620	127.0	5.29	0	8.7	104.0	0	0	0	2,399	0.67
7,632	127.2	5.30	0	8.7	104.0	0	0	0	2,503	0.70
7,644	127.4	5.31	0	8.7	104.0	0	0	0	2,607	0.73
7,656	127.6	5.32	0	8.7	104.0	0	0	0	2,710	0.75
7,668	127.8	5.33	0	8.7	104.0	0	0	0	2,814	0.78
7,680	128.0	5.33	0	8.7	104.0	0	0	0	2,918	0.81
7,692	128.2	5.34	0	8.7	104.0	0	0	0	3,022	0.84
7,704	128.4	5.35	0	8.7	104.0	0	0	0	3,126	0.87
7,716	128.6	5.36	0	8.7	104.0	0	0	0	3,230	0.90
7,728	128.8	5.37	0	8.7	104.0	0	0	0	3,334	0.93
7,740	129.0	5.38	0	8.7	104.0	0	0	0	3,438	0.96
7,752	129.2	5.38	0	8.7	104.0	0	0	0	3,542	0.99
7,764	129.4	5.39	0	8.7	104.0	0	0	0	3,646	1.02
7,776	129.6	5.40	0	8.7	104.0	100	0	1,200	2,550	0.71
7,788	129.8	5.41	0	8.7	104.0	100	0	1,200	1,454	0.40
7,800	130.0	5.42	0	8.7	104.0	0	0	0	1,558	0.43
7,812	130.2	5.43	0	8.7	104.0	0	0	0	1,662	0.46
7,824	130.4	5.43	0	8.7	104.0	0	0	0	1,766	0.49
7,836	130.6	5.44	0	8.7	104.0	0	0	0	1,870	0.52
7,848	130.8	5.45	0	8.7	104.0	0	0	0	1,974	0.55
7,860	131.0	5.46	0	8.7	104.0	0	0	0	2,078	0.58
7,872	131.2	5.47	0	8.7	104.0	0	0	0	2,182	0.61
7,884	131.4	5.48	0	8.7	104.0	0	0	0	2,286	0.64
7,896	131.6	5.48	0	8.7	104.0	0	0	0	2,389	0.67
7,908	131.8	5.49	0	8.7	104.0	0	0	0	2,493	0.69
7,920	132.0	5.50	0	8.7	104.0	0	0	0	2,597	0.72
7,932	132.2	5.51	0	8.7	104.0	0	0	0	2,701	0.75
7,944	132.4	5.52	0	8.7	104.0	0	0	0	2,805	0.78
7,956	132.6	5.53	0	8.7	104.0	0	0	0	2,909	0.81
7,968	132.8	5.53	0	8.7	104.0	0	0	0	3,013	0.84
7,980	133.0	5.54	0	8.7	104.0	0	0	0	3,117	0.87
7,992	133.2	5.55	0	8.7	104.0	0	0	0	3,221	0.90
8,004	133.4	5.56	0	8.7	104.0	0	0	0	3,325	0.93
8,016	133.6	5.57	0	8.7	104.0	0	0	0	3,429	0.96
8,028	133.8	5.58	0	8.7	104.0	0	0	0	3,533	0.98
8,040	134.0	5.58	0	8.7	104.0	0	0	0	3,637	1.01
8,052	134.2	5.59	0	8.7	104.0	100	0	1,200	2,541	0.71
8,064	134.4	5.60	0	8.7	104.0	100	0	1,200	1,445	0.40
8,076	134.6	5.61	0	8.7	104.0	0	0	0	1,549	0.43
8,088	134.8	5.62	0	8.7	104.0	0	0	0	1,653	0.46
8,100	135.0	5.63	0	8.7	104.0	0	0	0	1,757	0.49
8,112	135.2	5.63	0	8.7	104.0	0	0	0	1,861	0.52
8,124	135.4	5.64	0	8.7	104.0	0	0	0	1,965	0.55
8,136	135.6	5.65	0	8.7	104.0	0	0	0	2,068	0.58
8,148	135.8	5.66	0	8.7	104.0	0	0	0	2,172	0.61
8,160	136.0	5.67	0	8.7	104.0	0	0	0	2,276	0.63
8,172	136.2	5.68	0	8.7	104.0	0	0	0	2,380	0.66
8,184	136.4	5.68	0	8.7	104.0	0	0	0	2,484	0.69
8,196	136.6	5.69	0	8.7	104.0	0	0	0	2,588	0.72

Attachment 12 - Cell 3 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,208	136.8	5.70	0	8.7	104.0	0	0	0	2,692	0.75
8,220	137.0	5.71	0	8.7	104.0	0	0	0	2,796	0.78
8,232	137.2	5.72	0	8.7	104.0	0	0	0	2,900	0.81
8,244	137.4	5.73	0	8.7	104.0	0	0	0	3,004	0.84
8,256	137.6	5.73	0	8.7	104.0	0	0	0	3,108	0.87
8,268	137.8	5.74	0	8.7	104.0	0	0	0	3,212	0.89
8,280	138.0	5.75	0	8.7	104.0	0	0	0	3,316	0.92
8,292	138.2	5.76	0	8.7	104.0	0	0	0	3,420	0.95
8,304	138.4	5.77	0	8.7	104.0	0	0	0	3,524	0.98
8,316	138.6	5.78	0	8.7	104.0	0	0	0	3,628	1.01
8,328	138.8	5.78	0	8.7	104.0	100	0	1,200	2,532	0.71
8,340	139.0	5.79	0	8.7	104.0	100	0	1,200	1,436	0.40
8,352	139.2	5.80	0	8.7	104.0	0	0	0	1,540	0.43
8,364	139.4	5.81	0	8.7	104.0	0	0	0	1,644	0.46
8,376	139.6	5.82	0	8.7	104.0	0	0	0	1,747	0.49
8,388	139.8	5.83	0	8.7	104.0	0	0	0	1,851	0.52
8,400	140.0	5.83	0	8.7	104.0	0	0	0	1,955	0.54
8,412	140.2	5.84	0	8.7	104.0	0	0	0	2,059	0.57
8,424	140.4	5.85	0	8.7	104.0	0	0	0	2,163	0.60
8,436	140.6	5.86	0	8.7	104.0	0	0	0	2,267	0.63
8,448	140.8	5.87	0	8.7	104.0	0	0	0	2,371	0.66
8,460	141.0	5.88	0	8.7	104.0	0	0	0	2,475	0.69
8,472	141.2	5.88	0	8.7	104.0	0	0	0	2,579	0.72
8,484	141.4	5.89	0	8.7	104.0	0	0	0	2,683	0.75
8,496	141.6	5.90	0	8.7	104.0	0	0	0	2,787	0.78
8,508	141.8	5.91	0	8.7	104.0	0	0	0	2,891	0.81
8,520	142.0	5.92	0	8.7	104.0	0	0	0	2,995	0.83
8,532	142.2	5.93	0	8.7	104.0	0	0	0	3,099	0.86
8,544	142.4	5.93	0	8.7	104.0	0	0	0	3,203	0.89
8,556	142.6	5.94	0	8.7	104.0	0	0	0	3,307	0.92
8,568	142.8	5.95	0	8.7	104.0	0	0	0	3,411	0.95
8,580	143.0	5.96	0	8.7	104.0	0	0	0	3,515	0.98
8,592	143.2	5.97	0	8.7	104.0	0	0	0	3,619	1.01
8,604	143.4	5.98	0	8.7	104.0	100	0	1,200	2,523	0.70
8,616	143.6	5.98	0	8.7	104.0	100	0	1,200	1,426	0.40
8,628	143.8	5.99	0	8.7	104.0	0	0	0	1,530	0.43
8,640	144.0	6.00	0	8.7	104.0	0	0	0	1,634	0.46
8,652	144.2	6.01	0	8.7	104.0	0	0	0	1,738	0.48
8,664	144.4	6.02	0	8.7	104.0	0	0	0	1,842	0.51
8,676	144.6	6.03	0	8.7	104.0	0	0	0	1,946	0.54
8,688	144.8	6.03	0	8.7	104.0	0	0	0	2,050	0.57
8,700	145.0	6.04	0	8.7	104.0	0	0	0	2,154	0.60
8,712	145.2	6.05	0	8.7	104.0	0	0	0	2,258	0.63
8,724	145.4	6.06	0	8.7	104.0	0	0	0	2,362	0.66
8,736	145.6	6.07	0	8.7	104.0	0	0	0	2,466	0.69
8,748	145.8	6.08	0	8.7	104.0	0	0	0	2,570	0.72
8,760	146.0	6.08	0	8.7	104.0	0	0	0	2,674	0.74
8,772	146.2	6.09	0	8.7	104.0	0	0	0	2,778	0.77
8,784	146.4	6.10	0	8.7	104.0	0	0	0	2,882	0.80
8,796	146.6	6.11	0	8.7	104.0	0	0	0	2,986	0.83
8,808	146.8	6.12	0	8.7	104.0	0	0	0	3,090	0.86
8,820	147.0	6.13	0	8.7	104.0	0	0	0	3,194	0.89
8,832	147.2	6.13	0	8.7	104.0	0	0	0	3,298	0.92
8,844	147.4	6.14	0	8.7	104.0	0	0	0	3,402	0.95
8,856	147.6	6.15	0	8.7	104.0	0	0	0	3,505	0.98
8,868	147.8	6.16	0	8.7	104.0	0	0	0	3,609	1.01
8,880	148.0	6.17	0	8.7	104.0	100	0	1,200	2,513	0.70
8,892	148.2	6.18	0	8.7	104.0	100	0	1,200	1,417	0.39
8,904	148.4	6.18	0	8.7	104.0	0	0	0	1,521	0.42
8,916	148.6	6.19	0	8.7	104.0	0	0	0	1,625	0.45
8,928	148.8	6.20	0	8.7	104.0	0	0	0	1,729	0.48
8,940	149.0	6.21	0	8.7	104.0	0	0	0	1,833	0.51
8,952	149.2	6.22	0	8.7	104.0	0	0	0	1,937	0.54
8,964	149.4	6.23	0	8.7	104.0	0	0	0	2,041	0.57
8,976	149.6	6.23	0	8.7	104.0	0	0	0	2,145	0.60
8,988	149.8	6.24	0	8.7	104.0	0	0	0	2,249	0.63
9,000	150.0	6.25	0	8.7	104.0	0	0	0	2,353	0.66
9,012	150.2	6.26	0	8.7	104.0	0	0	0	2,457	0.68
9,024	150.4	6.27	0	8.7	104.0	0	0	0	2,561	0.71
9,036	150.6	6.28	0	8.7	104.0	0	0	0	2,665	0.74
9,048	150.8	6.28	0	8.7	104.0	0	0	0	2,769	0.77
9,060	151.0	6.29	0	8.7	104.0	0	0	0	2,873	0.80
9,072	151.2	6.30	0	8.7	104.0	0	0	0	2,977	0.83
9,084	151.4	6.31	0	8.7	104.0	0	0	0	3,081	0.86
9,096	151.6	6.32	0	8.7	104.0	0	0	0	3,184	0.89
9,108	151.8	6.33	0	8.7	104.0	0	0	0	3,288	0.92

Attachment 12 - Cell 3 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
9,120	152.0	6.33	0	8.7	104.0	0	0	0	3,392	0.94
9,132	152.2	6.34	0	8.7	104.0	0	0	0	3,496	0.97
9,144	152.4	6.35	0	8.7	104.0	0	0	0	3,600	1.00
9,156	152.6	6.36	0	8.7	104.0	100	0	1,200	2,504	0.70
9,168	152.8	6.37	0	8.7	104.0	100	0	1,200	1,408	0.39
9,180	153.0	6.38	0	8.7	104.0	0	0	0	1,512	0.42
9,192	153.2	6.38	0	8.7	104.0	0	0	0	1,616	0.45
9,204	153.4	6.39	0	8.7	104.0	0	0	0	1,720	0.48
9,216	153.6	6.40	0	8.7	104.0	0	0	0	1,824	0.51
9,228	153.8	6.41	0	8.7	104.0	0	0	0	1,928	0.54
9,240	154.0	6.42	0	8.7	104.0	0	0	0	2,032	0.57
9,252	154.2	6.43	0	8.7	104.0	0	0	0	2,136	0.59
9,264	154.4	6.43	0	8.7	104.0	0	0	0	2,240	0.62
9,276	154.6	6.44	0	8.7	104.0	0	0	0	2,344	0.65
9,288	154.8	6.45	0	8.7	104.0	0	0	0	2,448	0.68
9,300	155.0	6.46	0	8.7	104.0	0	0	0	2,552	0.71
9,312	155.2	6.47	0	8.7	104.0	0	0	0	2,656	0.74
9,324	155.4	6.48	0	8.7	104.0	0	0	0	2,760	0.77
9,336	155.6	6.48	0	8.7	104.0	0	0	0	2,863	0.80
9,348	155.8	6.49	0	8.7	104.0	0	0	0	2,967	0.83
9,360	156.0	6.50	0	8.7	104.0	0	0	0	3,071	0.86
9,372	156.2	6.51	0	8.7	104.0	0	0	0	3,175	0.88
9,384	156.4	6.52	0	8.7	104.0	0	0	0	3,279	0.91
9,396	156.6	6.53	0	8.7	104.0	0	0	0	3,383	0.94
9,408	156.8	6.53	0	8.7	104.0	0	0	0	3,487	0.97
9,420	157.0	6.54	0	8.7	104.0	0	0	0	3,591	1.00
9,432	157.2	6.55	0	8.7	104.0	100	0	1,200	2,495	0.69
9,444	157.4	6.56	0	8.7	104.0	100	0	1,200	1,399	0.39
9,456	157.6	6.57	0	8.7	104.0	0	0	0	1,503	0.42
9,468	157.8	6.58	0	8.7	104.0	0	0	0	1,607	0.45
9,480	158.0	6.58	0	8.7	104.0	0	0	0	1,711	0.48
9,492	158.2	6.59	0	8.7	104.0	0	0	0	1,815	0.51
9,504	158.4	6.60	0	8.7	104.0	0	0	0	1,919	0.53
9,516	158.6	6.61	0	8.7	104.0	0	0	0	2,023	0.56
9,528	158.8	6.62	0	8.7	104.0	0	0	0	2,127	0.59
9,540	159.0	6.63	0	8.7	104.0	0	0	0	2,231	0.62
9,552	159.2	6.63	0	8.7	104.0	0	0	0	2,335	0.65
9,564	159.4	6.64	0	8.7	104.0	0	0	0	2,439	0.68
9,576	159.6	6.65	0	8.7	104.0	0	0	0	2,542	0.71
9,588	159.8	6.66	0	8.7	104.0	0	0	0	2,646	0.74
9,600	160.0	6.67	0	8.7	104.0	0	0	0	2,750	0.77
9,612	160.2	6.68	0	8.7	104.0	0	0	0	2,854	0.79
9,624	160.4	6.68	0	8.7	104.0	0	0	0	2,958	0.82
9,636	160.6	6.69	0	8.7	104.0	0	0	0	3,062	0.85
9,648	160.8	6.70	0	8.7	104.0	0	0	0	3,166	0.88
9,660	161.0	6.71	0	8.7	104.0	0	0	0	3,270	0.91
9,672	161.2	6.72	0	8.7	104.0	0	0	0	3,374	0.94
9,684	161.4	6.73	0	8.7	104.0	0	0	0	3,478	0.97
9,696	161.6	6.73	0	8.7	104.0	0	0	0	3,582	1.00
9,708	161.8	6.74	0	8.7	104.0	0	0	0	3,686	1.03
9,720	162.0	6.75	0	8.7	104.0	100	0	1,200	2,590	0.72
9,732	162.2	6.76	0	8.7	104.0	100	0	1,200	1,494	0.42
9,744	162.4	6.77	0	8.7	104.0	0	0	0	1,598	0.45
9,756	162.6	6.78	0	8.7	104.0	0	0	0	1,702	0.47
9,768	162.8	6.78	0	8.7	104.0	0	0	0	1,806	0.50
9,780	163.0	6.79	0	8.7	104.0	0	0	0	1,910	0.53
9,792	163.2	6.80	0	8.7	104.0	0	0	0	2,014	0.56
9,804	163.4	6.81	0	8.7	104.0	0	0	0	2,118	0.59
9,816	163.6	6.82	0	8.7	104.0	0	0	0	2,221	0.62
9,828	163.8	6.83	0	8.7	104.0	0	0	0	2,325	0.65
9,840	164.0	6.83	0	8.7	104.0	0	0	0	2,429	0.68
9,852	164.2	6.84	0	8.7	104.0	0	0	0	2,533	0.71
9,864	164.4	6.85	0	8.7	104.0	0	0	0	2,637	0.73
9,876	164.6	6.86	0	8.7	104.0	0	0	0	2,741	0.76
9,888	164.8	6.87	0	8.7	104.0	0	0	0	2,845	0.79
9,900	165.0	6.88	0	8.7	104.0	0	0	0	2,949	0.82
9,912	165.2	6.88	0	8.7	104.0	0	0	0	3,053	0.85
9,924	165.4	6.89	0	8.7	104.0	0	0	0	3,157	0.88
9,936	165.6	6.90	0	8.7	104.0	0	0	0	3,261	0.91
9,948	165.8	6.91	0	8.7	104.0	0	0	0	3,365	0.94
9,960	166.0	6.92	0	8.7	104.0	0	0	0	3,469	0.97
9,972	166.2	6.93	0	8.7	104.0	0	0	0	3,573	1.00
9,984	166.4	6.93	0	8.7	104.0	0	0	0	3,677	1.02
9,996	166.6	6.94	0	8.7	104.0	100	0	1,200	2,581	0.72
10,008	166.8	6.95	0	8.7	104.0	100	0	1,200	1,485	0.41
10,020	167.0	6.96	0	8.7	104.0	0	0	0	1,589	0.44

Attachment 12 - Cell 3 Leachate Collection Sump - Average Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
10,032	167.2	6.97	0	8.7	104.0	0	0	0	1,693	0.47
10,044	167.4	6.98	0	8.7	104.0	0	0	0	1,797	0.50
10,056	167.6	6.98	0	8.7	104.0	0	0	0	1,900	0.53
10,068	167.8	6.99	0	8.7	104.0	0	0	0	2,004	0.56
10,080	168.0	7.00	0	8.7	104.0	0	0	0	2,108	0.59

ATTACHMENT 13

Cell 3 Leachate Collection Sump – Peak Conditions

Attachment 13 - Cell 3 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
0	0.0	0.00	0	90.6	0.0	0	0	0	3,590	1.00
12	0.2	0.01	0	90.6	1087.3	0	0	0	4,678	1.30
24	0.4	0.02	0	90.6	1087.3	100	0	1,200	4,565	1.27
36	0.6	0.03	0	90.6	1087.3	100	0	1,200	4,452	1.24
48	0.8	0.03	0	90.6	1087.3	100	0	1,200	4,340	1.21
60	1.0	0.04	0	90.6	1087.3	100	0	1,200	4,227	1.18
72	1.2	0.05	0	90.6	1087.3	100	0	1,200	4,114	1.15
84	1.4	0.06	0	90.6	1087.3	100	0	1,200	4,001	1.11
96	1.6	0.07	0	90.6	1087.3	100	0	1,200	3,889	1.08
108	1.8	0.08	0	90.6	1087.3	100	0	1,200	3,776	1.05
120	2.0	0.08	0	90.6	1087.3	100	0	1,200	3,663	1.02
132	2.2	0.09	0	90.6	1087.3	100	0	1,200	3,551	0.99
144	2.4	0.10	0	90.6	1087.3	100	0	1,200	3,438	0.96
156	2.6	0.11	0	90.6	1087.3	100	0	1,200	3,325	0.93
168	2.8	0.12	0	90.6	1087.3	100	0	1,200	3,212	0.89
180	3.0	0.13	0	90.6	1087.3	100	0	1,200	3,100	0.86
192	3.2	0.13	0	90.6	1087.3	100	0	1,200	2,987	0.83
204	3.4	0.14	0	90.6	1087.3	100	0	1,200	2,874	0.80
216	3.6	0.15	0	90.6	1087.3	100	0	1,200	2,762	0.77
228	3.8	0.16	0	90.6	1087.3	100	0	1,200	2,649	0.74
240	4.0	0.17	0	90.6	1087.3	100	0	1,200	2,536	0.71
252	4.2	0.18	0	90.6	1087.3	100	0	1,200	2,423	0.67
264	4.4	0.18	0	90.6	1087.3	100	0	1,200	2,311	0.64
276	4.6	0.19	0	90.6	1087.3	100	0	1,200	2,198	0.61
288	4.8	0.20	0	90.6	1087.3	100	0	1,200	2,085	0.58
300	5.0	0.21	10	90.6	1203.6	100	0	1,200	2,089	0.58
312	5.2	0.22	10	90.6	1203.6	100	0	1,200	2,093	0.58
324	5.4	0.23	10	90.6	1203.6	100	0	1,200	2,096	0.58
336	5.6	0.23	10	90.6	1203.6	100	0	1,200	2,100	0.58
348	5.8	0.24	10	90.6	1203.6	100	0	1,200	2,103	0.59
360	6.0	0.25	10	90.6	1203.6	100	0	1,200	2,107	0.59
372	6.2	0.26	19	90.6	1319.9	100	0	1,200	2,227	0.62
384	6.4	0.27	19	90.6	1319.9	100	0	1,200	2,347	0.65
396	6.6	0.28	19	90.6	1319.9	100	0	1,200	2,467	0.69
408	6.8	0.28	29	90.6	1436.3	100	0	1,200	2,703	0.75
420	7.0	0.29	29	90.6	1436.3	100	0	1,200	2,939	0.82
432	7.2	0.30	29	90.6	1436.3	100	0	1,200	3,176	0.88
444	7.4	0.31	39	90.6	1552.6	100	0	1,200	3,528	0.98
456	7.6	0.32	39	90.6	1552.6	100	0	1,200	3,881	1.08
468	7.8	0.33	39	90.6	1552.6	100	0	1,200	4,234	1.18
480	8.0	0.33	48	90.6	1668.9	100	0	1,200	4,703	1.31
492	8.2	0.34	48	90.6	1668.9	100	0	1,200	5,171	1.44
504	8.4	0.35	48	90.6	1668.9	100	0	1,200	5,640	1.57
516	8.6	0.36	58	90.6	1785.3	100	0	1,200	6,226	1.73
528	8.8	0.37	58	90.6	1785.3	100	0	1,200	6,811	1.90
540	9.0	0.38	68	90.6	1901.6	100	0	1,200	7,512	2.36
552	9.2	0.38	68	90.6	1901.6	100	0	1,200	8,214	2.45
564	9.4	0.39	78	90.6	2017.9	100	0	1,200	9,032	2.54
576	9.6	0.40	78	90.6	2017.9	100	0	1,200	9,850	2.63
588	9.8	0.41	87	90.6	2134.3	100	0	1,200	10,784	2.73
600	10.0	0.42	87	90.6	2134.3	100	0	1,200	11,718	2.83
612	10.2	0.43	97	90.6	2250.6	100	0	1,200	12,769	2.93
624	10.4	0.43	97	90.6	2250.6	100	0	1,200	13,820	3.02
636	10.6	0.44	107	90.6	2366.9	100	0	1,200	14,986	3.12
648	10.8	0.45	116	90.6	2483.2	100	0	1,200	16,270	3.23
660	11.0	0.46	126	90.6	2599.6	100	0	1,200	17,669	3.34
672	11.2	0.47	136	90.6	2715.9	100	0	1,200	19,185	3.45
684	11.4	0.48	145	90.6	2832.2	100	0	1,200	20,817	3.57
696	11.6	0.48	155	90.6	2948.6	100	0	1,200	22,566	3.69
708	11.8	0.49	204	90.6	3530.2	100	0	1,200	24,896	3.84
720	12.0	0.50	301	90.6	4693.5	100	0	1,200	28,390	4.05
732	12.2	0.51	349	90.6	5275.1	100	550	7,800	25,865	3.90
744	12.4	0.52	475	90.6	6787.4	100	550	7,800	24,852	3.84
756	12.6	0.53	708	90.6	9579.3	100	550	7,800	26,632	3.95
768	12.8	0.53	892	90.6	11789.6	100	550	7,800	30,621	4.18
780	13.0	0.54	1037	90.6	13534.5	100	550	7,800	36,356	4.48
792	13.2	0.55	1134	90.6	14697.8	100	550	7,800	43,253	4.81
804	13.4	0.56	1202	90.6	15512.1	100	550	7,800	50,965	5.14
816	13.6	0.57	1251	90.6	16093.7	100	550	7,800	59,259	5.46
828	13.8	0.58	1270	90.6	16326.4	100	550	7,800	67,786	5.77
840	14.0	0.58	1280	90.6	16442.7	100	550	7,800	76,428	6.06
852	14.2	0.59	1280	90.6	16442.7	100	550	7,800	85,071	6.33
864	14.4	0.60	1270	90.6	16326.4	100	550	7,800	93,597	6.58
876	14.6	0.61	1251	90.6	16093.7	100	550	7,800	101,891	6.81
888	14.8	0.62	1231	90.6	15861.1	100	550	7,800	109,952	7.02
900	15.0	0.63	1212	90.6	15628.4	100	550	7,800	117,781	7.22

Attachment 13 - Cell 3 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
912	15.2	0.63	1192	90.6	15395.8	100	550	7,800	125,376	7.41
924	15.4	0.64	1163	90.6	15046.8	100	550	7,800	132,623	7.58
936	15.6	0.65	1144	90.6	14814.1	100	550	7,800	139,637	7.74
948	15.8	0.66	1115	90.6	14465.1	100	550	7,800	146,302	7.89
960	16.0	0.67	1086	90.6	14116.1	100	550	7,800	152,618	8.02
972	16.2	0.68	1057	90.6	13767.1	100	550	7,800	158,586	8.15
984	16.4	0.68	1028	90.6	13418.2	100	550	7,800	164,204	8.27
996	16.6	0.69	998	90.6	13069.2	100	550	7,800	169,473	8.37
1,008	16.8	0.70	969	90.6	12720.2	100	550	7,800	174,393	8.47
1,020	17.0	0.71	940	90.6	12371.2	100	550	7,800	178,964	8.56
1,032	17.2	0.72	921	90.6	12138.5	100	550	7,800	183,303	8.64
1,044	17.4	0.73	892	90.6	11789.6	100	550	7,800	187,292	8.72
1,056	17.6	0.73	872	90.6	11556.9	100	550	7,800	191,049	8.79
1,068	17.8	0.74	843	90.6	11207.9	100	550	7,800	194,457	8.85
1,080	18.0	0.75	824	90.6	10975.3	100	550	7,800	197,632	8.91
1,092	18.2	0.76	805	90.6	10742.6	100	550	7,800	200,575	8.97
1,104	18.4	0.77	785	90.6	10509.9	100	550	7,800	203,285	9.02
1,116	18.6	0.78	766	90.6	10277.3	100	550	7,800	205,762	9.06
1,128	18.8	0.78	746	90.6	10044.6	100	550	7,800	208,007	9.10
1,140	19.0	0.79	727	90.6	9812.0	100	550	7,800	210,019	9.14
1,152	19.2	0.80	708	90.6	9579.3	100	550	7,800	211,798	9.17
1,164	19.4	0.81	698	90.6	9463.0	100	550	7,800	213,461	9.20
1,176	19.6	0.82	679	90.6	9230.3	100	550	7,800	214,891	9.22
1,188	19.8	0.83	659	90.6	8997.7	100	550	7,800	216,089	9.24
1,200	20.0	0.83	650	90.6	8881.3	100	550	7,800	217,170	9.26
1,212	20.2	0.84	630	90.6	8648.7	100	550	7,800	218,019	9.28
1,224	20.4	0.85	620	90.6	8532.3	100	550	7,800	218,751	9.29
1,236	20.6	0.86	601	90.6	8299.7	100	550	7,800	219,251	9.30
1,248	20.8	0.87	591	90.6	8183.4	100	550	7,800	219,634	9.30
1,260	21.0	0.88	582	90.6	8067.0	100	550	7,800	219,901	9.31
1,272	21.2	0.88	562	90.6	7834.4	100	550	7,800	219,936	9.31
1,284	21.4	0.89	553	90.6	7718.0	100	550	7,800	219,854	9.31
1,296	21.6	0.90	543	90.6	7601.7	100	550	7,800	219,656	9.30
1,308	21.8	0.91	533	90.6	7485.4	100	550	7,800	219,341	9.30
1,320	22.0	0.92	523	90.6	7369.1	100	550	7,800	218,910	9.29
1,332	22.2	0.93	514	90.6	7252.7	100	550	7,800	218,363	9.28
1,344	22.4	0.93	504	90.6	7136.4	100	550	7,800	217,699	9.27
1,356	22.6	0.94	494	90.6	7020.1	100	550	7,800	216,919	9.26
1,368	22.8	0.95	494	90.6	7020.1	100	550	7,800	216,139	9.24
1,380	23.0	0.96	485	90.6	6903.7	100	550	7,800	215,243	9.23
1,392	23.2	0.97	475	90.6	6787.4	100	550	7,800	214,230	9.21
1,404	23.4	0.98	465	90.6	6671.1	100	550	7,800	213,102	9.19
1,416	23.6	0.98	465	90.6	6671.1	100	550	7,800	211,973	9.17
1,428	23.8	0.99	456	90.6	6554.8	100	550	7,800	210,727	9.15
1,440	24.0	1.00	446	90.6	6438.4	100	550	7,800	209,366	9.12
1,452	24.2	1.01	427	90.6	6205.8	100	550	7,800	207,772	9.10
1,464	24.4	1.02	407	90.6	5973.1	100	550	7,800	205,945	9.06
1,476	24.6	1.03	397	90.6	5856.8	100	550	7,800	204,001	9.03
1,488	24.8	1.03	378	90.6	5624.1	100	550	7,800	201,826	8.99
1,500	25.0	1.04	359	90.6	5391.5	100	550	7,800	199,417	8.95
1,512	25.2	1.05	349	90.6	5275.1	100	550	7,800	196,892	8.90
1,524	25.4	1.06	349	90.6	5275.1	100	550	7,800	194,367	8.85
1,536	25.6	1.07	349	90.6	5275.1	100	550	7,800	191,842	8.81
1,548	25.8	1.08	349	90.6	5275.1	100	550	7,800	189,318	8.76
1,560	26.0	1.08	349	90.6	5275.1	100	550	7,800	186,793	8.71
1,572	26.2	1.09	349	90.6	5275.1	100	550	7,800	184,268	8.66
1,584	26.4	1.10	349	90.6	5275.1	100	550	7,800	181,743	8.61
1,596	26.6	1.11	339	90.6	5158.8	100	550	7,800	179,102	8.56
1,608	26.8	1.12	339	90.6	5158.8	100	550	7,800	176,461	8.51
1,620	27.0	1.13	339	90.6	5158.8	100	550	7,800	173,819	8.46
1,632	27.2	1.13	339	90.6	5158.8	100	550	7,800	171,178	8.41
1,644	27.4	1.14	339	90.6	5158.8	100	550	7,800	168,537	8.35
1,656	27.6	1.15	339	90.6	5158.8	100	550	7,800	165,896	8.30
1,668	27.8	1.16	339	90.6	5158.8	100	550	7,800	163,255	8.25
1,680	28.0	1.17	339	90.6	5158.8	100	550	7,800	160,613	8.19
1,692	28.2	1.18	339	90.6	5158.8	100	550	7,800	157,972	8.14
1,704	28.4	1.18	339	90.6	5158.8	100	550	7,800	155,331	8.08
1,716	28.6	1.19	339	90.6	5158.8	100	550	7,800	152,690	8.03
1,728	28.8	1.20	339	90.6	5158.8	100	550	7,800	150,049	7.97
1,740	29.0	1.21	339	90.6	5158.8	100	550	7,800	147,407	7.91
1,752	29.2	1.22	330	90.6	5042.5	100	550	7,800	144,650	7.85
1,764	29.4	1.23	330	90.6	5042.5	100	550	7,800	141,892	7.79
1,776	29.6	1.23	330	90.6	5042.5	100	550	7,800	139,135	7.73
1,788	29.8	1.24	330	90.6	5042.5	100	550	7,800	136,377	7.67
1,800	30.0	1.25	330	90.6	5042.5	100	550	7,800	133,620	7.60
1,812	30.2	1.26	330	90.6	5042.5	100	550	7,800	130,862	7.54

Attachment 13 - Cell 3 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
1,824	30.4	1.27	330	90.6	5042.5	100	550	7,800	128,105	7.47
1,836	30.6	1.28	330	90.6	5042.5	100	550	7,800	125,347	7.41
1,848	30.8	1.28	330	90.6	5042.5	100	550	7,800	122,590	7.34
1,860	31.0	1.29	330	90.6	5042.5	100	550	7,800	119,832	7.27
1,872	31.2	1.30	330	90.6	5042.5	100	550	7,800	117,075	7.20
1,884	31.4	1.31	320	90.6	4926.1	100	550	7,800	114,201	7.13
1,896	31.6	1.32	320	90.6	4926.1	100	550	7,800	111,327	7.06
1,908	31.8	1.33	320	90.6	4926.1	100	550	7,800	108,453	6.98
1,920	32.0	1.33	320	90.6	4926.1	100	550	7,800	105,579	6.91
1,932	32.2	1.34	320	90.6	4926.1	100	550	7,800	102,705	6.83
1,944	32.4	1.35	320	90.6	4926.1	100	550	7,800	99,831	6.75
1,956	32.6	1.36	320	90.6	4926.1	100	550	7,800	96,958	6.67
1,968	32.8	1.37	320	90.6	4926.1	100	550	7,800	94,084	6.59
1,980	33.0	1.38	320	90.6	4926.1	100	550	7,800	91,210	6.51
1,992	33.2	1.38	320	90.6	4926.1	100	550	7,800	88,336	6.42
2,004	33.4	1.39	320	90.6	4926.1	100	550	7,800	85,462	6.34
2,016	33.6	1.40	320	90.6	4926.1	100	550	7,800	82,588	6.25
2,028	33.8	1.41	310	90.6	4809.8	100	550	7,800	79,598	6.16
2,040	34.0	1.42	310	90.6	4809.8	100	550	7,800	76,608	6.06
2,052	34.2	1.43	310	90.6	4809.8	100	550	7,800	73,618	5.97
2,064	34.4	1.43	310	90.6	4809.8	100	550	7,800	70,628	5.87
2,076	34.6	1.44	310	90.6	4809.8	100	550	7,800	67,637	5.76
2,088	34.8	1.45	310	90.6	4809.8	100	550	7,800	64,647	5.66
2,100	35.0	1.46	310	90.6	4809.8	100	550	7,800	61,657	5.55
2,112	35.2	1.47	310	90.6	4809.8	100	550	7,800	58,667	5.44
2,124	35.4	1.48	310	90.6	4809.8	100	550	7,800	55,677	5.33
2,136	35.6	1.48	310	90.6	4809.8	100	550	7,800	52,687	5.21
2,148	35.8	1.49	310	90.6	4809.8	100	550	7,800	49,696	5.09
2,160	36.0	1.50	310	90.6	4809.8	100	550	7,800	46,706	4.96
2,172	36.2	1.51	310	90.6	4809.8	100	550	7,800	43,716	4.83
2,184	36.4	1.52	301	90.6	4693.5	100	550	7,800	40,609	4.68
2,196	36.6	1.53	301	90.6	4693.5	100	550	7,800	37,503	4.54
2,208	36.8	1.53	301	90.6	4693.5	100	550	7,800	34,396	4.38
2,220	37.0	1.54	301	90.6	4693.5	100	550	7,800	31,290	4.21
2,232	37.2	1.55	301	90.6	4693.5	100	550	7,800	28,183	4.04
2,244	37.4	1.56	301	90.6	4693.5	100	550	7,800	25,077	3.85
2,256	37.6	1.57	301	90.6	4693.5	100	550	7,800	21,970	3.65
2,268	37.8	1.58	301	90.6	4693.5	100	550	7,800	18,864	3.43
2,280	38.0	1.58	301	90.6	4693.5	100	550	7,800	15,757	3.19
2,292	38.2	1.59	301	90.6	4693.5	100	550	7,800	12,651	2.92
2,304	38.4	1.60	301	90.6	4693.5	100	550	7,800	9,544	2.60
2,316	38.6	1.61	291	90.6	4577.2	100	550	7,800	6,321	1.76
2,328	38.8	1.62	291	90.6	4577.2	100	0	1,200	9,699	2.62
2,340	39.0	1.63	291	90.6	4577.2	100	0	1,200	13,076	2.96
2,352	39.2	1.63	291	90.6	4577.2	100	0	1,200	16,453	3.24
2,364	39.4	1.64	291	90.6	4577.2	100	0	1,200	19,830	3.50
2,376	39.6	1.65	291	90.6	4577.2	100	0	1,200	23,207	3.73
2,388	39.8	1.66	291	90.6	4577.2	100	0	1,200	26,584	3.94
2,400	40.0	1.67	291	90.6	4577.2	100	0	1,200	29,962	4.14
2,412	40.2	1.68	291	90.6	4577.2	100	550	7,800	26,739	3.95
2,424	40.4	1.68	291	90.6	4577.2	100	550	7,800	23,516	3.75
2,436	40.6	1.69	291	90.6	4577.2	100	550	7,800	20,293	3.53
2,448	40.8	1.70	291	90.6	4577.2	100	550	7,800	17,070	3.29
2,460	41.0	1.71	291	90.6	4577.2	100	550	7,800	13,847	3.03
2,472	41.2	1.72	281	90.6	4460.8	100	550	7,800	10,508	2.70
2,484	41.4	1.73	281	90.6	4460.8	100	550	7,800	7,169	2.00
2,496	41.6	1.73	281	90.6	4460.8	100	0	1,200	10,430	2.70
2,508	41.8	1.74	281	90.6	4460.8	100	0	1,200	13,691	3.01
2,520	42.0	1.75	281	90.6	4460.8	100	0	1,200	16,952	3.28
2,532	42.2	1.76	281	90.6	4460.8	100	0	1,200	20,212	3.53
2,544	42.4	1.77	281	90.6	4460.8	100	0	1,200	23,473	3.75
2,556	42.6	1.78	281	90.6	4460.8	100	0	1,200	26,734	3.95
2,568	42.8	1.78	281	90.6	4460.8	100	0	1,200	29,995	4.14
2,580	43.0	1.79	281	90.6	4460.8	100	550	7,800	26,656	3.95
2,592	43.2	1.80	281	90.6	4460.8	100	550	7,800	23,317	3.74
2,604	43.4	1.81	281	90.6	4460.8	100	550	7,800	19,977	3.51
2,616	43.6	1.82	271	90.6	4344.5	100	550	7,800	16,522	3.25
2,628	43.8	1.83	271	90.6	4344.5	100	550	7,800	13,066	2.95
2,640	44.0	1.83	271	90.6	4344.5	100	550	7,800	9,611	2.61
2,652	44.2	1.84	271	90.6	4344.5	100	550	7,800	6,155	1.71
2,664	44.4	1.85	271	90.6	4344.5	100	0	1,200	9,300	2.57
2,676	44.6	1.86	271	90.6	4344.5	100	0	1,200	12,444	2.90
2,688	44.8	1.87	271	90.6	4344.5	100	0	1,200	15,589	3.17
2,700	45.0	1.88	271	90.6	4344.5	100	0	1,200	18,733	3.42
2,712	45.2	1.88	271	90.6	4344.5	100	0	1,200	21,878	3.64
2,724	45.4	1.89	271	90.6	4344.5	100	0	1,200	25,022	3.85

Attachment 13 - Cell 3 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
2,736	45.6	1.90	271	90.6	4344.5	100	0	1,200	28,167	4.04
2,748	45.8	1.91	271	90.6	4344.5	100	550	7,800	24,711	3.83
2,760	46.0	1.92	262	90.6	4228.2	100	550	7,800	21,140	3.59
2,772	46.2	1.93	262	90.6	4228.2	100	550	7,800	17,568	3.33
2,784	46.4	1.93	262	90.6	4228.2	100	550	7,800	13,996	3.04
2,796	46.6	1.94	262	90.6	4228.2	100	550	7,800	10,424	2.70
2,808	46.8	1.95	262	90.6	4228.2	100	550	7,800	6,852	1.91
2,820	47.0	1.96	262	90.6	4228.2	100	0	1,200	9,880	2.64
2,832	47.2	1.97	262	90.6	4228.2	100	0	1,200	12,909	2.94
2,844	47.4	1.98	262	90.6	4228.2	100	0	1,200	15,937	3.20
2,856	47.6	1.98	262	90.6	4228.2	100	0	1,200	18,965	3.44
2,868	47.8	1.99	262	90.6	4228.2	100	0	1,200	21,993	3.65
2,880	48.0	2.00	262	90.6	4228.2	100	0	1,200	25,021	3.85
2,892	48.2	2.01	262	90.6	4228.2	100	0	1,200	28,049	4.03
2,904	48.4	2.02	262	90.6	4228.2	100	550	7,800	24,478	3.81
2,916	48.6	2.03	252	90.6	4111.8	100	550	7,800	20,789	3.57
2,928	48.8	2.03	252	90.6	4111.8	100	550	7,800	17,101	3.30
2,940	49.0	2.04	252	90.6	4111.8	100	550	7,800	13,413	2.99
2,952	49.2	2.05	252	90.6	4111.8	100	550	7,800	9,725	2.62
2,964	49.4	2.06	252	90.6	4111.8	100	550	7,800	6,037	1.68
2,976	49.6	2.07	252	90.6	4111.8	100	0	1,200	8,949	2.53
2,988	49.8	2.08	252	90.6	4111.8	100	0	1,200	11,861	2.84
3,000	50.0	2.08	252	90.6	4111.8	100	0	1,200	14,772	3.11
3,012	50.2	2.09	252	90.6	4111.8	100	0	1,200	17,684	3.34
3,024	50.4	2.10	252	90.6	4111.8	100	0	1,200	20,596	3.55
3,036	50.6	2.11	252	90.6	4111.8	100	0	1,200	23,508	3.75
3,048	50.8	2.12	242	90.6	3995.5	100	0	1,200	26,303	3.93
3,060	51.0	2.13	242	90.6	3995.5	100	0	1,200	29,099	4.09
3,072	51.2	2.13	242	90.6	3995.5	100	550	7,800	25,294	3.86
3,084	51.4	2.14	242	90.6	3995.5	100	550	7,800	21,490	3.62
3,096	51.6	2.15	242	90.6	3995.5	100	550	7,800	17,685	3.34
3,108	51.8	2.16	242	90.6	3995.5	100	550	7,800	13,881	3.03
3,120	52.0	2.17	242	90.6	3995.5	100	550	7,800	10,076	2.66
3,132	52.2	2.18	242	90.6	3995.5	100	550	7,800	6,272	1.75
3,144	52.4	2.18	242	90.6	3995.5	100	0	1,200	9,068	2.55
3,156	52.6	2.19	242	90.6	3995.5	100	0	1,200	11,863	2.84
3,168	52.8	2.20	242	90.6	3995.5	100	0	1,200	14,659	3.10
3,180	53.0	2.21	242	90.6	3995.5	100	0	1,200	17,454	3.32
3,192	53.2	2.22	242	90.6	3995.5	100	0	1,200	20,250	3.53
3,204	53.4	2.23	242	90.6	3995.5	100	0	1,200	23,045	3.72
3,216	53.6	2.23	233	90.6	3879.2	100	0	1,200	25,724	3.89
3,228	53.8	2.24	233	90.6	3879.2	100	0	1,200	28,403	4.05
3,240	54.0	2.25	233	90.6	3879.2	100	550	7,800	24,483	3.81
3,252	54.2	2.26	233	90.6	3879.2	100	550	7,800	20,562	3.55
3,264	54.4	2.27	233	90.6	3879.2	100	550	7,800	16,641	3.26
3,276	54.6	2.28	233	90.6	3879.2	100	550	7,800	12,720	2.92
3,288	54.8	2.28	233	90.6	3879.2	100	550	7,800	8,799	2.52
3,300	55.0	2.29	233	90.6	3879.2	100	550	7,800	4,879	1.36
3,312	55.2	2.30	233	90.6	3879.2	100	0	1,200	7,558	2.37
3,324	55.4	2.31	233	90.6	3879.2	100	0	1,200	10,237	2.68
3,336	55.6	2.32	233	90.6	3879.2	100	0	1,200	12,916	2.94
3,348	55.8	2.33	233	90.6	3879.2	100	0	1,200	15,595	3.17
3,360	56.0	2.33	223	90.6	3762.9	100	0	1,200	18,158	3.38
3,372	56.2	2.34	223	90.6	3762.9	100	0	1,200	20,721	3.56
3,384	56.4	2.35	223	90.6	3762.9	100	0	1,200	23,284	3.74
3,396	56.6	2.36	223	90.6	3762.9	100	0	1,200	25,847	3.90
3,408	56.8	2.37	223	90.6	3762.9	100	0	1,200	28,410	4.05
3,420	57.0	2.38	223	90.6	3762.9	100	550	7,800	24,372	3.81
3,432	57.2	2.38	223	90.6	3762.9	100	550	7,800	20,335	3.54
3,444	57.4	2.39	223	90.6	3762.9	100	550	7,800	16,298	3.23
3,456	57.6	2.40	223	90.6	3762.9	100	550	7,800	12,261	2.88
3,468	57.8	2.41	223	90.6	3762.9	100	550	7,800	8,224	2.45
3,480	58.0	2.42	223	90.6	3762.9	100	550	7,800	4,187	1.17
3,492	58.2	2.43	223	90.6	3762.9	100	0	1,200	6,750	1.88
3,504	58.4	2.43	213	90.6	3646.5	100	0	1,200	9,196	2.56
3,516	58.6	2.44	213	90.6	3646.5	100	0	1,200	11,643	2.82
3,528	58.8	2.45	213	90.6	3646.5	100	0	1,200	14,089	3.05
3,540	59.0	2.46	213	90.6	3646.5	100	0	1,200	16,536	3.25
3,552	59.2	2.47	213	90.6	3646.5	100	0	1,200	18,982	3.44
3,564	59.4	2.48	213	90.6	3646.5	100	0	1,200	21,429	3.61
3,576	59.6	2.48	213	90.6	3646.5	100	0	1,200	23,875	3.77
3,588	59.8	2.49	213	90.6	3646.5	100	0	1,200	26,322	3.93
3,600	60.0	2.50	213	90.6	3646.5	100	0	1,200	28,768	4.07
3,612	60.2	2.51	213	90.6	3646.5	100	550	7,800	24,615	3.82
3,624	60.4	2.52	213	90.6	3646.5	100	550	7,800	20,461	3.55
3,636	60.6	2.53	213	90.6	3646.5	100	550	7,800	16,308	3.23

Attachment 13 - Cell 3 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
3,648	60.8	2.53	213	90.6	3646.5	100	550	7,800	12,154	2.87
3,660	61.0	2.54	213	90.6	3646.5	100	550	7,800	8,001	2.42
3,672	61.2	2.55	204	90.6	3530.2	100	550	7,800	3,731	1.04
3,684	61.4	2.56	204	90.6	3530.2	100	0	1,200	6,061	1.69
3,696	61.6	2.57	204	90.6	3530.2	100	0	1,200	8,392	2.47
3,708	61.8	2.58	204	90.6	3530.2	100	0	1,200	10,722	2.73
3,720	62.0	2.58	204	90.6	3530.2	100	0	1,200	13,052	2.95
3,732	62.2	2.59	204	90.6	3530.2	100	0	1,200	15,382	3.16
3,744	62.4	2.60	204	90.6	3530.2	100	0	1,200	17,712	3.34
3,756	62.6	2.61	204	90.6	3530.2	100	0	1,200	20,043	3.52
3,768	62.8	2.62	204	90.6	3530.2	100	0	1,200	22,373	3.68
3,780	63.0	2.63	204	90.6	3530.2	100	0	1,200	24,703	3.83
3,792	63.2	2.63	204	90.6	3530.2	100	0	1,200	27,033	3.97
3,804	63.4	2.64	204	90.6	3530.2	100	0	1,200	29,363	4.11
3,816	63.6	2.65	194	90.6	3413.9	100	550	7,800	24,977	3.84
3,828	63.8	2.66	194	90.6	3413.9	100	550	7,800	20,591	3.55
3,840	64.0	2.67	194	90.6	3413.9	100	550	7,800	16,205	3.22
3,852	64.2	2.68	194	90.6	3413.9	100	550	7,800	11,819	2.84
3,864	64.4	2.68	194	90.6	3413.9	100	550	7,800	7,433	2.35
3,876	64.6	2.69	194	90.6	3413.9	100	550	7,800	3,047	0.85
3,888	64.8	2.70	194	90.6	3413.9	100	0	1,200	5,260	1.47
3,900	65.0	2.71	194	90.6	3413.9	100	0	1,200	7,474	2.35
3,912	65.2	2.72	194	90.6	3413.9	100	0	1,200	9,688	2.62
3,924	65.4	2.73	194	90.6	3413.9	100	0	1,200	11,902	2.84
3,936	65.6	2.73	194	90.6	3413.9	100	0	1,200	14,116	3.05
3,948	65.8	2.74	194	90.6	3413.9	100	0	1,200	16,330	3.23
3,960	66.0	2.75	194	90.6	3413.9	100	0	1,200	18,544	3.41
3,972	66.2	2.76	194	90.6	3413.9	100	0	1,200	20,757	3.57
3,984	66.4	2.77	184	90.6	3297.5	100	0	1,200	22,855	3.71
3,996	66.6	2.78	184	90.6	3297.5	100	0	1,200	24,953	3.84
4,008	66.8	2.78	184	90.6	3297.5	100	0	1,200	27,050	3.97
4,020	67.0	2.79	184	90.6	3297.5	100	0	1,200	29,148	4.09
4,032	67.2	2.80	184	90.6	3297.5	100	550	7,800	24,645	3.82
4,044	67.4	2.81	184	90.6	3297.5	100	550	7,800	20,143	3.52
4,056	67.6	2.82	184	90.6	3297.5	100	550	7,800	15,640	3.18
4,068	67.8	2.83	184	90.6	3297.5	100	550	7,800	11,138	2.77
4,080	68.0	2.83	184	90.6	3297.5	100	550	7,800	6,635	1.85
4,092	68.2	2.84	184	90.6	3297.5	100	0	1,200	8,733	2.51
4,104	68.4	2.85	184	90.6	3297.5	100	0	1,200	10,830	2.74
4,116	68.6	2.86	184	90.6	3297.5	100	0	1,200	12,928	2.94
4,128	68.8	2.87	174	90.6	3181.2	100	0	1,200	14,909	3.12
4,140	69.0	2.88	174	90.6	3181.2	100	0	1,200	16,890	3.28
4,152	69.2	2.88	174	90.6	3181.2	100	0	1,200	18,872	3.43
4,164	69.4	2.89	174	90.6	3181.2	100	0	1,200	20,853	3.57
4,176	69.6	2.90	174	90.6	3181.2	100	0	1,200	22,834	3.71
4,188	69.8	2.91	174	90.6	3181.2	100	0	1,200	24,815	3.83
4,200	70.0	2.92	174	90.6	3181.2	100	0	1,200	26,796	3.96
4,212	70.2	2.93	174	90.6	3181.2	100	0	1,200	28,778	4.07
4,224	70.4	2.93	174	90.6	3181.2	100	550	7,800	24,159	3.79
4,236	70.6	2.94	174	90.6	3181.2	100	550	7,800	19,540	3.48
4,248	70.8	2.95	174	90.6	3181.2	100	550	7,800	14,921	3.12
4,260	71.0	2.96	174	90.6	3181.2	100	550	7,800	10,303	2.68
4,272	71.2	2.97	174	90.6	3181.2	100	550	7,800	5,684	1.58
4,284	71.4	2.98	165	90.6	3064.9	100	0	1,200	7,549	2.36
4,296	71.6	2.98	165	90.6	3064.9	100	0	1,200	9,413	2.59
4,308	71.8	2.99	165	90.6	3064.9	100	0	1,200	11,278	2.78
4,320	72.0	3.00	165	90.6	3064.9	100	0	1,200	13,143	2.96
4,332	72.2	3.01	165	90.6	3064.9	100	0	1,200	15,008	3.13
4,344	72.4	3.02	165	90.6	3064.9	100	0	1,200	16,873	3.28
4,356	72.6	3.03	165	90.6	3064.9	100	0	1,200	18,738	3.42
4,368	72.8	3.03	165	90.6	3064.9	100	0	1,200	20,603	3.56
4,380	73.0	3.04	165	90.6	3064.9	100	0	1,200	22,468	3.68
4,392	73.2	3.05	165	90.6	3064.9	100	0	1,200	24,333	3.80
4,404	73.4	3.06	165	90.6	3064.9	100	0	1,200	26,197	3.92
4,416	73.6	3.07	165	90.6	3064.9	100	0	1,200	28,062	4.03
4,428	73.8	3.08	165	90.6	3064.9	100	550	7,800	23,327	3.74
4,440	74.0	3.08	155	90.6	2948.6	100	550	7,800	18,476	3.40
4,452	74.2	3.09	155	90.6	2948.6	100	550	7,800	13,624	3.01
4,464	74.4	3.10	155	90.6	2948.6	100	550	7,800	8,773	2.51
4,476	74.6	3.11	155	90.6	2948.6	100	550	7,800	3,921	1.09
4,488	74.8	3.12	155	90.6	2948.6	100	0	1,200	5,670	1.58
4,500	75.0	3.13	155	90.6	2948.6	100	0	1,200	7,419	2.35
4,512	75.2	3.13	155	90.6	2948.6	100	0	1,200	9,167	2.56
4,524	75.4	3.14	155	90.6	2948.6	100	0	1,200	10,916	2.75
4,536	75.6	3.15	155	90.6	2948.6	100	0	1,200	12,664	2.92
4,548	75.8	3.16	155	90.6	2948.6	100	0	1,200	14,413	3.07

Attachment 13 - Cell 3 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
4,560	76.0	3.17	155	90.6	2948.6	100	0	1,200	16,161	3.22
4,572	76.2	3.18	155	90.6	2948.6	100	0	1,200	17,910	3.36
4,584	76.4	3.18	155	90.6	2948.6	100	0	1,200	19,658	3.49
4,596	76.6	3.19	145	90.6	2832.2	100	0	1,200	21,291	3.60
4,608	76.8	3.20	145	90.6	2832.2	100	0	1,200	22,923	3.71
4,620	77.0	3.21	145	90.6	2832.2	100	0	1,200	24,555	3.82
4,632	77.2	3.22	145	90.6	2832.2	100	0	1,200	26,187	3.92
4,644	77.4	3.23	145	90.6	2832.2	100	0	1,200	27,820	4.02
4,656	77.6	3.23	145	90.6	2832.2	100	550	7,800	22,852	3.71
4,668	77.8	3.24	145	90.6	2832.2	100	550	7,800	17,884	3.36
4,680	78.0	3.25	145	90.6	2832.2	100	550	7,800	12,916	2.94
4,692	78.2	3.26	145	90.6	2832.2	100	550	7,800	7,948	2.41
4,704	78.4	3.27	145	90.6	2832.2	100	550	7,800	2,981	0.83
4,716	78.6	3.28	145	90.6	2832.2	100	0	1,200	4,613	1.28
4,728	78.8	3.28	145	90.6	2832.2	100	0	1,200	6,245	1.74
4,740	79.0	3.29	145	90.6	2832.2	100	0	1,200	7,877	2.41
4,752	79.2	3.30	145	90.6	2832.2	100	0	1,200	9,510	2.60
4,764	79.4	3.31	136	90.6	2715.9	100	0	1,200	11,025	2.76
4,776	79.6	3.32	136	90.6	2715.9	100	0	1,200	12,541	2.91
4,788	79.8	3.33	136	90.6	2715.9	100	0	1,200	14,057	3.04
4,800	80.0	3.33	136	90.6	2715.9	100	0	1,200	15,573	3.17
4,812	80.2	3.34	136	90.6	2715.9	100	0	1,200	17,089	3.30
4,824	80.4	3.35	136	90.6	2715.9	100	0	1,200	18,605	3.41
4,836	80.6	3.36	136	90.6	2715.9	100	0	1,200	20,121	3.52
4,848	80.8	3.37	136	90.6	2715.9	100	0	1,200	21,637	3.63
4,860	81.0	3.38	136	90.6	2715.9	100	0	1,200	23,153	3.73
4,872	81.2	3.38	136	90.6	2715.9	100	0	1,200	24,668	3.83
4,884	81.4	3.39	136	90.6	2715.9	100	0	1,200	26,184	3.92
4,896	81.6	3.40	136	90.6	2715.9	100	0	1,200	27,700	4.01
4,908	81.8	3.41	136	90.6	2715.9	100	550	7,800	22,616	3.69
4,920	82.0	3.42	126	90.6	2599.6	100	550	7,800	17,416	3.32
4,932	82.2	3.43	126	90.6	2599.6	100	550	7,800	12,215	2.87
4,944	82.4	3.43	126	90.6	2599.6	100	550	7,800	7,015	1.95
4,956	82.6	3.44	126	90.6	2599.6	100	0	1,200	8,414	2.47
4,968	82.8	3.45	126	90.6	2599.6	100	0	1,200	9,814	2.63
4,980	83.0	3.46	126	90.6	2599.6	100	0	1,200	11,214	2.78
4,992	83.2	3.47	126	90.6	2599.6	100	0	1,200	12,613	2.91
5,004	83.4	3.48	126	90.6	2599.6	100	0	1,200	14,013	3.04
5,016	83.6	3.48	126	90.6	2599.6	100	0	1,200	15,412	3.16
5,028	83.8	3.49	126	90.6	2599.6	100	0	1,200	16,812	3.27
5,040	84.0	3.50	126	90.6	2599.6	100	0	1,200	18,211	3.38
5,052	84.2	3.51	126	90.6	2599.6	100	0	1,200	19,611	3.48
5,064	84.4	3.52	126	90.6	2599.6	100	0	1,200	21,011	3.58
5,076	84.6	3.53	126	90.6	2599.6	100	0	1,200	22,410	3.68
5,088	84.8	3.53	116	90.6	2483.2	100	0	1,200	23,693	3.76
5,100	85.0	3.54	116	90.6	2483.2	100	0	1,200	24,977	3.84
5,112	85.2	3.55	116	90.6	2483.2	100	0	1,200	26,260	3.92
5,124	85.4	3.56	116	90.6	2483.2	100	0	1,200	27,543	4.00
5,136	85.6	3.57	116	90.6	2483.2	100	550	7,800	22,226	3.67
5,148	85.8	3.58	116	90.6	2483.2	100	550	7,800	16,910	3.28
5,160	86.0	3.58	116	90.6	2483.2	100	550	7,800	11,593	2.81
5,172	86.2	3.59	116	90.6	2483.2	100	550	7,800	6,276	1.75
5,184	86.4	3.60	116	90.6	2483.2	100	0	1,200	7,559	2.37
5,196	86.6	3.61	116	90.6	2483.2	100	0	1,200	8,842	2.52
5,208	86.8	3.62	116	90.6	2483.2	100	0	1,200	10,126	2.66
5,220	87.0	3.63	116	90.6	2483.2	100	0	1,200	11,409	2.80
5,232	87.2	3.63	116	90.6	2483.2	100	0	1,200	12,692	2.92
5,244	87.4	3.64	116	90.6	2483.2	100	0	1,200	13,975	3.04
5,256	87.6	3.65	116	90.6	2483.2	100	0	1,200	15,259	3.15
5,268	87.8	3.66	107	90.6	2366.9	100	0	1,200	16,426	3.24
5,280	88.0	3.67	107	90.6	2366.9	100	0	1,200	17,592	3.33
5,292	88.2	3.68	107	90.6	2366.9	100	0	1,200	18,759	3.42
5,304	88.4	3.68	107	90.6	2366.9	100	0	1,200	19,926	3.51
5,316	88.6	3.69	107	90.6	2366.9	100	0	1,200	21,093	3.59
5,328	88.8	3.70	107	90.6	2366.9	100	0	1,200	22,260	3.67
5,340	89.0	3.71	107	90.6	2366.9	100	0	1,200	23,427	3.75
5,352	89.2	3.72	107	90.6	2366.9	100	0	1,200	24,594	3.82
5,364	89.4	3.73	107	90.6	2366.9	100	0	1,200	25,761	3.89
5,376	89.6	3.73	107	90.6	2366.9	100	0	1,200	26,928	3.96
5,388	89.8	3.74	107	90.6	2366.9	100	0	1,200	28,095	4.03
5,400	90.0	3.75	107	90.6	2366.9	100	550	7,800	22,662	3.70
5,412	90.2	3.76	107	90.6	2366.9	100	550	7,800	17,228	3.31
5,424	90.4	3.77	97	90.6	2250.6	100	550	7,800	11,679	2.82
5,436	90.6	3.78	97	90.6	2250.6	100	550	7,800	6,130	1.71
5,448	90.8	3.78	97	90.6	2250.6	100	0	1,200	7,180	2.00
5,460	91.0	3.79	97	90.6	2250.6	100	0	1,200	8,231	2.45

Attachment 13 - Cell 3 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
5,472	91.2	3.80	97	90.6	2250.6	100	0	1,200	9,281	2.57
5,484	91.4	3.81	97	90.6	2250.6	100	0	1,200	10,332	2.69
5,496	91.6	3.82	97	90.6	2250.6	100	0	1,200	11,383	2.79
5,508	91.8	3.83	97	90.6	2250.6	100	0	1,200	12,433	2.90
5,520	92.0	3.83	97	90.6	2250.6	100	0	1,200	13,484	2.99
5,532	92.2	3.84	97	90.6	2250.6	100	0	1,200	14,534	3.09
5,544	92.4	3.85	97	90.6	2250.6	100	0	1,200	15,585	3.17
5,556	92.6	3.86	97	90.6	2250.6	100	0	1,200	16,635	3.26
5,568	92.8	3.87	97	90.6	2250.6	100	0	1,200	17,686	3.34
5,580	93.0	3.88	97	90.6	2250.6	100	0	1,200	18,737	3.42
5,592	93.2	3.88	97	90.6	2250.6	100	0	1,200	19,787	3.50
5,604	93.4	3.89	97	90.6	2250.6	100	0	1,200	20,838	3.57
5,616	93.6	3.90	87	90.6	2134.3	100	0	1,200	21,772	3.64
5,628	93.8	3.91	87	90.6	2134.3	100	0	1,200	22,706	3.70
5,640	94.0	3.92	87	90.6	2134.3	100	0	1,200	23,640	3.76
5,652	94.2	3.93	87	90.6	2134.3	100	0	1,200	24,575	3.82
5,664	94.4	3.93	87	90.6	2134.3	100	0	1,200	25,509	3.88
5,676	94.6	3.94	87	90.6	2134.3	100	0	1,200	26,443	3.93
5,688	94.8	3.95	87	90.6	2134.3	100	0	1,200	27,378	3.99
5,700	95.0	3.96	87	90.6	2134.3	100	0	1,200	28,312	4.05
5,712	95.2	3.97	87	90.6	2134.3	100	550	7,800	22,646	3.69
5,724	95.4	3.98	87	90.6	2134.3	100	550	7,800	16,980	3.29
5,736	95.6	3.98	87	90.6	2134.3	100	550	7,800	11,315	2.79
5,748	95.8	3.99	87	90.6	2134.3	100	550	7,800	5,649	1.57
5,760	96.0	4.00	78	90.6	2017.9	100	0	1,200	6,467	1.80
5,772	96.2	4.01	78	90.6	2017.9	100	0	1,200	7,285	2.33
5,784	96.4	4.02	78	90.6	2017.9	100	0	1,200	8,103	2.43
5,796	96.6	4.03	78	90.6	2017.9	100	0	1,200	8,920	2.53
5,808	96.8	4.03	78	90.6	2017.9	100	0	1,200	9,738	2.62
5,820	97.0	4.04	78	90.6	2017.9	100	0	1,200	10,556	2.71
5,832	97.2	4.05	78	90.6	2017.9	100	0	1,200	11,374	2.79
5,844	97.4	4.06	78	90.6	2017.9	100	0	1,200	12,192	2.87
5,856	97.6	4.07	78	90.6	2017.9	100	0	1,200	13,010	2.95
5,868	97.8	4.08	78	90.6	2017.9	100	0	1,200	13,828	3.02
5,880	98.0	4.08	78	90.6	2017.9	100	0	1,200	14,646	3.09
5,892	98.2	4.09	78	90.6	2017.9	100	0	1,200	15,464	3.16
5,904	98.4	4.10	78	90.6	2017.9	100	0	1,200	16,282	3.23
5,916	98.6	4.11	78	90.6	2017.9	100	0	1,200	17,100	3.30
5,928	98.8	4.12	78	90.6	2017.9	100	0	1,200	17,918	3.36
5,940	99.0	4.13	78	90.6	2017.9	100	0	1,200	18,736	3.42
5,952	99.2	4.13	78	90.6	2017.9	100	0	1,200	19,553	3.48
5,964	99.4	4.14	78	90.6	2017.9	100	0	1,200	20,371	3.54
5,976	99.6	4.15	68	90.6	1901.6	100	0	1,200	21,073	3.59
5,988	99.8	4.16	68	90.6	1901.6	100	0	1,200	21,775	3.64
6,000	100.0	4.17	68	90.6	1901.6	100	0	1,200	22,476	3.68
6,012	100.2	4.18	68	90.6	1901.6	100	0	1,200	23,178	3.73
6,024	100.4	4.18	68	90.6	1901.6	100	0	1,200	23,879	3.78
6,036	100.6	4.19	68	90.6	1901.6	100	0	1,200	24,581	3.82
6,048	100.8	4.20	68	90.6	1901.6	100	0	1,200	25,282	3.86
6,060	101.0	4.21	68	90.6	1901.6	100	0	1,200	25,984	3.91
6,072	101.2	4.22	68	90.6	1901.6	100	0	1,200	26,686	3.95
6,084	101.4	4.23	68	90.6	1901.6	100	0	1,200	27,387	3.99
6,096	101.6	4.23	68	90.6	1901.6	100	0	1,200	28,089	4.03
6,108	101.8	4.24	68	90.6	1901.6	100	550	7,800	22,190	3.66
6,120	102.0	4.25	68	90.6	1901.6	100	550	7,800	16,292	3.23
6,132	102.2	4.26	68	90.6	1901.6	100	550	7,800	10,394	2.69
6,144	102.4	4.27	68	90.6	1901.6	100	550	7,800	4,495	1.25
6,156	102.6	4.28	58	90.6	1785.3	100	0	1,200	5,080	1.42
6,168	102.8	4.28	58	90.6	1785.3	100	0	1,200	5,666	1.58
6,180	103.0	4.29	58	90.6	1785.3	100	0	1,200	6,251	1.74
6,192	103.2	4.30	58	90.6	1785.3	100	0	1,200	6,836	1.90
6,204	103.4	4.31	58	90.6	1785.3	100	0	1,200	7,422	2.35
6,216	103.6	4.32	58	90.6	1785.3	100	0	1,200	8,007	2.42
6,228	103.8	4.33	58	90.6	1785.3	100	0	1,200	8,592	2.49
6,240	104.0	4.33	58	90.6	1785.3	100	0	1,200	9,177	2.56
6,252	104.2	4.34	58	90.6	1785.3	100	0	1,200	9,763	2.62
6,264	104.4	4.35	58	90.6	1785.3	100	0	1,200	10,348	2.69
6,276	104.6	4.36	58	90.6	1785.3	100	0	1,200	10,933	2.75
6,288	104.8	4.37	58	90.6	1785.3	100	0	1,200	11,518	2.81
6,300	105.0	4.38	58	90.6	1785.3	100	0	1,200	12,104	2.86
6,312	105.2	4.38	58	90.6	1785.3	100	0	1,200	12,689	2.92
6,324	105.4	4.39	58	90.6	1785.3	100	0	1,200	13,274	2.97
6,336	105.6	4.40	58	90.6	1785.3	100	0	1,200	13,859	3.03
6,348	105.8	4.41	58	90.6	1785.3	100	0	1,200	14,445	3.08
6,360	106.0	4.42	48	90.6	1668.9	100	0	1,200	14,914	3.12
6,372	106.2	4.43	48	90.6	1668.9	100	0	1,200	15,383	3.16

Attachment 13 - Cell 3 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
6,384	106.4	4.43	48	90.6	1668.9	100	0	1,200	15,852	3.20
6,396	106.6	4.44	48	90.6	1668.9	100	0	1,200	16,320	3.23
6,408	106.8	4.45	48	90.6	1668.9	100	0	1,200	16,789	3.27
6,420	107.0	4.46	48	90.6	1668.9	100	0	1,200	17,258	3.31
6,432	107.2	4.47	48	90.6	1668.9	100	0	1,200	17,727	3.34
6,444	107.4	4.48	48	90.6	1668.9	100	0	1,200	18,196	3.38
6,456	107.6	4.48	48	90.6	1668.9	100	0	1,200	18,665	3.42
6,468	107.8	4.49	48	90.6	1668.9	100	0	1,200	19,134	3.45
6,480	108.0	4.50	48	90.6	1668.9	100	0	1,200	19,603	3.48
6,492	108.2	4.51	48	90.6	1668.9	100	0	1,200	20,072	3.52
6,504	108.4	4.52	48	90.6	1668.9	100	0	1,200	20,541	3.55
6,516	108.6	4.53	48	90.6	1668.9	100	0	1,200	21,010	3.58
6,528	108.8	4.53	48	90.6	1668.9	100	0	1,200	21,479	3.62
6,540	109.0	4.54	48	90.6	1668.9	100	0	1,200	21,948	3.65
6,552	109.2	4.55	48	90.6	1668.9	100	0	1,200	22,417	3.68
6,564	109.4	4.56	48	90.6	1668.9	100	0	1,200	22,886	3.71
6,576	109.6	4.57	48	90.6	1668.9	100	0	1,200	23,354	3.74
6,588	109.8	4.58	39	90.6	1552.6	100	0	1,200	23,707	3.76
6,600	110.0	4.58	39	90.6	1552.6	100	0	1,200	24,060	3.79
6,612	110.2	4.59	39	90.6	1552.6	100	0	1,200	24,412	3.81
6,624	110.4	4.60	39	90.6	1552.6	100	0	1,200	24,765	3.83
6,636	110.6	4.61	39	90.6	1552.6	100	0	1,200	25,118	3.85
6,648	110.8	4.62	39	90.6	1552.6	100	0	1,200	25,470	3.88
6,660	111.0	4.63	39	90.6	1552.6	100	0	1,200	25,823	3.90
6,672	111.2	4.63	39	90.6	1552.6	100	0	1,200	26,175	3.92
6,684	111.4	4.64	39	90.6	1552.6	100	0	1,200	26,528	3.94
6,696	111.6	4.65	39	90.6	1552.6	100	0	1,200	26,881	3.96
6,708	111.8	4.66	39	90.6	1552.6	100	0	1,200	27,233	3.98
6,720	112.0	4.67	39	90.6	1552.6	100	0	1,200	27,586	4.00
6,732	112.2	4.68	39	90.6	1552.6	100	550	7,800	21,338	3.61
6,744	112.4	4.68	39	90.6	1552.6	100	550	7,800	15,091	3.13
6,756	112.6	4.69	39	90.6	1552.6	100	550	7,800	8,844	2.52
6,768	112.8	4.70	39	90.6	1552.6	100	550	7,800	2,596	0.72
6,780	113.0	4.71	39	90.6	1552.6	100	0	1,200	2,949	0.82
6,792	113.2	4.72	39	90.6	1552.6	100	0	1,200	3,301	0.92
6,804	113.4	4.73	39	90.6	1552.6	100	0	1,200	3,654	1.02
6,816	113.6	4.73	29	90.6	1436.3	100	0	1,200	3,890	1.08
6,828	113.8	4.74	29	90.6	1436.3	100	0	1,200	4,127	1.15
6,840	114.0	4.75	29	90.6	1436.3	100	0	1,200	4,363	1.22
6,852	114.2	4.76	29	90.6	1436.3	100	0	1,200	4,599	1.28
6,864	114.4	4.77	29	90.6	1436.3	100	0	1,200	4,835	1.35
6,876	114.6	4.78	29	90.6	1436.3	100	0	1,200	5,072	1.41
6,888	114.8	4.78	29	90.6	1436.3	100	0	1,200	5,308	1.48
6,900	115.0	4.79	29	90.6	1436.3	100	0	1,200	5,544	1.54
6,912	115.2	4.80	29	90.6	1436.3	100	0	1,200	5,780	1.61
6,924	115.4	4.81	29	90.6	1436.3	100	0	1,200	6,017	1.68
6,936	115.6	4.82	29	90.6	1436.3	100	0	1,200	6,253	1.74
6,948	115.8	4.83	29	90.6	1436.3	100	0	1,200	6,489	1.81
6,960	116.0	4.83	29	90.6	1436.3	100	0	1,200	6,726	1.87
6,972	116.2	4.84	29	90.6	1436.3	100	0	1,200	6,962	1.94
6,984	116.4	4.85	29	90.6	1436.3	100	0	1,200	7,198	2.32
6,996	116.6	4.86	29	90.6	1436.3	100	0	1,200	7,434	2.35
7,008	116.8	4.87	29	90.6	1436.3	100	0	1,200	7,671	2.38
7,020	117.0	4.88	29	90.6	1436.3	100	0	1,200	7,907	2.41
7,032	117.2	4.88	29	90.6	1436.3	100	0	1,200	8,143	2.44
7,044	117.4	4.89	19	90.6	1319.9	100	0	1,200	8,263	2.45
7,056	117.6	4.90	19	90.6	1319.9	100	0	1,200	8,383	2.47
7,068	117.8	4.91	19	90.6	1319.9	100	0	1,200	8,503	2.48
7,080	118.0	4.92	19	90.6	1319.9	100	0	1,200	8,623	2.50
7,092	118.2	4.93	19	90.6	1319.9	100	0	1,200	8,743	2.51
7,104	118.4	4.93	19	90.6	1319.9	100	0	1,200	8,863	2.52
7,116	118.6	4.94	19	90.6	1319.9	100	0	1,200	8,983	2.54
7,128	118.8	4.95	19	90.6	1319.9	100	0	1,200	9,103	2.55
7,140	119.0	4.96	19	90.6	1319.9	100	0	1,200	9,223	2.56
7,152	119.2	4.97	19	90.6	1319.9	100	0	1,200	9,343	2.58
7,164	119.4	4.98	19	90.6	1319.9	100	0	1,200	9,463	2.59
7,176	119.6	4.98	19	90.6	1319.9	100	0	1,200	9,583	2.60
7,188	119.8	4.99	19	90.6	1319.9	100	0	1,200	9,703	2.62
7,200	120.0	5.00	19	90.6	1319.9	100	0	1,200	9,823	2.63
7,212	120.2	5.01	0	90.6	1087.3	100	0	1,200	9,710	2.62
7,224	120.4	5.02	0	90.6	1087.3	100	0	1,200	9,597	2.61
7,236	120.6	5.03	0	90.6	1087.3	100	0	1,200	9,484	2.59
7,248	120.8	5.03	0	90.6	1087.3	100	0	1,200	9,372	2.58
7,260	121.0	5.04	0	90.6	1087.3	100	0	1,200	9,259	2.57
7,272	121.2	5.05	0	90.6	1087.3	100	0	1,200	9,146	2.56
7,284	121.4	5.06	0	90.6	1087.3	100	0	1,200	9,034	2.54

Attachment 13 - Cell 3 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
7,296	121.6	5.07	0	90.6	1087.3	100	0	1,200	8,921	2.53
7,308	121.8	5.08	0	90.6	1087.3	100	0	1,200	8,808	2.52
7,320	122.0	5.08	0	90.6	1087.3	100	0	1,200	8,695	2.50
7,332	122.2	5.09	0	90.6	1087.3	100	0	1,200	8,583	2.49
7,344	122.4	5.10	0	90.6	1087.3	100	0	1,200	8,470	2.48
7,356	122.6	5.11	0	90.6	1087.3	100	0	1,200	8,357	2.46
7,368	122.8	5.12	0	90.6	1087.3	100	0	1,200	8,245	2.45
7,380	123.0	5.13	0	90.6	1087.3	100	0	1,200	8,132	2.44
7,392	123.2	5.13	0	90.6	1087.3	100	0	1,200	8,019	2.42
7,404	123.4	5.14	0	90.6	1087.3	100	0	1,200	7,906	2.41
7,416	123.6	5.15	0	90.6	1087.3	100	0	1,200	7,794	2.39
7,428	123.8	5.16	0	90.6	1087.3	100	0	1,200	7,681	2.38
7,440	124.0	5.17	0	90.6	1087.3	100	0	1,200	7,568	2.37
7,452	124.2	5.18	0	90.6	1087.3	100	0	1,200	7,456	2.35
7,464	124.4	5.18	0	90.6	1087.3	100	0	1,200	7,343	2.34
7,476	124.6	5.19	0	90.6	1087.3	100	0	1,200	7,230	2.32
7,488	124.8	5.20	0	90.6	1087.3	100	0	1,200	7,117	1.98
7,500	125.0	5.21	0	90.6	1087.3	100	0	1,200	7,005	1.95
7,512	125.2	5.22	0	90.6	1087.3	100	0	1,200	6,892	1.92
7,524	125.4	5.23	0	90.6	1087.3	100	0	1,200	6,779	1.89
7,536	125.6	5.23	0	90.6	1087.3	100	0	1,200	6,667	1.86
7,548	125.8	5.24	0	90.6	1087.3	100	0	1,200	6,554	1.83
7,560	126.0	5.25	0	90.6	1087.3	100	0	1,200	6,441	1.79
7,572	126.2	5.26	0	90.6	1087.3	100	0	1,200	6,329	1.76
7,584	126.4	5.27	0	90.6	1087.3	100	0	1,200	6,216	1.73
7,596	126.6	5.28	0	90.6	1087.3	100	0	1,200	6,103	1.70
7,608	126.8	5.28	0	90.6	1087.3	100	0	1,200	5,990	1.67
7,620	127.0	5.29	0	90.6	1087.3	100	0	1,200	5,878	1.64
7,632	127.2	5.30	0	90.6	1087.3	100	0	1,200	5,765	1.61
7,644	127.4	5.31	0	90.6	1087.3	100	0	1,200	5,652	1.57
7,656	127.6	5.32	0	90.6	1087.3	100	0	1,200	5,540	1.54
7,668	127.8	5.33	0	90.6	1087.3	100	0	1,200	5,427	1.51
7,680	128.0	5.33	0	90.6	1087.3	100	0	1,200	5,314	1.48
7,692	128.2	5.34	0	90.6	1087.3	100	0	1,200	5,201	1.45
7,704	128.4	5.35	0	90.6	1087.3	100	0	1,200	5,089	1.42
7,716	128.6	5.36	0	90.6	1087.3	100	0	1,200	4,976	1.39
7,728	128.8	5.37	0	90.6	1087.3	100	0	1,200	4,863	1.35
7,740	129.0	5.38	0	90.6	1087.3	100	0	1,200	4,751	1.32
7,752	129.2	5.38	0	90.6	1087.3	100	0	1,200	4,638	1.29
7,764	129.4	5.39	0	90.6	1087.3	100	0	1,200	4,525	1.26
7,776	129.6	5.40	0	90.6	1087.3	100	0	1,200	4,412	1.23
7,788	129.8	5.41	0	90.6	1087.3	100	0	1,200	4,300	1.20
7,800	130.0	5.42	0	90.6	1087.3	100	0	1,200	4,187	1.17
7,812	130.2	5.43	0	90.6	1087.3	100	0	1,200	4,074	1.13
7,824	130.4	5.43	0	90.6	1087.3	100	0	1,200	3,962	1.10
7,836	130.6	5.44	0	90.6	1087.3	100	0	1,200	3,849	1.07
7,848	130.8	5.45	0	90.6	1087.3	100	0	1,200	3,736	1.04
7,860	131.0	5.46	0	90.6	1087.3	100	0	1,200	3,623	1.01
7,872	131.2	5.47	0	90.6	1087.3	100	0	1,200	3,511	0.98
7,884	131.4	5.48	0	90.6	1087.3	100	0	1,200	3,398	0.95
7,896	131.6	5.48	0	90.6	1087.3	100	0	1,200	3,285	0.92
7,908	131.8	5.49	0	90.6	1087.3	100	0	1,200	3,173	0.88
7,920	132.0	5.50	0	90.6	1087.3	100	0	1,200	3,060	0.85
7,932	132.2	5.51	0	90.6	1087.3	100	0	1,200	2,947	0.82
7,944	132.4	5.52	0	90.6	1087.3	100	0	1,200	2,835	0.79
7,956	132.6	5.53	0	90.6	1087.3	100	0	1,200	2,722	0.76
7,968	132.8	5.53	0	90.6	1087.3	100	0	1,200	2,609	0.73
7,980	133.0	5.54	0	90.6	1087.3	100	0	1,200	2,496	0.70
7,992	133.2	5.55	0	90.6	1087.3	100	0	1,200	2,384	0.66
8,004	133.4	5.56	0	90.6	1087.3	100	0	1,200	2,271	0.63
8,016	133.6	5.57	0	90.6	1087.3	100	0	1,200	2,158	0.60
8,028	133.8	5.58	0	90.6	1087.3	100	0	1,200	2,046	0.57
8,040	134.0	5.58	0	90.6	1087.3	100	0	1,200	1,933	0.54
8,052	134.2	5.59	0	90.6	1087.3	100	0	1,200	1,820	0.51
8,064	134.4	5.60	0	90.6	1087.3	100	0	1,200	1,707	0.48
8,076	134.6	5.61	0	90.6	1087.3	0	0	0	2,795	0.78
8,088	134.8	5.62	0	90.6	1087.3	0	0	0	3,882	1.08
8,100	135.0	5.63	0	90.6	1087.3	100	0	1,200	3,769	1.05
8,112	135.2	5.63	0	90.6	1087.3	100	0	1,200	3,657	1.02
8,124	135.4	5.64	0	90.6	1087.3	100	0	1,200	3,544	0.99
8,136	135.6	5.65	0	90.6	1087.3	100	0	1,200	3,431	0.96
8,148	135.8	5.66	0	90.6	1087.3	100	0	1,200	3,318	0.92
8,160	136.0	5.67	0	90.6	1087.3	100	0	1,200	3,206	0.89
8,172	136.2	5.68	0	90.6	1087.3	100	0	1,200	3,093	0.86
8,184	136.4	5.68	0	90.6	1087.3	100	0	1,200	2,980	0.83
8,196	136.6	5.69	0	90.6	1087.3	100	0	1,200	2,868	0.80

Attachment 13 - Cell 3 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
8,208	136.8	5.70	0	90.6	1087.3	100	0	1,200	2,755	0.77
8,220	137.0	5.71	0	90.6	1087.3	100	0	1,200	2,642	0.74
8,232	137.2	5.72	0	90.6	1087.3	100	0	1,200	2,529	0.70
8,244	137.4	5.73	0	90.6	1087.3	100	0	1,200	2,417	0.67
8,256	137.6	5.73	0	90.6	1087.3	100	0	1,200	2,304	0.64
8,268	137.8	5.74	0	90.6	1087.3	100	0	1,200	2,191	0.61
8,280	138.0	5.75	0	90.6	1087.3	100	0	1,200	2,079	0.58
8,292	138.2	5.76	0	90.6	1087.3	100	0	1,200	1,966	0.55
8,304	138.4	5.77	0	90.6	1087.3	100	0	1,200	1,853	0.52
8,316	138.6	5.78	0	90.6	1087.3	100	0	1,200	1,740	0.48
8,328	138.8	5.78	0	90.6	1087.3	0	0	0	2,828	0.79
8,340	139.0	5.79	0	90.6	1087.3	0	0	0	3,915	1.09
8,352	139.2	5.80	0	90.6	1087.3	100	0	1,200	3,802	1.06
8,364	139.4	5.81	0	90.6	1087.3	100	0	1,200	3,690	1.03
8,376	139.6	5.82	0	90.6	1087.3	100	0	1,200	3,577	1.00
8,388	139.8	5.83	0	90.6	1087.3	100	0	1,200	3,464	0.96
8,400	140.0	5.83	0	90.6	1087.3	100	0	1,200	3,352	0.93
8,412	140.2	5.84	0	90.6	1087.3	100	0	1,200	3,239	0.90
8,424	140.4	5.85	0	90.6	1087.3	100	0	1,200	3,126	0.87
8,436	140.6	5.86	0	90.6	1087.3	100	0	1,200	3,013	0.84
8,448	140.8	5.87	0	90.6	1087.3	100	0	1,200	2,901	0.81
8,460	141.0	5.88	0	90.6	1087.3	100	0	1,200	2,788	0.78
8,472	141.2	5.88	0	90.6	1087.3	100	0	1,200	2,675	0.75
8,484	141.4	5.89	0	90.6	1087.3	100	0	1,200	2,563	0.71
8,496	141.6	5.90	0	90.6	1087.3	100	0	1,200	2,450	0.68
8,508	141.8	5.91	0	90.6	1087.3	100	0	1,200	2,337	0.65
8,520	142.0	5.92	0	90.6	1087.3	100	0	1,200	2,224	0.62
8,532	142.2	5.93	0	90.6	1087.3	100	0	1,200	2,112	0.59
8,544	142.4	5.93	0	90.6	1087.3	100	0	1,200	1,999	0.56
8,556	142.6	5.94	0	90.6	1087.3	100	0	1,200	1,886	0.53
8,568	142.8	5.95	0	90.6	1087.3	100	0	1,200	1,774	0.49
8,580	143.0	5.96	0	90.6	1087.3	0	0	0	2,861	0.80
8,592	143.2	5.97	0	90.6	1087.3	0	0	0	3,948	1.10
8,604	143.4	5.98	0	90.6	1087.3	100	0	1,200	3,835	1.07
8,616	143.6	5.98	0	90.6	1087.3	100	0	1,200	3,723	1.04
8,628	143.8	5.99	0	90.6	1087.3	100	0	1,200	3,610	1.01
8,640	144.0	6.00	0	90.6	1087.3	100	0	1,200	3,497	0.97
8,652	144.2	6.01	0	90.6	1087.3	100	0	1,200	3,385	0.94
8,664	144.4	6.02	0	90.6	1087.3	100	0	1,200	3,272	0.91
8,676	144.6	6.03	0	90.6	1087.3	100	0	1,200	3,159	0.88
8,688	144.8	6.03	0	90.6	1087.3	100	0	1,200	3,046	0.85
8,700	145.0	6.04	0	90.6	1087.3	100	0	1,200	2,934	0.82
8,712	145.2	6.05	0	90.6	1087.3	100	0	1,200	2,821	0.79
8,724	145.4	6.06	0	90.6	1087.3	100	0	1,200	2,708	0.75
8,736	145.6	6.07	0	90.6	1087.3	100	0	1,200	2,596	0.72
8,748	145.8	6.08	0	90.6	1087.3	100	0	1,200	2,483	0.69
8,760	146.0	6.08	0	90.6	1087.3	100	0	1,200	2,370	0.66
8,772	146.2	6.09	0	90.6	1087.3	100	0	1,200	2,258	0.63
8,784	146.4	6.10	0	90.6	1087.3	100	0	1,200	2,145	0.60
8,796	146.6	6.11	0	90.6	1087.3	100	0	1,200	2,032	0.57
8,808	146.8	6.12	0	90.6	1087.3	100	0	1,200	1,919	0.53
8,820	147.0	6.13	0	90.6	1087.3	100	0	1,200	1,807	0.50
8,832	147.2	6.13	0	90.6	1087.3	100	0	1,200	1,694	0.47
8,844	147.4	6.14	0	90.6	1087.3	0	0	0	2,781	0.77
8,856	147.6	6.15	0	90.6	1087.3	0	0	0	3,869	1.08
8,868	147.8	6.16	0	90.6	1087.3	100	0	1,200	3,756	1.05
8,880	148.0	6.17	0	90.6	1087.3	100	0	1,200	3,643	1.01
8,892	148.2	6.18	0	90.6	1087.3	100	0	1,200	3,530	0.98
8,904	148.4	6.18	0	90.6	1087.3	100	0	1,200	3,418	0.95
8,916	148.6	6.19	0	90.6	1087.3	100	0	1,200	3,305	0.92
8,928	148.8	6.20	0	90.6	1087.3	100	0	1,200	3,192	0.89
8,940	149.0	6.21	0	90.6	1087.3	100	0	1,200	3,080	0.86
8,952	149.2	6.22	0	90.6	1087.3	100	0	1,200	2,967	0.83
8,964	149.4	6.23	0	90.6	1087.3	100	0	1,200	2,854	0.79
8,976	149.6	6.23	0	90.6	1087.3	100	0	1,200	2,741	0.76
8,988	149.8	6.24	0	90.6	1087.3	100	0	1,200	2,629	0.73
9,000	150.0	6.25	0	90.6	1087.3	100	0	1,200	2,516	0.70
9,012	150.2	6.26	0	90.6	1087.3	100	0	1,200	2,403	0.67
9,024	150.4	6.27	0	90.6	1087.3	100	0	1,200	2,291	0.64
9,036	150.6	6.28	0	90.6	1087.3	100	0	1,200	2,178	0.61
9,048	150.8	6.28	0	90.6	1087.3	100	0	1,200	2,065	0.58
9,060	151.0	6.29	0	90.6	1087.3	100	0	1,200	1,952	0.54
9,072	151.2	6.30	0	90.6	1087.3	100	0	1,200	1,840	0.51
9,084	151.4	6.31	0	90.6	1087.3	100	0	1,200	1,727	0.48
9,096	151.6	6.32	0	90.6	1087.3	0	0	0	2,814	0.78
9,108	151.8	6.33	0	90.6	1087.3	0	0	0	3,902	1.09

Attachment 13 - Cell 3 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
9,120	152.0	6.33	0	90.6	1087.3	100	0	1,200	3,789	1.06
9,132	152.2	6.34	0	90.6	1087.3	100	0	1,200	3,676	1.02
9,144	152.4	6.35	0	90.6	1087.3	100	0	1,200	3,564	0.99
9,156	152.6	6.36	0	90.6	1087.3	100	0	1,200	3,451	0.96
9,168	152.8	6.37	0	90.6	1087.3	100	0	1,200	3,338	0.93
9,180	153.0	6.38	0	90.6	1087.3	100	0	1,200	3,225	0.90
9,192	153.2	6.38	0	90.6	1087.3	100	0	1,200	3,113	0.87
9,204	153.4	6.39	0	90.6	1087.3	100	0	1,200	3,000	0.84
9,216	153.6	6.40	0	90.6	1087.3	100	0	1,200	2,887	0.80
9,228	153.8	6.41	0	90.6	1087.3	100	0	1,200	2,775	0.77
9,240	154.0	6.42	0	90.6	1087.3	100	0	1,200	2,662	0.74
9,252	154.2	6.43	0	90.6	1087.3	100	0	1,200	2,549	0.71
9,264	154.4	6.43	0	90.6	1087.3	100	0	1,200	2,436	0.68
9,276	154.6	6.44	0	90.6	1087.3	100	0	1,200	2,324	0.65
9,288	154.8	6.45	0	90.6	1087.3	100	0	1,200	2,211	0.62
9,300	155.0	6.46	0	90.6	1087.3	100	0	1,200	2,098	0.58
9,312	155.2	6.47	0	90.6	1087.3	100	0	1,200	1,986	0.55
9,324	155.4	6.48	0	90.6	1087.3	100	0	1,200	1,873	0.52
9,336	155.6	6.48	0	90.6	1087.3	100	0	1,200	1,760	0.49
9,348	155.8	6.49	0	90.6	1087.3	0	0	0	2,847	0.79
9,360	156.0	6.50	0	90.6	1087.3	0	0	0	3,935	1.10
9,372	156.2	6.51	0	90.6	1087.3	100	0	1,200	3,822	1.06
9,384	156.4	6.52	0	90.6	1087.3	100	0	1,200	3,709	1.03
9,396	156.6	6.53	0	90.6	1087.3	100	0	1,200	3,597	1.00
9,408	156.8	6.53	0	90.6	1087.3	100	0	1,200	3,484	0.97
9,420	157.0	6.54	0	90.6	1087.3	100	0	1,200	3,371	0.94
9,432	157.2	6.55	0	90.6	1087.3	100	0	1,200	3,258	0.91
9,444	157.4	6.56	0	90.6	1087.3	100	0	1,200	3,146	0.88
9,456	157.6	6.57	0	90.6	1087.3	100	0	1,200	3,033	0.84
9,468	157.8	6.58	0	90.6	1087.3	100	0	1,200	2,920	0.81
9,480	158.0	6.58	0	90.6	1087.3	100	0	1,200	2,808	0.78
9,492	158.2	6.59	0	90.6	1087.3	100	0	1,200	2,695	0.75
9,504	158.4	6.60	0	90.6	1087.3	100	0	1,200	2,582	0.72
9,516	158.6	6.61	0	90.6	1087.3	100	0	1,200	2,469	0.69
9,528	158.8	6.62	0	90.6	1087.3	100	0	1,200	2,357	0.66
9,540	159.0	6.63	0	90.6	1087.3	100	0	1,200	2,244	0.63
9,552	159.2	6.63	0	90.6	1087.3	100	0	1,200	2,131	0.59
9,564	159.4	6.64	0	90.6	1087.3	100	0	1,200	2,019	0.56
9,576	159.6	6.65	0	90.6	1087.3	100	0	1,200	1,906	0.53
9,588	159.8	6.66	0	90.6	1087.3	100	0	1,200	1,793	0.50
9,600	160.0	6.67	0	90.6	1087.3	0	0	0	2,881	0.80
9,612	160.2	6.68	0	90.6	1087.3	0	0	0	3,968	1.11
9,624	160.4	6.68	0	90.6	1087.3	100	0	1,200	3,855	1.07
9,636	160.6	6.69	0	90.6	1087.3	100	0	1,200	3,742	1.04
9,648	160.8	6.70	0	90.6	1087.3	100	0	1,200	3,630	1.01
9,660	161.0	6.71	0	90.6	1087.3	100	0	1,200	3,517	0.98
9,672	161.2	6.72	0	90.6	1087.3	100	0	1,200	3,404	0.95
9,684	161.4	6.73	0	90.6	1087.3	100	0	1,200	3,292	0.92
9,696	161.6	6.73	0	90.6	1087.3	100	0	1,200	3,179	0.89
9,708	161.8	6.74	0	90.6	1087.3	100	0	1,200	3,066	0.85
9,720	162.0	6.75	0	90.6	1087.3	100	0	1,200	2,953	0.82
9,732	162.2	6.76	0	90.6	1087.3	100	0	1,200	2,841	0.79
9,744	162.4	6.77	0	90.6	1087.3	100	0	1,200	2,728	0.76
9,756	162.6	6.78	0	90.6	1087.3	100	0	1,200	2,615	0.73
9,768	162.8	6.78	0	90.6	1087.3	100	0	1,200	2,503	0.70
9,780	163.0	6.79	0	90.6	1087.3	100	0	1,200	2,390	0.67
9,792	163.2	6.80	0	90.6	1087.3	100	0	1,200	2,277	0.63
9,804	163.4	6.81	0	90.6	1087.3	100	0	1,200	2,164	0.60
9,816	163.6	6.82	0	90.6	1087.3	100	0	1,200	2,052	0.57
9,828	163.8	6.83	0	90.6	1087.3	100	0	1,200	1,939	0.54
9,840	164.0	6.83	0	90.6	1087.3	100	0	1,200	1,826	0.51
9,852	164.2	6.84	0	90.6	1087.3	100	0	1,200	1,714	0.48
9,864	164.4	6.85	0	90.6	1087.3	0	0	0	2,801	0.78
9,876	164.6	6.86	0	90.6	1087.3	0	0	0	3,888	1.08
9,888	164.8	6.87	0	90.6	1087.3	100	0	1,200	3,775	1.05
9,900	165.0	6.88	0	90.6	1087.3	100	0	1,200	3,663	1.02
9,912	165.2	6.88	0	90.6	1087.3	100	0	1,200	3,550	0.99
9,924	165.4	6.89	0	90.6	1087.3	100	0	1,200	3,437	0.96
9,936	165.6	6.90	0	90.6	1087.3	100	0	1,200	3,325	0.93
9,948	165.8	6.91	0	90.6	1087.3	100	0	1,200	3,212	0.89
9,960	166.0	6.92	0	90.6	1087.3	100	0	1,200	3,099	0.86
9,972	166.2	6.93	0	90.6	1087.3	100	0	1,200	2,987	0.83
9,984	166.4	6.93	0	90.6	1087.3	100	0	1,200	2,874	0.80
9,996	166.6	6.94	0	90.6	1087.3	100	0	1,200	2,761	0.77
10,008	166.8	6.95	0	90.6	1087.3	100	0	1,200	2,648	0.74
10,020	167.0	6.96	0	90.6	1087.3	100	0	1,200	2,536	0.71

Attachment 13 - Cell 3 Leachate Collection Sump - Peak Conditions										
Time (min)	Time (hr)	Time (day)	Stormwater (gpm)	Infiltration (gpm)	Incremental Volume of Leachate Generated (gal)	Low-Flow Pump (gpm)	High-Flow Pump (gpm)	Volume of Leachate Removed (gal)	Volume of Leachate in Sump (gal)	Head (ft)
10,032	167.2	6.97	0	90.6	1087.3	100	0	1,200	2,423	0.67
10,044	167.4	6.98	0	90.6	1087.3	100	0	1,200	2,310	0.64
10,056	167.6	6.98	0	90.6	1087.3	100	0	1,200	2,198	0.61
10,068	167.8	6.99	0	90.6	1087.3	100	0	1,200	2,085	0.58
10,080	168.0	7.00	0	90.6	1087.3	100	0	1,200	1,972	0.55

APPENDIX IV-4

Solid HDPE Pipe Stability Calculation

Calculation Title:
Solid HDPE Pipe Stability Calculation

Summary:
The maximum allowable waste height over SDR-11 HDPE pipe is 230 feet and the maximum allowable waste height over SDR-17 HDPE pipe is 180 feet, assuming an average ash waste fill unit weight of 101.1 pcf. The maximum allowable waste height is sensitive to SDR but not sensitive to pipe diameter.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal	Chris Jordan	Lee Eaves	Cedric H. Ruhl

OBJECTIVE:

The objective of this calculation is to provide design guidelines for maximum waste fill heights over solid HDPE leachate collection pipes for the proposed Dan River Landfill.

METHOD:

The structural stability of the solid HDPE leachate collection pipes was evaluated in accordance with the methodology described by the Plastic Pipe Institute [Ref. 1]. Structural stability was evaluated for compressive ring thrust stress, ring deflection, and constrained pipe wall buckling.

DEFINITION OF VARIABLES:

ε_S = soil strain;
γ = unit weight;
φ = calibration factor;
ν_S = Poisson's modulus of soil;
d = diameter;
D_F = deformation factor;
D_M = mean pipe diameter;
E = modulus of elasticity of the pipe;
E_S = elastic modulus of soil;
H = height;
I = pipe wall moment of inertia;
ID = inside diameter;
M_S = one-dimensional modulus of soil;
n = number of perforations per row per longitudinal foot of pipe;
OD = outside diameter;
PF = perforation factor;
P_{CR} = critical buckling pressure;
P_{RD} = radial directed earth pressure;
r_{cent} = radius to centroidal axis of pipe;
R_F = rigidity factor;
R_H = geometry factor
S = pipe wall compressive stress;
S_A = hoop thrust stiffness ratio;
SDR = standard dimension ratio;
t = pipe wall thickness;
VAF = vertical arching factor;
w = moisture content;

CALCULATIONS:

1.0 Define proposed pipe materials

The leachate collection pipes will be constructed using perforated solid HDPE pipes. The minimum nominal pipe diameter will be 8 inches to facilitate camera and cleanout equipment. The maximum nominal pipe diameter will be 36 inches. Pipes with nominal diameters of 8 inches and 36 inches, and Standard Dimension Ratios (SDR) of 11 and 17, will be evaluated for compressive ring thrust stress, ring deflection, and constrained pipe wall buckling. The range of pipe dimensions are summarized in the following table:

Table 1: Pipe Dimensions

Nominal Size (in) [Ref. 1]	Outside Diameter {OD} (in) [Ref. 1]	Minimum Wall Thickness {t} (in) [Ref. 1]	Average Inside Diameter {ID} (in) [Ref. 1]	Standard Dimension Ratio {SDR} [Ref. 1]
8	8.625	0.784	6.963	11
36	36.00	3.273	29.062	11
8	8.625	0.507	7.549	17
36	36.00	2.118	31.511	17

2.0 Estimate unit weight of cover over pipes

Cover over the leachate collection pipes will consist predominantly of ash waste fill. The ash waste will be placed as compacted fill to a minimum 95 percent Standard Proctor maximum dry density, within 5 percent of optimum moisture content. The moist unit weight of the ash waste fill was estimated based on Standard Proctor test results assuming 95 percent compaction and +5 percent optimum moisture content as shown in the following table:

Table 2: Ash Waste Fill Unit Weight

Location ID	Sample Type	Sample Depth (ft)	Maximum Dry Density {γ_{max}} (pcf)	Optimum Moisture Content {w} (%)	Ash Waste Fill Unit Weight at 95% MDD, +5% OMC {γ} (pcf)
B319	bulk	10'-20'	74.9	28.9%	95.3
B322	bulk	38.5'-48.5'	87.5	23.2%	106.6
B322	bulk	48.6'-58.5'	88.9	22.8%	107.9
B324	bulk	25'-35'	73.0	31.8%	94.8
		Average	81.1	26.7%	101.1

3.0 Estimate vertical arching factor

The vertical arching factor accounts for load reduction due to arching around the pipes and lateral earth pressure applied to the embedment and was calculated using the following equations:

$$VAF = 0.88 - 0.71\frac{S_A - 1}{S_A + 2.5}$$ [Ref. 2]

$$S_A = \frac{1.43 M_S r_{cent}}{Et}$$ [Ref. 2]

$$M_S = \frac{E_S(1-\upsilon_S)}{(1+\upsilon_S)(1-2\upsilon_S)}$$ [Ref. 3]

The backfill material will be fly ash which typically has a USCS classification of ML. The ash will be compacted in excess of 95 percent of Standard Proctor maximum dry density. Additionally, the HDPE pipe will be constructed with resin meeting PE3408 or better. The vertical arching factor was estimated as shown in the following table:

Table 3: Vertical Arching Factor

Nominal Size (in) [Ref. 1]	Standard Dimension Ratio {SDR} [Ref. 1]	Elastic Modulus of Soil $\{E_s\}$ (psi) [Ref. 3]	Poissons Ratio $\{\upsilon_s\}$ [Ref. 3]	One-Dimensional Modulus of Soil $\{M_s\}$ (psi)	Radius to Centroidal Axis of Pipe $\{r_{cent}\}$ (in)	Apparent Modulus of Elasticity of Pipe {E} (psi) [Ref. 2]	Wall Thickness {t} (in) [Ref. 1]	Hoop Thrust Stiffness Ratio $\{S_A\}$	Vertical Arching Factor {VAF}
8	11	4,100	0.35	6,580	3.921	27,000	0.784	1.743	0.756
36	11	4,100	0.35	6,580	16.364	27,000	3.273	1.742	0.756
8	17	4,100	0.35	6,580	4.059	27,000	0.507	2.790	0.640
36	17	4,100	0.35	6,580	16.941	27,000	2.118	2.788	0.640

4.0 Estimate factor for perforations

The leachate collection pipes will be perforated. The perforations will be 1/5-inch in diameter on 3-inch centers longitudinally. The reduction factor for perforations was calculated using the following equation:

$$PF = \frac{1}{1-nd/12}$$ [Ref. 3]

The perforation factor was estimated as shown in the following table:

Table 4: Perforation Factor

Number of Perforations Per Row Per Foot of Pipe {n}	Perforation Diameter {d} (in)	Perforation Factor {PF}
4	0.2	1.071

5.0 Estimate maximum allowable waste height for ring compressive stress

The radial directed earth pressure for a deep fill application can be calculated using the following equation:

$$P_{RD} = (VAF)(PF)\gamma H$$ [Ref. 2]

Assuming that live loads are negligible for large fill depths, the pipe wall compressive stress can be calculated using the following equation:

$$S = \frac{P_{RD}(SDR)}{288} = \frac{(VAF)(PF)\gamma H(SDR)}{288}$$ [Ref. 2]

The maximum allowable waste height for ring compressive stress "H" can be estimated by substituting the maximum allowable compressive strength of the pipe for "S", by rearranging terms as follows:

$$H = \frac{288S}{(VAF)(PF)\gamma(SDR)}$$

The maximum allowable waste height for ring compressive stress was estimated as shown in the following table:

Table 5: Maximum Allowable Waste Height for Ring Thrust

Nominal Size (in) [Ref. 1]	Standard Dimension Ratio {SDR} [Ref. 1]	Vertical Arching Factor {VAF}	Perforation Factor {PF}	Ash Waste Fill Unit Weight at 95% MDD, +5% OMC {γ} (pcf)	Maximum Allowable Compressive Strength {S} (psi) [Ref. 2]	Maximum Depth of Cover for Ring Thrust {H_{RT}} (ft)
8	11	0.756	1.071	101.1	1,000	320
36	11	0.756	1.071	101.1	1,000	320
8	17	0.640	1.071	101.1	1,000	244
36	17	0.640	1.071	101.1	1,000	244

6.0 Estimate maximum allowable waste height for deflection

Pipe deflection can be calculated using the following equations:

$$\frac{\Delta X}{D_M}(100) = D_F \varepsilon_S$$ [Ref. 2]

$$\varepsilon_S = \frac{\gamma H}{144 E_S}$$ [Ref. 2]

The maximum allowable waste height for deflection stress "H" can be estimated by substituting the maximum allowable deformation of the pipe for "$\Delta X/D_M$", by rearranging terms as follows:

$$H = \frac{144\frac{\Delta X}{D_M}(100)E_S}{D_F \gamma}$$

The rigidify factor "R_F" was used to estimate the deformation factor "D_F" from the Watkins-Gaube graph. First, the rigidity factor was calculated using the following equation:

$$R_F = \frac{12E_S(DR-1)^3}{E}$$ [Ref. 2]

Next the Watkins-Gaube graph was used to estimate the deformation factor "D_F". The maximum allowable waste height for deflection was estimated as shown in the following table:

Table 6: Maximum Allowable Waste Height for Deflection						
Nominal Size (in) [Ref. 1]	Standard Dimension Ratio {SDR} [Ref. 1]	Rigidity Factor {R_F}	Deflection Factor {D_F} [Ref. 2]	Maximum Allowable Deflection {$\Delta X/D_M$} (percent) [Ref. 2]	Maximum Allowable Soil Strain {ε_s}	Maximum Depth of Cover for Deflection {$H_{\Delta X}$} (ft)
8	11	1,822	1.42	7.5%	0.0528	308
36	11	1,822	1.42	7.5%	0.0528	308
8	17	7,464	1.78	7.5%	0.0421	246
36	17	7,464	1.78	7.5%	0.0421	246

7.0 Estimate maximum allowable waste height for buckling

The maximum allowable waste height for buckling was estimated by first calculating the critical buckling pressure using the Moore-Selig equation as follows:

$$P_{CR} = \frac{2.4\varphi R_H}{D_M}(EI)^{1/3}(E_S^*)^{2/3}$$ [Ref. 2]

Where:

$$E_S^* = \frac{E_S}{1-\upsilon_S}$$ [Ref. 2]

The critical constrained buckling pressure was calculated as shown in the following table:

Table 7: Critical Constrained Buckling Pressure							
Nominal Size (in) [Ref. 1]	Standard Dimension Ratio {SDR} [Ref. 1]	Calibration Factor {φ} [Ref. 2]	Geometry Factor {R_H} [Ref. 2]	Mean Pipe Diameter {D_M} (in)	Pipe Wall Moment of Inertia {I} (in^4/in)	Factored Secant Modulus {E^*_s} (psi)	Critical Constrained Buckling Pressure {P_{CR}} (psi)
8	11	0.55	1.0	7.794	0.0402	6,308	594
36	11	0.55	1.0	32.531	2.9218	6,308	594
8	17	0.55	1.0	8.087	0.0109	6,308	370
36	17	0.55	1.0	33.756	0.7918	6,308	371

The maximum allowable waste height for buckling was estimated by assuming a safety factor of 3.0 as shown in the following table:

Table 8: Maximum Allowable Waste Height for Buckling								
Nominal Size (in) [Ref. 1]	Standard Dimension Ratio {SDR} [Ref. 1]	Critical Constrained Buckling Pressure {P_{CR}} (psi)	Safety Factor [assumed]	Maximum Allowable Load for Buckling {$P_{E,B}$} (psi)	Vertical Arching Factor {VAF}	Perforation Factor {PF}	Ash Waste Fill Unit Weight at 95% MDD, +5% OMC {γ} (pcf)	Maximum Depth of Cover for Buckling {H_B} (ft)
8	11	594	3	198	0.756	1.032	101.1	361
36	11	594	3	198	0.756	1.032	101.1	361
8	17	370	3	123	0.640	1.032	101.1	266
36	17	371	3	124	0.640	1.032	101.1	266

8.0 Estimate maximum allowable waste height

Maximum allowable waste heights were calculated for ring thrust, deformation, and buckling failure mechanisms. The lowest waste height controls. The allowable waste height was estimated as shown in the following table, assuming an additional reduction factor of 0.75 to account for material variability:

Table 9: Maximum Allowable Waste Height

Nominal Size (in) [Ref. 1]	Standard Dimension Ratio {SDR} [Ref. 1]	Ash Waste Fill Unit Weight at 95% MDD, +5% OMC {γ} (pcf)	Maximum Depth of Cover for Ring Thrust $\{H_{RT}\}$ (ft)	Maximum Depth of Cover for Deformation $\{H_{\Delta X}\}$ (ft)	Maximum Depth of Cover for Buckling $\{H_B\}$ (ft)	Controlling Depth of Cover {H} (ft)	Reduction Factor [assumed]	Allowable Waste Height $\{H_{allow}\}$ (ft)
8	11	101.1	320	308	361	308	0.75	231
36	11	101.1	320	308	361	308	0.75	231
8	17	101.1	244	246	266	244	0.75	183
36	17	101.1	244	246	266	244	0.75	183

DISCUSSION:

The maximum allowable waste height over SDR-11 HDPE pipe is 230 feet and the maximum allowable waste height over SDR-17 HDPE pipe is 180 feet, assuming an average ash waste fill unit weight of 101.1 pcf. The maximum allowable waste height is sensitive to SDR but not sensitive to pipe diameter.

REFERENCES:

1. CAVCO Pipe Valves and Fittings product information.
2. "Handbook of Polyethylene Pipe", 2nd. Ed., Plastics Pipe Institute.
3. Qian, Xuede et. al. "Geotechnical Aspects of Landfill Design and Construction", 2002.

REFERENCE 1

CAVCO Pipe Valves and Fittings product information.

PE 3608/3408 IPS HDPE PIPE SIZES

Pressure Rating		DR 7 (267psi)			DR 7.3 (254psi)			DR 9 (200psi)			DR 11 (160psi)			DR 13.5 (128psi)			DR 15.5 (110psi)		
Nominal Size	Actual O.D.	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf
3/4"	1.05"	0.150"	0.732"	0.184	0.144"	0.745"	0.178	0.117"	0.803"	0.150	0.095"	0.848"	0.125	---	---	---	---	---	---
1"	1.315"	0.188"	0.917"	0.289	0.180"	0.933"	0.279	0.146"	1.005"	0.234	0.120"	1.062"	0.197	---	---	---	---	---	---
1 1/4"	1.66"	0.237"	1.157"	0.460	0.227"	1.178"	0.444	0.184"	1.269"	0.372	0.151"	1.340"	0.312	---	---	---	---	---	---
1 1/2"	1.90"	0.271"	1.325"	0.603	0.260"	1.348"	0.582	0.211"	1.452"	0.488	0.173"	1.534"	0.409	---	---	---	---	---	---
2"	2.375"	0.339"	1.656"	0.943	0.325"	1.685"	0.762	0.264"	1.816"	0.762	0.216"	1.917"	0.639	0.176"	2.002"	0.531	0.153"	2.050"	0.467
3"	3.500"	0.500"	2.440"	2.047	0.479"	2.484"	1.656	0.389"	2.676"	1.656	0.318"	2.825"	1.387	0.259"	2.950"	1.153	0.226"	3.021"	1.015
4"	4.500"	0.643"	3.137"	3.384	0.616"	3.193"	2.737	0.500"	3.440"	2.737	0.409"	3.633"	2.294	0.333"	3.793"	1.906	0.290"	3.885"	1.678
5"	5.375"	0.768"	3.747"	4.830	0.736"	3.814"	4.663	0.597"	4.109"	3.903	0.489"	4.339"	3.272	0.398"	4.531"	2.718	0.347"	4.640"	2.396
5"	5.563"	0.795"	3.878"	5.172	0.762"	3.947"	4.182	0.618"	4.253"	4.182	0.506"	4.491"	3.505	0.412"	4.689"	2.912	0.359"	4.802"	2.564
6"	6.625"	0.946"	4.619"	7.336	0.908"	4.701"	5.932	0.736"	5.064"	5.932	0.602"	5.348"	4.971	0.491"	5.585"	4.130	0.427"	5.719"	3.637
7"	7.125"	1.018"	4.967"	8.195	0.976"	5.056"	8.200	0.792"	5.447"	6.863	0.648"	5.752"	5.750	0.528"	6.006"	4.779	0.460"	6.150"	3.985
8"	8.625"	1.232"	6.013"	12.433	1.182"	6.120"	10.054	0.958"	6.593"	10.054	0.784"	6.963"	8.425	0.639"	7.271"	7.001	0.556"	7.445"	6.164
10"	10.750"	1.536"	7.494"	19.314	1.473"	7.628"	15.618	1.194"	8.218"	15.618	0.977"	8.678"	13.089	0.796"	9.062"	10.875	0.694"	9.280"	9.576
12"	12.750"	1.821"	8.889"	27.170	1.747"	9.047"	21.970	1.417"	9.747"	21.970	1.159"	10.293"	18.412	0.944"	10.748"	15.298	0.823"	11.006"	13.471
14"	14.000"	2.000"	9.760"	32.758	1.918"	9.934"	26.489	1.556"	10.702"	26.489	1.273"	11.302"	22.199	1.037"	11.801"	18.445	0.903"	12.085"	16.242
16"	16.00"	2.286"	11.154"	42.786	2.192"	11.353"	34.598	1.778"	12.231"	34.598	1.455"	12.916"	28.994	1.185"	13.487"	24.092	1.032"	13.812"	21.214
18"	18.00"	2.571"	12.549"	54.151	2.466"	12.773"	43.788	2.000"	13.760"	43.788	1.636"	14.531"	36.696	1.333"	15.173"	30.491	1.161"	15.538"	26.849
20"	20.00"	2.857"	13.943"	66.853	2.740"	14.192"	54.059	2.222"	15.289"	54.059	1.818"	16.145"	45.304	1.481"	16.859"	37.643	1.290"	17.265"	33.146
22"	22.00"	3.143"	15.337"	80.170	3.014"	15.611"	65.412	2.444"	16.818"	65.412	2.000"	17.760"	54.818	1.630"	18.545"	45.548	1.419"	18.991"	40.107
24"	24.00"	3.429"	16.731"	96.267	3.288"	17.030"	92.988	2.667"	18.347"	77.845	2.182"	19.375"	65.237	1.778"	20.231"	54.206	1.548"	20.717"	47.731
26"	26.00"	---	---	---	3.562"	18.449"	110.192	2.889"	19.876"	92.050	2.364"	20.989"	76.563	1.926"	21.917"	63.617	1.677"	22.444"	56.018
28"	28.00"	---	---	---	---	---	---	3.111"	21.404"	106.750	2.545"	22.604"	88.795	2.074"	23.603"	73.781	1.806"	24.170"	64.967
30"	30.00"	---	---	---	---	---	---	3.333"	22.933"	121.633	2.727"	24.218"	101.934	2.222"	25.289"	84.697	1.935"	25.897"	74.580
32"	32.00"	---	---	---	---	---	---	3.556"	24.462"	139.452	2.909"	25.833"	116.670	2.370"	26.975"	96.367	2.065"	27.623"	84.855
34"	34.00"	---	---	---	---	---	---	---	---	---	3.091"	27.447"	130.930	2.519"	28.661"	109.332	2.194"	29.350"	96.209
36"	36.00"	---	---	---	---	---	---	---	---	---	3.273"	29.062"	146.780	2.667"	30.347"	121.960	2.323"	31.076"	107.395
42"	42.00"	---	---	---	---	---	---	---	---	---	---	---	---	3.111"	35.404"	166.800	2.710"	36.255"	146.176
48"	48.00"	---	---	---	---	---	---	---	---	---	---	---	---	3.556"	40.462"	217.895	3.097"	41.435"	175.891
54"	54.00"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3.484"	46.614"	242.649
63"	62.99"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

NOTE:

- Items highlighted in Blue indicates standard stocking items that are more readily available.
- Pressures are based on using water at 23°C (73°F).
- Average inside diameter calculated using nominal OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.
- Service factors should be utilized to compensate for the effect of liquids other than water, and for other temperatures.
- Other piping sizes or DR's may be available upon request.
- Standard Lengths: 40' for 2"-24" / 50' for 26" and larger / Coils available for 3/4"-6"(8" by special order)

PE 3608/3408 IPS HDPE PIPE SIZES

Pressure Rating		DR 17 (100psi)			DR 19 (89psi)			DR 21 (80psi)			DR 26 (65psi)			DR 32.5 (50psi)		
Nominal Size	Actual O.D.	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf
3/4"	1.050"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1"	1.315"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1 1/4"	1.660"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1 1/2"	1.900"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2"	2.375"	0.140"	2.079"	0.429	---	---	---	---	---	---	---	---	---	---	---	---
3"	3.500"	0.206"	3.064"	0.932	---	---	---	---	---	---	---	---	---	---	---	---
4"	4.500"	0.265"	3.939"	1.540	0.237"	3.998"	1.387	0.214"	4.046"	1.262	0.173"	4.133"	1.030	0.138"	4.206"	0.831
5"	5.375"	0.316"	4.705"	2.197	0.283"	4.775"	1.980	0.256"	4.832"	1.801	0.207"	4.937"	1.470	0.165"	5.024"	1.186
5"	5.563"	0.327"	4.869"	2.353	0.293"	4.942"	2.120	0.265"	5.001"	1.929	0.214"	5.109"	1.574	0.171"	5.200"	1.270
6"	6.625"	0.390"	5.799"	3.338	0.349"	5.886"	3.007	0.315"	5.956"	2.736	0.255"	6.085"	2.233	0.204"	6.193"	1.801
7"	7.125"	0.419"	6.236"	3.860	0.375"	6.330"	3.478	0.339"	6.406"	3.165	0.274"	6.544"	2.582	0.219"	6.660"	2.083
8"	8.625"	0.507"	7.549"	5.657	0.454"	7.663"	5.097	0.411"	7.754"	4.637	0.332"	7.922"	3.784	0.265"	8.062"	3.053
10"	10.750"	0.632"	9.409"	8.788	0.566"	9.551"	7.918	0.512"	9.665"	7.204	0.413"	9.873"	5.878	0.331"	10.049"	4.742
12"	12.750"	0.750"	11.160"	12.362	0.671"	11.327"	11.138	0.607"	11.463"	10.134	0.490"	11.710"	8.269	0.392"	11.918"	6.671
14"	14.000"	0.824"	12.254"	14.905	0.737"	12.438"	13.429	0.667"	12.587"	12.218	0.538"	12.858"	9.970	0.431"	13.087"	8.044
16"	16.00"	0.941"	14.005"	19.467	0.842"	14.215"	17.540	0.762"	14.385"	15.959	0.615"	14.695"	13.022	0.492"	14.956"	10.506
18"	18.00"	1.059"	15.755"	24.638	0.947"	15.992"	22.199	0.857"	16.183"	20.198	0.692"	16.532"	16.480	0.554"	16.826"	13.296
20"	20.00"	1.176"	17.506"	30.418	1.053"	17.768"	27.406	0.952"	17.981"	24.936	0.769"	18.369"	20.346	0.615"	18.695"	16.415
22"	22.00"	1.294"	19.256"	36.805	1.158"	19.545"	33.162	1.048"	19.779"	30.172	0.846"	20.206"	24.619	0.677"	20.565"	19.863
24"	24.00"	1.412"	21.007"	43.801	1.263"	21.322"	39.465	1.143"	21.577"	35.907	0.923"	22.043"	29.299	0.738"	22.434"	23.638
26"	26.00"	1.529"	22.758"	51.406	1.368"	23.099"	46.316	1.238"	23.375"	42.141	1.000"	23.880"	34.385	0.800"	24.304"	27.742
28"	28.00"	1.647"	24.508"	59.618	1.474"	24.876"	53.716	1.333"	25.173"	48.874	1.077"	25.717"	39.879	0.862"	26.174"	32.174
30"	30.00"	1.765"	26.259"	68.439	1.579"	26.653"	61.664	1.429"	26.971"	56.105	1.154"	27.554"	45.779	0.923"	28.043"	36.934
32"	32.00"	1.882"	28.009"	77.869	1.684"	28.429"	70.160	1.524"	28.770"	63.835	1.231"	29.391"	52.086	0.985"	29.913"	42.023
34"	34.00"	2.000"	29.760"	87.907	1.789"	30.206"	79.204	1.619"	30.568"	72.064	1.308"	31.228"	58.814	1.046"	31.782"	47.440
36"	36.00"	2.118"	31.511"	98.553	1.895"	31.983"	88.796	1.714"	32.366"	80.791	1.385"	33.065"	65.922	1.108"	33.652"	53.186
42"	42.00"	2.471"	36.762"	134.141	2.211"	37.314"	120.861	2.000"	37.760"	109.966	1.615"	38.575"	89.727	1.292"	39.260"	72.392
48"	48.00"	2.824"	42.014"	175.205	2.526"	42.644"	157.857	2.286"	43.154"	143.629	1.846"	44.086"	117.194	1.477"	44.869"	94.552
54"	54.00"	3.176"	47.266"	222.547	2.842"	47.975"	199.791	2.571"	48.549"	182.298	2.077"	49.597"	148.324	1.662"	50.478"	119.668
63"	62.99"	---	---	---	---	---	---	3.000"	56.631"	247.800	2.423"	57.854"	202.010	1.938"	58.881"	162.980

NOTE:

- Items highlighted in Blue indicates standard stocking items that are more readily available.
- Pressures are based on using water at 23°C (73°F).
- Average inside diameter calculated using nominal OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.
- Service factors should be utilized to compensate for the effect of liquids other than water, and for other temperatures.
- Other piping sizes or DR's may be available upon request.
- Standard Lengths: 40' for 2"-24" / 50' for 26" and larger / Coils available for 3/4"-6"(8" by special order)

REFERENCE 2

“Handbook of Polyethylene Pipe”, 2nd. Ed., Plastics Pipe Institute.

Appendix B
Apparent Elastic Modulus

B.1 – Apparent Elastic Modulus for the Condition of Either a Sustained Constant Load or a Sustained Constant Deformation

B.1.1 – Design Values for the Base Temperature of 73°F (23°C)

TABLE B.1.1
Apparent Elastic Modulus for 73°F (23°C)

Duration of Sustained Loading	Design Values For 73°F (23°C) (1,2,3)					
	PE 2XXX		PE3XXX		PE4XXX	
	psi	MPa	psi	MPa	psi	MPa
0.5hr	62,000	428	78,000	538	82,000	565
1hr	59,000	407	74,000	510	78,000	538
2hr	57,000	393	71,000	490	74,000	510
10hr	50,000	345	62,000	428	65,000	448
12hr	48,000	331	60,000	414	63,000	434
24hr	46,000	317	57,000	393	60,000	414
100hr	42,000	290	52,000	359	55,000	379
1,000hr	35,000	241	44,000	303	46,000	317
1 year	30,000	207	38,000	262	40,000	276
10 years	26,000	179	32,000	221	34,000	234
50 years	22,000	152	28,000	193	29,000	200
100 years	21,000	145	27,000	186	28,000	193

(1) Although there are various factors that determine the exact apparent modulus response of a PE, a major factor is its ratio of crystalline to amorphous content – a parameter that is reflected by a PE's density. Hence, the major headings PE2XXX, PE3XXX and, PE4XXX, which are based on PE's Standard Designation Code. The first numeral of this code denotes the PE's density category in accordance with ASTM D3350 (An explanation of this code is presented in Chapter 5).

(2) The values in this table are applicable to both the condition of sustained and constant loading (under which the resultant strain increases with increased duration of loading) and that of constant strain (under which an initially generated stress gradually relaxes with increased time).

(3) The design values in this table are based on results obtained under uni-axial loading, such as occurs in a test bar that is being subjected to a pulling load. When a PE is subjected to multi-axial stressing its strain response is inhibited, which results in a somewhat higher apparent modulus. For example, the apparent modulus of a PE pipe that is subjected to internal hydrostatic pressure – a condition that induces bi-axial stressing – is about 25% greater than that reported by this table. Thus, the Uni-axial condition represents a conservative estimate of the value that is achieved in most applications.

It should also be kept in mind that these values are for the condition of continually sustained loading. If there is an interruption or a decrease in the loading this, effectively, results in a somewhat larger modulus.

In addition, the values in this table apply to a stress intensity ranging up to about 400psi, a value that is seldom exceeded under normal service conditions.

Appendix C
Allowable Compressive Stress

Table C.1 lists allowable compressive stress values for 73°F (23°C). Values for allowable compressive stress for other temperatures may be determined by application of the same multipliers that are used for pipe pressure rating (See Table A.2).

TABLE C.1
Allowable Compressive Stress for 73°F (23°C)

	Pe Pipe Material Designation Code (1)					
	PE 2406		PE3408		PE 4710	
	PE 2708		PE 3608			
			PE 3708			
			PE 3710			
			PE 4708			
	psi	MPa	psi	MPa	psi	MPa
Allowable Compressive Stress	800	5.52	1000	6.90	1150	7.93

(1) See Chapter 5 for an explanation of the PE Pipe Material Designation Code.

Appendix D
Poisson's Ratio

Poisson's Ratio for ambient temperature for all PE pipe materials is approximately 0.45.

This 0.45 value applies both to the condition of tension and compression. While this value increases with temperature, and vice versa, the effect is relatively small over the range of typical working temperatures.

TABLE 2-1
Surface Roughness for Various New Pipes

Type of Pipe	'ε' Absolute Roughness of Surface, ft		
	Values for New Pipe Reported by Reference [18]	Values for New Pipe and Recommended Design Values Reported by Reference [19]	
		Mean Value	Recommended Design Value
Riveted steel	0.03 - 0.003	–	–
Concrete	0.01 – 0.001	–	–
Wood stave	0.0003 – 0.0006	–	–
Cast Iron – Uncoated	0.00085	0.00074	0.00083
Cast Iron – Coated	–	0.00033	0.00042
Galvanized Iron	0.00050	0.00033	0.00042
Cast Iron – Asphalt Dipped	0.0004	–	–
Commercial Steel or Wrought Iron	0.00015	–	–
Drawn Tubing	0.000005 corresponds to "smooth pipe"	–	–
Uncoated Stee	–	0.00009	0.00013
Coated Steel	–	0.00018	0.00018
Uncoated Asbestos – Cement	–		
Cement Mortar Relined Pipes (Tate Process)	–	0.00167	0.00167
Smooth Pipes (PE and other thermoplastics, Brass, Glass and Lead)	–	"smooth pipe" (0.000005 feet) (See Note)	"smooth pipe" (0.000005) (See Note)

Note: Pipes that have absolute roughness equal to or less than 0.000005 feet are considered to exhibit "smooth pipe" characteristics.

Pipe Deflection Effects

Pipe flow formulas generally assume round pipe. Because of its flexibility, buried PE pipe will deform slightly under earth and other loads to assume somewhat of an elliptical shape having a slightly increased lateral diameter and a correspondingly reduced vertical diameter. Elliptical deformation slightly reduces the pipe's flow area. Practically speaking, this phenomenon can be considered negligible as it relates to pipe flow capacity. Calculations reveal that an elliptical deformation which reduces the pipe's vertical diameter by 7% results in a flow reduction of approximately 1%.

Compressive Ring Thrust

Earth pressure exerts a radial-directed force around the circumference of a pipe that results in a compressive ring thrust in the pipe wall. (This thrust is exactly opposite to the tensile hoop thrust induced when a pipe is pressurized.) See Figure 3-1B. Excessive ring compressive thrust may lead to two different performance limits: crushing of the material or buckling (loss of stability) of the pipe wall. See Figure 3-1C. This section will discuss crushing, and the next section will discuss buckling.

As is often the case, the radial soil pressure causing the stress is not uniform around the pipe's circumference. However, for calculation purposes it is assumed uniform and equal to the vertical soil pressure at the pipe crown.

Pressure pipes often have internal pressure higher than the radial pressure applied by the soil. As long as there is pressure in the pipe that exceeds the external pressure, the net thrust in the pipe wall is tensile rather than compressive, and wall crush or buckling checks are not necessary. Whether one needs to check this or not can be quickly determined by simply comparing the internal pressure with the vertical soil pressure.

Crushing occurs when the compressive stress in the wall exceeds the compressive yield stress of the pipe material. Equations 3-13 and 3-14 give the compressive stress resulting from earth and live load pressure for conventional extruded DR pipe and for ASTM F894 profile wall PE Pipe:

(3-13)
$$S = \frac{(P_E + P_L)\,DR}{288}$$

(3-14)
$$S = \frac{(P_E + P_L)\,D_O}{288A}$$

WHERE

P_E = **vertical soil pressure due to earth load, psf**

P_L = **vertical soil pressure due to live-load, psf**

S = **pipe wall compressive stress, lb/in²**

DR = **Dimension Ratio, D_0/t**

D_O = **pipe outside diameter (for profile pipe $D_0 = D_I + 2H_P$), in**

D_I = **pipe inside diameter, in**

H_P = **profile wall height, in**

A = **profile wall average cross-sectional area, in²/in**
(Obtain the profile wall area from the manufacturer of the profile pipe.)

(Note: These equations contain a factor of 144 in the denominator for correct units conversions.)

Where deep fill applications are in dry soil, Luscher's equation (Eq. 3-15 or 3-16) may often be too conservative for design as it considers a radial driving force from ground water or vacuum. Moore and Selig[17] developed a constrained pipe wall buckling equation suitable for pipes in dry soils, which is given in a following section.

Considerable care should be taken in the design of deeply buried pipes whose failure may cause slope failure in earthen structures, or refuse piles or whose failure may have severe environmental or economical impact. These cases normally justify the use of methods beyond those given in this Chapter, including finite element analysis and field testing, along with considerable professional design review.

Compressive Ring Thrust and the Vertical Arching Factor

The combined horizontal and vertical earth load acting on a buried pipe creates a radially-directed compressive load acting around the pipe's circumference. When a PE pipe is subjected to ring compression, thrust stress develops around the pipe hoop, and the pipe's circumference will ever so slightly shorten. The shortening permits "thrust arching," that is, the pipe hoop thrust stiffness is less than the soil hoop thrust stiffness and, as the pipe deforms, less load follows the pipe. This occurs much like the vertical arching described by Marston.[18] Viscoelasticity enhances this effect. McGrath[19] has shown thrust arching to be the predominant form of arching with PE pipes.

Burns and Richard[6] have published equations that give the resulting stress occurring in a pipe due to arching. As discussed above, the arching is usually considered when calculating the ring compressive stress in profile pipes. For deeply buried pipes McGrath [19] has simplified the Burns and Richard's equations to derive a vertical arching factor as given by Equation 3-21.

(3-21)

$$VAF = 0.88 - 0.71\frac{S_A - 1}{S_A + 2.5}$$

WHERE

VAF **= Vertical Arching Factor**

S_A **= Hoop Thrust Stiffness Ratio**

(3-22)

$$S_A = \frac{1.43\, M_S\, r_{CENT}}{EA}$$

WHERE

r_{CENT} **= radius to centroidal axis of pipe, in**

M_s**= one-dimensional modulus of soil, psi**

E **= apparent modulus of elasticity of pipe material, psi (See Appendix, Chapter 3)**

A**= profile wall average cross-sectional area, in^2/in, or wall thickness (in) for DR pipe**

One-dimensional modulus values for soil can be obtained from soil testing, geotechnical texts, or Table 3-12 which gives typical values. The typical values in Table 3-12 were obtained by converting values from McGrath [20].

TABLE 3-12
Typical Values of M_S, One-Dimensional Modulus of Soil

Vertical Soil Stress[1] (psi)	Gravelly Sand/Gravels 95% Std. Proctor (psi)	Gravelly Sand/Gravels 90% Std. Proctor (psi)	Gravelly Sand/Gravels 85% Std. Proctor (psi)
10	3000	1600	550
20	3500	1800	650
40	4200	2100	800
60	5000	2500	1000
80	6000	2900	1300
100	6500	3200	1450

* Adapted and extended from values given by McGrath[20]. For depths not shown in McGrath[20], the MS values were approximated using the hyperbolic soil model with appropriate values for K and n where n=0.4 and K=200, K=100, and K=45 for 95% Proctor, 90% Proctor, and 85% Proctor, respectively.

[1] Vertical Soil Stress (psi) = [soil depth (ft) x soil density (pcf)]/144

The radial directed earth pressure can be found by multiplying the prism load (pressure) by the vertical arching factor as shown in Eq. 3-23.

(3-23) $$P_{RD} = (VAF)wH$$

WHERE
P_{RD} **= radial directed earth pressure, lb/ft^2**
w **= unit weight of soil, pcf**
H **= depth of cover, ft**

The ring compressive stress in the pipe wall can be found by substituting P_{RD} from Equation 3-23 for P_E in Equation 3-13 for DR pipe and Equation 3-14 for profile wall pipe.

Earth Pressure Example

Determine the earth pressure acting on a 36″ profile wall pipe buried 30 feet deep. The following properties are for one unique 36″ profile pipe made from PE3608 material. Other 36″ profile pipe may have different properties. The pipe's cross-sectional area, A, equals 0.470 inches^2/inch, its radius to the centroidal axis is 18.00 inches plus 0.58 inches, and its apparent modulus is 27,000 psi. Its wall height is 2.02 in and its D_O equals 36 in +2 (2.02 in) or 40.04 in. Assume the pipe is installed in a clean granular soil compacted to 90% Standard Proctor (Ms = 1875 psi), the insitu soil is as stiff as the embedment, and the backfill weighs 120 pcf. (Where the excavation

this method is that it assumes a constant Deformation Factor independent of depth of cover and it does not address the effect of the presence of ground water on the Deformation Factor.

To use the Watkins-Gaube Graph, the designer first determines the relative stiffness between pipe and soil, which is given by the Rigidity Factor, R_F. Equation 3-24 and 3-25 are for DR pipe and for profile pipe respectively:

(3-24)
$$R_F = \frac{12\,E_S\,(DR-1)^3}{E}$$

(3-25)
$$R_F = \frac{E_S D_m^{\,3}}{EI}$$

WHERE

DR = **Dimension Ratio**

E_S = **Secant modulus of the soil, psi**

E = **Apparent modulus of elasticity of pipe material, psi**

I = **Pipe wall moment of inertia of pipe, in^4/in**

D_m = **Mean diameter (D_I + 2z or D_O – t), in**

The secant modulus of the soil may be obtained from testing or from a geotechnical engineer's evaluation. In lieu of a precise determination, the soil modulus may be related to the one-dimensional modulus, M_S, from Table 3-12 by the following equation where μ is the soil's Poisson ratio.

(3-26)
$$E_S = M_S \frac{(1+\mu)(1-2\mu)}{(1-\mu)}$$

TABLE 3-13
Typical range of Poisson's Ratio for Soil (Bowles [21])

Soil Type	Poisson's Ratio, μ
Saturated Clay	0.4-0.5
Unsaturated Clay	0.1-0.3
Sandy Clay	0.2-0.3
Silt	0.3-0.35
Sand (Dense)	0.2-0.4
Coarse Sand (Void Ratio 0.4-0.7)	0.15
Fine-grained Sand (Void Ratio 0.4-0.7)	0.25

Next, the designer determines the Deformation Factor, D_F , by entering the Watkins-Gaube Graph with the Rigidity Factor. See Fig. 3-6. The Deformation Factor is the proportionality constant between vertical deflection (compression) of the soil layer containing the pipe and the deflection of the pipe. Thus, pipe deflection can be obtained by multiplying the proportionality constant D_F times the soil settlement. If D_F is less than 1.0 in Fig. 3-6, use 1.0.

The soil layer surrounding the pipe bears the entire load of the overburden above it without arching. Therefore, settlement (compression) of the soil layer is proportional to the prism load and not the radial directed earth pressure. Soil strain, ε_S, may be determined from geotechnical analysis or from the following equation:

(3-27)

$$\varepsilon_S = \frac{wH}{144E_S}$$

WHERE

w **= unit weight of soil, pcf**

H **= depth of cover (height of fill above pipe crown), ft**

E_S **= secant modulus of the soil, psi**

The designer can find the pipe deflection as a percent of the diameter by multiplying the soil strain, in percent, by the deformation factor:

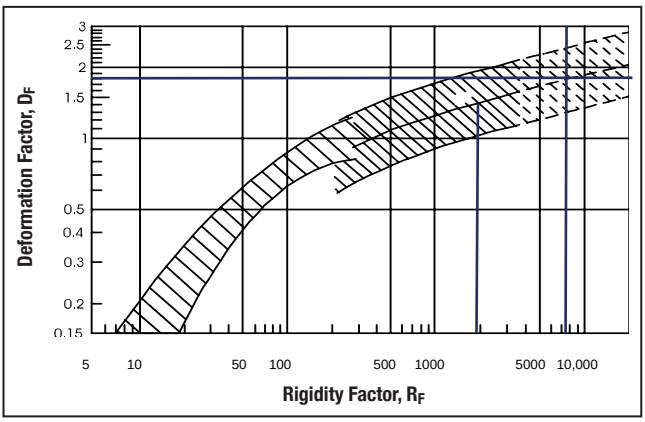


Figure 3-6 Watkins-Gaube Graph

(3-28)

$$\frac{\Delta X}{D_M}(100) = D_F \varepsilon_S$$

WHERE

$\Delta X/D_M$ **multiplied by 100 gives percent deflection.**

The Moore-Selig Equation for critical buckling pressure follows: (Critical buckling pressure is the pressure at which buckling will occur. A safety factor should be provided.)

(3-29)
$$P_{CR} = \frac{2.4\,\varphi\,R_H}{D_M}(EI)^{\frac{1}{3}}(E_S^*)^{\frac{2}{3}}$$

WHERE

P_{CR} **= Critical constrained buckling pressure, psi**

φ **= Calibration Factor, 0.55 for granular soils**

R_H **= Geometry Factor**

E **= Apparent modulus of elasticity of pipe material, psi**

I **= Pipe wall moment of Inertia, in^4/in (t^3/12, if solid wall construction)**

E_S* **= E_S /(1-μ)**

E_S **= Secant modulus of the soil, psi**

μ_S **= Poisson's Ratio of Soil (Consult a textbook on soil for values. Bowles (1982) gives typical values for sand and rock ranging from 0.1 to 0.4.)**

The geometry factor is dependent on the depth of burial and the relative stiffness between the embedment soil and the insitu soil. Moore has shown that for deep burials in uniform fills, R_H equals 1.0.

Critical Buckling Example

Determine the critical buckling pressure and safety factor against buckling for the 6″ SDR 11 pipe (5.987″ mean diameter) in the previous example.

SOLUTION:

$$E_S^* = \frac{2000}{(1-0.3)} = 2860\ \frac{lbs}{inch^2}$$

$$P_{CR} = \frac{2.4*0.55*1.0}{5.987}(29000*0.018)^{\frac{1}{3}}(2860)^{\frac{2}{3}} = 358\ \frac{lbs}{in^2}$$

Determine the Safety Factor against buckling:

$$S.F. = \frac{P_{CR}}{P_E} = \frac{358*144}{140*75} = 4.9$$

Installation Category #4: Shallow Cover Flotation Effects

Shallow cover presents some special considerations for flexible pipes. As already discussed, full soil structure interaction (membrane effect) may not occur, and live loads are carried in part by the bending stiffness of the pipe. Even if the pipe has sufficient strength to carry live load, the cover depth may not be sufficient to prevent

REFERENCE 3

Qian, Xuede et. al. “Geotechnical Aspects of Landfill Design and Construction”, 2002.

TABLE 9.1 Values of Bedding Constant, K

Bedding Angle, θ (degree)	Bedding Constant, K
0	0.110
30	0.108
45	0.105
60	0.102
90	0.096
120	0.090
180	0.083

The deflection of the pipe, ΔX, calculated from Equation 9.16 is the deflection in the horizontal direction, as shown in Figure 9.6. When the deflection of pipe is not large (e.g., less than 10%), the vertical deflection of pipe, ΔY, is usually assumed to be approximately equal to the horizontal deflection of pipe, ΔX.

Vertical Load per Unit Length of Pipe:
For Solid Pipe,

$$W_c = (\Sigma\gamma_i \cdot H_i)\cdot D_o \tag{9.17}$$

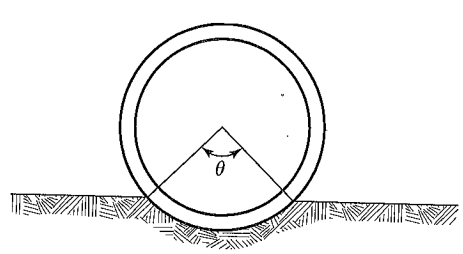
where W_c = vertical load per unit length of the pipe, lb/in or kN/m;
γ_i = unit weight of material i on the pipe (sand, clay or solid waste), lb/in^3 or kN/m^3;
H_i = thickness of material i, in or m; and
D_o = outside diameter of the pipe, in or m.

For Perforated Pipe,

$$W_c = \frac{(\Sigma\gamma_i \cdot H_i)\cdot D_o}{(1 - n\cdot d/12)} \tag{9.18}$$

where W_c = vertical load per unit length of the pipe, lb/in or kN/m;
γ_i = unit weight of material i (soils or solid waste), lb/in^3 or kN/m^3;
H_i = thickness of material i, in or m;
D_o = outside diameter of the pipe, in or m;
d = diameter of perforated hole or width of perforated slot on the pipe, in or m; and
n = number of perforated holes or slots per row per foot of pipe.

FIGURE 9.7 Pipe Bedding Angle



Young's modulus of soil, E_s, and the constrained modulus of soil, M_s, where E_s and D_s are related through Poisson's ratio of soil, v_s, by

$$M_s = \frac{E_s \cdot (1 - v_s)}{(1 + v_s)(1 - 2 \cdot v_s)} \tag{9.27}$$

where M_s = constrained modulus of soil, lb/ft^2 or kN/m^2;
E_s = elastic modulus of soil, lb/ft^2 or kN/m^2; and
v_s = Poisson's ratio of soil.

The studies and analyses by Neilson (1967), Allgood and Takahashi (1972), and Hartely and Duncan (1987) indicated that for

$$E' = k \cdot M_s \tag{9.28}$$

the value of k may vary from 0.7 to 2.3. Using $k = 1.5$ as a representative value and $v_s = 0.3$, in addition to combining Equations 9.27 and 9.28 yields the following relationship between the elastic modulus of the pipe and soil (Selig, 1990):

$$E' = 2 \cdot E_s \tag{9.29}$$

The values of elastic parameters, E_s and v_s, can be found in Table 9.5 according to different percents of density from a standard Proctor compaction test (ASTM D698).

TABLE 9.5 Elastic Soil Parameters (Selig, 1990)

Soil Type	Stress Level		85% Standard Density			95% Standard Density		
			E_s			E_s		
	psi	kPa	psi	MPa	v_s	psi	MPa	v_s
SW, SP, GW, GP	1	7	1,300	9	0.26	1,600	11	0.40
	5	35	2,100	14	0.21	4,100	28	0.29
	10	70	2,600	18	0.19	6,000	41	0.24
	20	140	3,300	23	0.19	8,600	59	0.23
	40	280	4,100	28	0.23	13,000	90	0.25
	60	420	4,700	32	0.28	16,000	110	0.29
GM, SM, ML, and GC, SC with < 20% fines	1	7	600	4	0.25	1,800	12	0.34
	5	35	700	5	0.24	2,500	17	0.29
	10	70	800	6	0.23	2,900	20	0.27
	20	140	850	6	0.30	3,200	22	0.29
	40	280	900	6	0.38	3,700	25	0.32
	60	420	1,000	7	0.41	4,100	28	0.35
CL, MH, GC, SC	1	7	100	1	0.33	400	3	0.42
	5	35	250	2	0.29	800	6	0.35
	10	70	400	3	0.28	1,100	8	0.32
	20	140	600	4	0.25	1,300	9	0.30
	40	280	700	5	0.35	1,400	10	0.35
	60	420	800	6	0.40	1,500	10	0.38

9.4.2 Pipe Wall Buckli

Buckling can oc
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E = r
I = r
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Because

where

APPENDIX IV-5

Ash Filter Calculation

Calculation Title:
Ash Filter Calculation

Summary:
The fine aggregate portion of a two-stage filter adjacent to ash will consist of ASTM C-33 fine aggregate.

The coarse aggregate portion of a two-stage filter will consist of NCDOT 78M aggregate.

Perforated drainage pipe sections (i.e., chimney drains or leachate collection pipes) will be located within the NCDOT 78M (coarse aggregate) portion of the filter and should have a maximum perforation size of 0.1875 inch (3/16 inch).

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal			
		Tryambak Kaushik	**Lee Eaves**	**Cedric H. Ruhl**

OBJECTIVE:

The objective of this calculation is to develop particle size criteria for a two-stage mineral filter for ash, such as for use around chimney drains.

METHOD:

A two-stage filter generally consists of a coarse material and fine grain material to prevent clogging. The chimney drain riser pipe will be surrounded by coarse aggregate with a sand-type shell to filter the ash and reduce ash migration into the leachate collection system.

The two-stage filter material will be designed in accordance with NRCS publication "Part 633 National Engineering Handbook", Chapter 26: Gradation Design of Sand and Gravel Filters [Ref. 1].

CALCULATIONS:

1.0 Grain size of base soil (ash) (Step 1)

Amec Foster Wheeler performed soil borings on Ash Fills 1 and 2, and the Primary Ash Basin. Grain size distributions were developed for ash samples as summarized in the following table:

Table 1: Grain Size Distributions of Fly Ash Material

No.	Boring [Ref. 2]	Depth [Ref. 2]	Description [Ref. 2]	% Passing [Ref. 2]									D_{85} (mm)
				0.75 (in)	.375 (in)	#4	#10	#20	#40	#60	#100	#200	
1	B316	1'-10'	ash from Ash Fill 1	100.0	100.0	98.1	97.6	97.0	96.0	93.5	89.6	79.8	0.102
2	B317	18.5'-20'	ash from Ash Fill 2	100.0	100.0	99.4	98.3	96.8	94.7	90.3	84.1	71.9	0.160
3	B318	8.5'-10'	ash from Ash Fill 2	100.0	100.0	100.0	99.4	98.8	97.8	95.9	92.7	85.2	0.075
4	B318	23.5'-25'	ash from Ash Fill 2	100.0	100.0	98.1	95.5	90.8	84.8	77.7	68.6	56.2	0.432
5	B319	10'-20'	ash from Ash Fill 2	100.0	100.0	99.7	99.5	99.1	98.5	96.9		88.8	0.075
6	B320	58.5'-60'	ash from Ash Fill 1	100.0	100.0	100.0	99.2	98.2	96.4	93.1	87.9	78.2	0.118
7	B322	38.5'-48.5'	ash from Ash Fill 1	100.0	100.0	98.4	96.4	92.8	89.6	85.6	79.4	69.1	0.235
8	B322	48.6'-58.5'	ash from Ash Fill 1	100.0	100.0	99.5	98.6	97.1	95.3	92.7		80.8	0.106
9	B322	68.5'-70'	ash from Ash Fill 1	100.0	100.0	100.0	100.0	99.9	99.8	99.8	99.7	99.1	0.075
10	B324	25'-35'	ash from Ash Fill 1	100.0	100.0	99.8	99.2	98.4	97.3	95.4	92.2	83.5	0.086
11	B324	25'-35'	ash from Ash Fill 1	100.0	100.0	100.0	99.6	99.0	98.1	96.5		87.0	0.075
12	B324	43.5'-45'	ash from Ash Fill 1	100.0	100.0	100.0	91.9	78.1	70.7	66.1	61.9	55.7	1.299
13	B327	19'-20.5'	ash under intermediate dike	100.0	100.0	100.0	100.0	99.8	98.2	94.1	84.0	66.0	0.156
14	B328	14'-20'	ash from Primary Ash Basin	100.0	100.0	100.0	99.8	99.5	98.9	98.4		95.6	0.075
15	B328	20'-29.5'	ash from Primary Ash Basin	100.0	100.0	100.0	99.9	99.6	98.6	95.8	91.6	84.0	0.081
16	B330	0'-10'	ash from Primary Ash Basin	100.0	100.0	98.6	96.4	93.7	90.9	87.4	82.2	72.7	0.193
17	B331	10'-20'	ash from Primary Ash Basin	100.0	100.0	99.5	99.2	98.5	97.0	94.1	90.0	81.8	0.094
18	B331	40'-50'	ash from Primary Ash Basin	100.0	99.1	96.4	91.1	86.0	81.8	76.5		59.7	0.749
19	B333	0'-10'	ash from Primary Ash Basin	100.0	100.0	99.7	99.2	98.6	97.5	84.2		74.3	0.147
20	B333	10'-20'	ash from Primary Ash Basin	100.0	100.0	100.0	99.8	99.6	99.1	97.0	93.1	83.3	0.082
21	B335	0'-10'	ash from Primary Ash Basin	100.0	100.0	100.0	99.9	99.9	99.5	97.7	93.5	82.7	0.084
22	B335	10'-20'	ash from Primary Ash Basin	100.0	100.0	99.7	99.1	98.0	96.8	94.1	88.6	77.6	0.114
											AVERAGE	**77.9**	**0.210**

For the purposes of this calculation it was assumed that samples with a D_{85} smaller than the No. 200 sieve had a D_{85} equal to 0.075 mm (No. 200 sieve opening size).

Because no appreciable amount of material is retained on the #4 sieve, proceed to Step 4 of the NRCS filter design process.

2.0 Categorize the base soil (ash) (Step 4)

The base soil in this instance is ash and is categorized by the percent finer than the #200 sieve. According to the grain size distribution curves, the ash on average is 78 percent finer than the #200 sieve; therefore, the base soil will be categorized as Type 2, sand, silts, clays, and silty and clayey sands as shown in the following table:

Table 2: Categorize Base Soil (Embankment Material)			
Average Percent Finer than #200 Sieve	**Assumed % Finer than #200 Sieve**	**Base Soil Category [Ref. 1]**	**Base Soil Description [Ref. 1]**
78	40-85	2	Sand, silts, clays, and silty & clayey sands

3.0 Calculate maximum allowable D_{15} size for the filter material (Step 5)

The maximum D_{15} of the filter material is defined to prevent the migration of the retained material into the filter media. The maximum D_{15} value for the filter depends on the base soil category, as shown in the following table:

Table 3: Maximum D_{15} (Filter)			
Base Soil Category [Ref. 1]	**Filtering Criteria [Ref. 1]**	**Average Embankment Material D_{85} (mm)**	**Maximum Filter D_{15} (mm)**
2	≤ 0.7 mm	0.210	0.700

4.0 Calculate minimum allowable D_{15} size for the filter material (Step 6)

The minimum D_{15} of the filter material is defined to allow sufficient permeability for effective drainage of the retained soil. The minimum D_{15} value for the filter depends on the base soil category, as shown in the following table:

Table 4: Minimum D_{15} (Filter)	
Base Soil Category [Ref. 1]	**Minimum D_{15} [Ref. 1]**
All	≥ 4 x d_{15} of the base soil but not less than 0.1 mm

The minimum D_{15} value for the filter was selected to be 0.1 mm.

5.0 Check the ratio of max. D_{15} to min. D_{15} for the filter material (Step 7)

The ratio of maximum D_{15} to minimum D_{15} for the filter material, as calculated in steps 5 and 6, should be 5 or less as summarized in the following table:

Table 5: Maximum and Minimum D_{15} (Filter)							
Maximum Allowable D_{15} for Filter (mm) [Step 5]	Minimum Allowable D_{15} for Filter (mm) [Step 6]	$\frac{D_{15,max}}{D_{15,min}}$	Check	Maximum Allowable D_{15} for Filter (mm) [Control Point 1]	Minimum Allowable D_{15} for Filter (mm) [Control Point 2]	$\frac{D_{15,max}}{D_{15,min}}$	Check
0.70	0.10	7	**NOT OK**	0.50	0.10	5	**OK**

The initial ratio is greater than 5, therefore the maximum D_{15} value is modified to achieve a ratio of 5.

6.0 Calculate max. / min. allowable D_{60} values for filter material (Step 8)

The maximum allowable D_{10} value for filter material is calculated by dividing the maximum D_{15} value (Step 7) by 1.2. The maximum allowable D_{60} value for filter material is then calculated by multiplying the maximum D_{10} by 6. The minimum allowable D_{60} is calculated by dividing the maximum allowable D_{60} by 5, as summarized in the following table:

Table 6: Maximum and Minimum D_{60} (Filter)			
Maximum Allowable D_{15} for Filter (mm) [Step 7]	Maximum Allowable D_{10} for Filter (mm)	Maximum Allowable D_{60} for Filter (mm) [Control Point 3]	Minimum Allowable D_{60} for Filter (mm) [Control Point 4]
0.50	0.42	2.50	0.50

7.0 Calculate min. D_5 and max. D_{100} for filter material (Step 9)

The maximum allowable D_{100} and minimum allowable D_5 values for filter material are summarized in the following table:

Table 7: Maximum D_{100} and Minimum D_5 (Filter)		
Base Soil Category	Maximum Allowable D_{100} for Filter (mm) [Control Point 6]	Minimum Allowable D_5 for Filter (mm) [Control Point 5]
All Categories	≤ 3 inches (75 mm)	0.075 mm (# 200 sieve)

8.0 Calculate maximum allowable D_{90} for filter material (Step 10)

The minimum allowable D_{10} value for filter material is calculated by dividing the minimum D_{15} value (Step 7) by 1.2. The maximum D_{90} value for filter material is taken from Table 26-6 in Reference 1 and shown in the following table:

Table 8: Maximum D_{90} (Filter)		
Minimum Allowable D_{15} for Filter (mm) [Step 7]	Minimum Allowable D_{10} for Filter (mm)	Maximum Allowable D_{90} for Filter (mm) [Control Point 7]
0.10	0.08	20.00

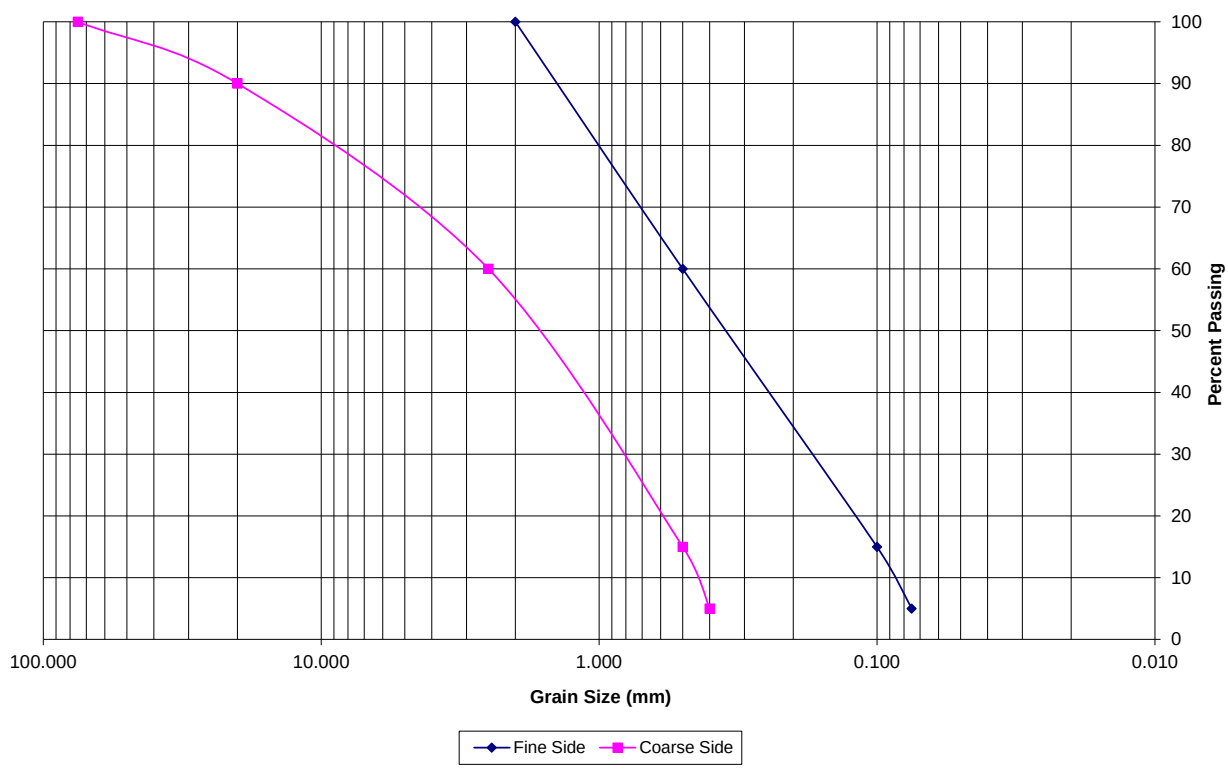
9.0 Develop the acceptable grain size band for filter material (Step 11)

The fine side of the filter band is drawn by connecting Control Points 4, 2, and 5. The coarse side of the filter band is drawn by connecting Control Points 6, 7, 3, and 1. Additional values were added to complete the filter curve. Control Points are summarized in the following table, the filter band is shown in the following figure:

Table 9: Control Point Summary (Filter)

Control Point	Percent Passing	Value (mm)	Side of Curve	Step Calculated
1	15	0.50	Coarse	Step 7
2	15	0.10	Fine	Step 7
3	60	2.50	Coarse	Step 8
4	60	0.50	Fine	Step 8
5	5	0.075	Fine	Step 9
6	100	75	Coarse	Step 9
7	90	20	Coarse	Step 10
8	100	2.00	Fine	Assumed
9	5	0.40	Coarse	Assumed

Figure 1: Filter Grain Size Band



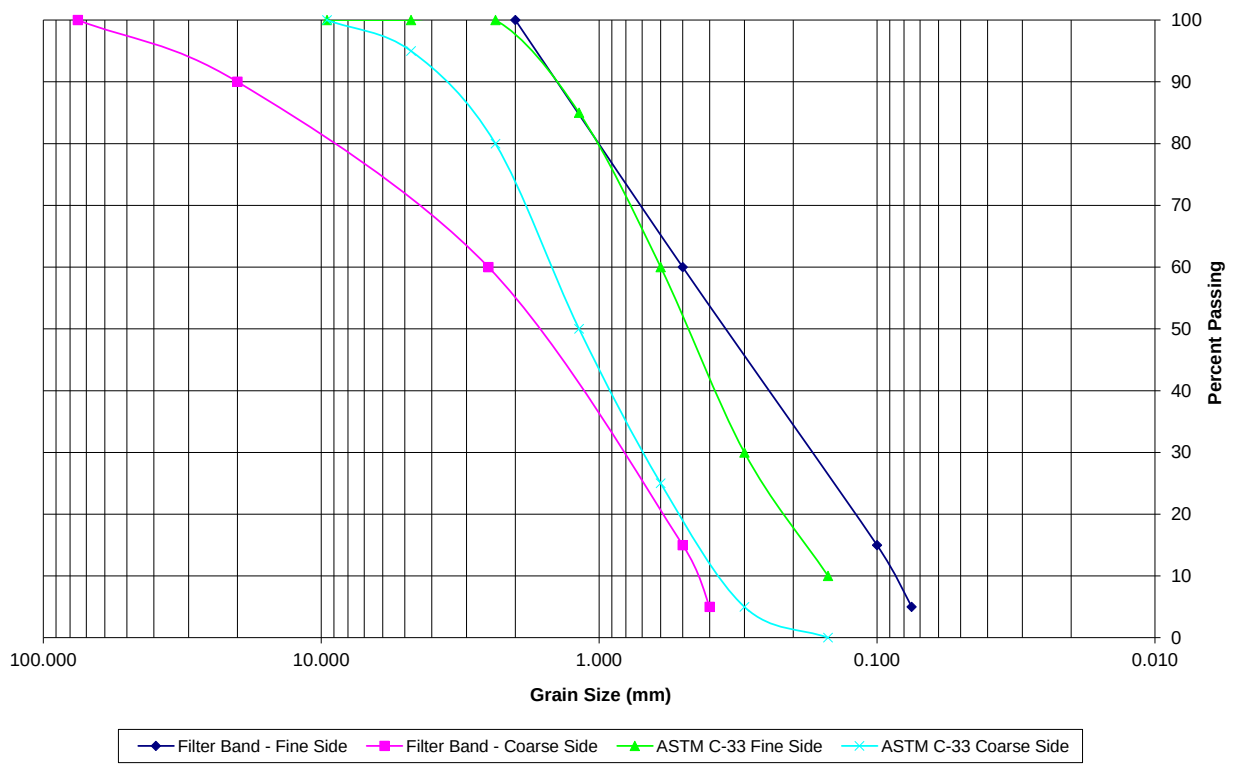
10.0 Check the suitability of ASTM C-33 fine aggregate to serve as a filter

ASTM C-33 fine aggregate conforms to the ranges given in the following table:

Table 10: Grain Size Ranges for ASTM C-33 Aggregate			
Sieve [Ref. 3]	Aperture Size (mm) [Ref. 3]	Percent Passing (fine side) [Ref. 3]	Percent Passing (coarse side) [Ref. 3]
0.375 in	9.525	100	100
#4	4.750	100	95
#8	2.360	100	80
#16	1.180	85	50
#30	0.600	60	25
#50	0.300	30	5
#100	0.150	10	0

The ASTM C-33 fine aggregate relationship to the filter grain size band is shown in the following figure:

Figure 2: Filter Band vs. ASTM C-33 Fine Aggregate



ASTM C-33 fine aggregate falls within the calculated portion of the target filter band, indicating that ASTM C-33 is a suitable filter for the fly ash. Next, a coarse aggregate will be selected to filter the ASTM C-33 fine aggregate.

11.0 Check the grain size distribution of the fine filter material (Step 1)

The fine filter material is the "base" soil for design of the coarse filter. The fine filter material grain size distribution is summarized in the following table.

Table 11: Grain Size Distributions (Filter)										
Filter Material	% Passing (smallest particle size)								D_{15} (mm)	D_{85} (mm)
	0.5 (in)	.375 (in)	#4	#8	#16	#30	#50	#100		
ASTM C-33		100	100	100	85	60	30	10	0.19	1.18

Because the proposed fine filter material will contain no material retained on the #4 sieve, proceed to Step 4 of the NRCS filter design process.

12.0 Categorize the "base" soil (Step 4)

The "base" soil in this instance is the fine filter material and is categorized by the percent finer than the #200 sieve. According to the grain size distribution curve, the proposed fine filter material has less than 10 percent finer than the #200 sieve as shown in the following table:

Table 12: Categorize Base Soil (Filter)		
Maximum % Finer than #200 Sieve	Base Soil Category [Ref. 1]	Base Soil Description [Ref. 1]
10.0	4	Sands and gravel

13.0 Calculate max. allowable D_{15} size for the drainage material (Step 5)

The maximum D_{15} of the coarse filter (also referred to herein as drainage material) is defined to prevent the migration of the filter material into the drainage material. The D_{15} value for the drainage material depends on the base soil category and D_{85} of retained soil, in this case fine filter material, as shown in the following table:

Table 13: Maximum D_{15} (Drainage)			
Base Soil Category	Filtering Criteria [Ref. 1]	d_{85} (mm) [filter material]	Maximum D_{15} (mm)
4	$\leq 4 \times d_{85}$	1.18	4.72

14.0 Calculate min. allowable D_{15} size for the drainage material (Step 6)

The minimum D_{15} of the drainage material is defined to allow sufficient permeability for effective drainage of the fine filter material. The D_{15} value for the drainage material depends on the base soil category and d_{85} of retained soil, in this case fine filter material, as shown in the following table:

Table 14: Minimum D_{15} (Drainage)			
Base Soil Category	Minimum D_{15} [Ref. 1]	d_{15} (mm) [filter material]	Minimum D_{15} (mm)
All	$\geq 4 \times d_{15}$ of the base soil but not less than 0.1 mm	0.19	0.76

15.0 Check ratio of max. D_{15} to min. D_{15} for the drainage material (Step 7)

The ratio of maximum D_{15} to minimum D_{15} for the drainage material, as calculated in steps 5 and 6, should be 5 or less as summarized in the following table:

Table 15: Maximum and Minimum D_{15} (Drainage)							
Maximum Allowable D_{15} for Drainage (mm) [Step 5]	Minimum Allowable D_{15} for Drainage (mm) [Step 6]	$\frac{D_{15,max}}{D_{15,min}}$	Check	Maximum Allowable D_{15} for Drainage (mm) [Control Point 1]	Minimum Allowable D_{15} for Drainage (mm) [Control Point 2]	$\frac{D_{15,max}}{D_{15,min}}$	Check
4.72	0.76	6.21	**NOT OK**	4.72	0.96	4.92	**OK**

The initial ratio is greater than 5, therefore the D_{15} minimum is modified to achieve a ratio of 5.

16.0 Calculate max. and min. D_{60} values for drainage material (Step 8)

The maximum allowable D_{10} value for drainage material is calculated by dividing the maximum D_{15} value (Step 7) by 1.2. The maximum allowable D_{60} value for drainage material is then calculated by multiplying the maximum D_{10} by 6. The minimum allowable D_{60} is calculated by dividing the maximum allowable D_{60} by 5, as summarized in the following table:

Table 16: Maximum and Minimum D_{60} (Drainage)			
Maximum Allowable D_{15} for Drainage (mm) [Step 7]	Maximum Allowable D_{10} for Drainage (mm)	Maximum Allowable D_{60} for Drainage (mm) [Control Point 3]	Minimum Allowable D_{60} for Drainage (mm) [Control Point 4]
4.72	3.93	23.60	4.72

17.0 Calculate min. D_5 and max. D_{100} for drainage material (Step 9)

The maximum allowable D_{100} and minimum allowable D_5 values for drainage material are summarized in the following table:

Table 17: Maximum D_{100} and Minimum D_5 (Drainage)		
Base Soil Category [Ref. 1]	Maximum Allowable D_{100} for Aggregate (mm) [Control Point 6] [Ref. 1]	Minimum Allowable D_5 for Aggregate (mm) [Control Point 5] [Ref. 1]
All Categories	≤ 3 inches (75 mm)	0.075 mm (# 200 sieve)

18.0 Calculate maximum allowable D_{90} for drainage material (Step 10)

The minimum allowable D_{10} for drainage material is calculated by dividing the minimum D_{15} value (Step 7) by 1.2. The maximum D_{90} value for drainage material is taken from Table 26-6 in Reference 1 and is shown in the following table:

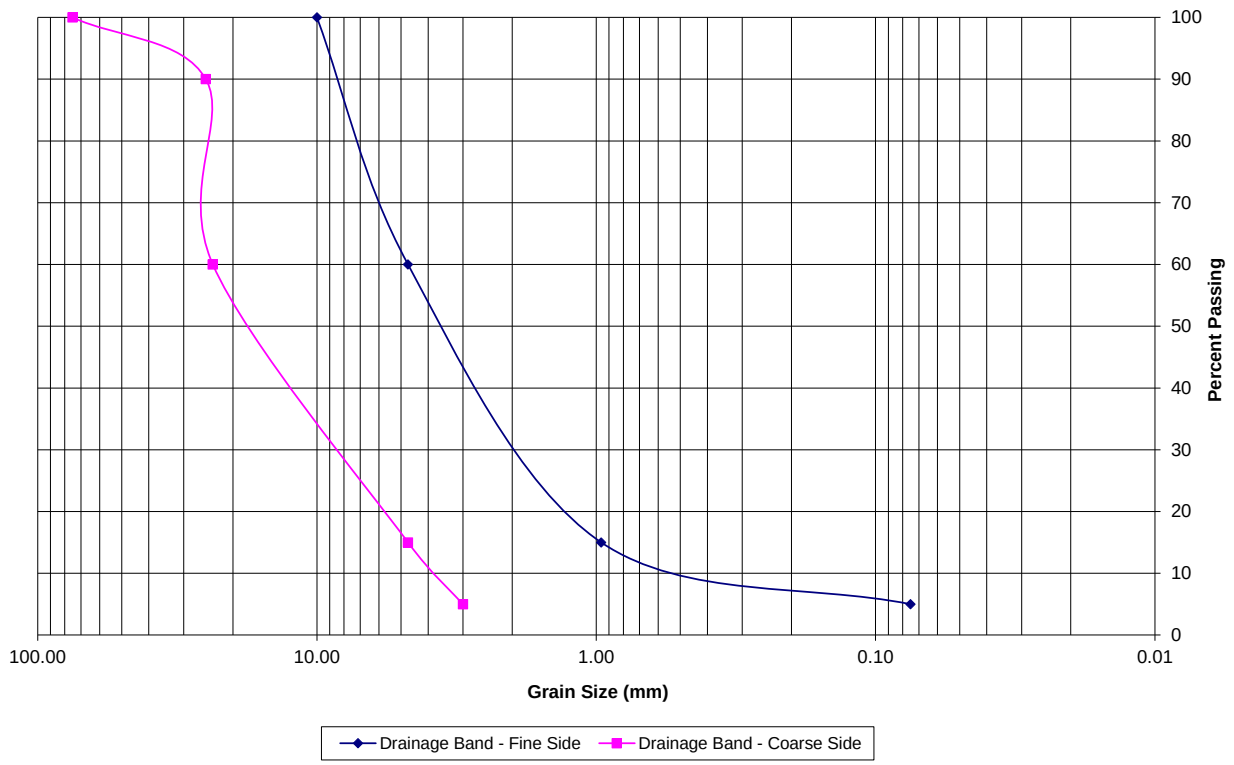
Table 18: Maximum D_{90} (Drainage)		
Minimum Allowable D_{15} for Drainage (mm) [Step 7]	Minimum Allowable D_{10} for Drainage (mm)	Maximum Allowable D_{90} for Drainage (mm) [Control Point 7]
0.96	0.80	25.00

19.0 Develop acceptable grain size band for drainage material (Step 11)

The fine side of the drainage band is drawn by connecting Control Points 4, 2, and 5. The coarse side of the drainage band is drawn by connecting Control Points 6, 7, 3, and 1. Additional values were added to complete the filter curve. Control Points are summarized in the following table, the filter band is shown in the following figure:

Table 19: Control Point Summary (Drainage)				
Control Point	Percent Passing	Value (mm)	Side of Curve	Step Calculated
1	15	4.72	Coarse	Step 7
2	15	0.96	Fine	Step 7
3	60	23.60	Coarse	Step 8
4	60	4.72	Fine	Step 8
5	5	0.075	Fine	Step 9
6	100	75	Coarse	Step 9
7	90	25	Coarse	Step 10
8	100	2.00	Fine	Assumed
9	5	3.00	Coarse	Assumed

Figure 3 - Drainage Band



20.0 Check the suitability of NCDOT 78M coarse aggregate

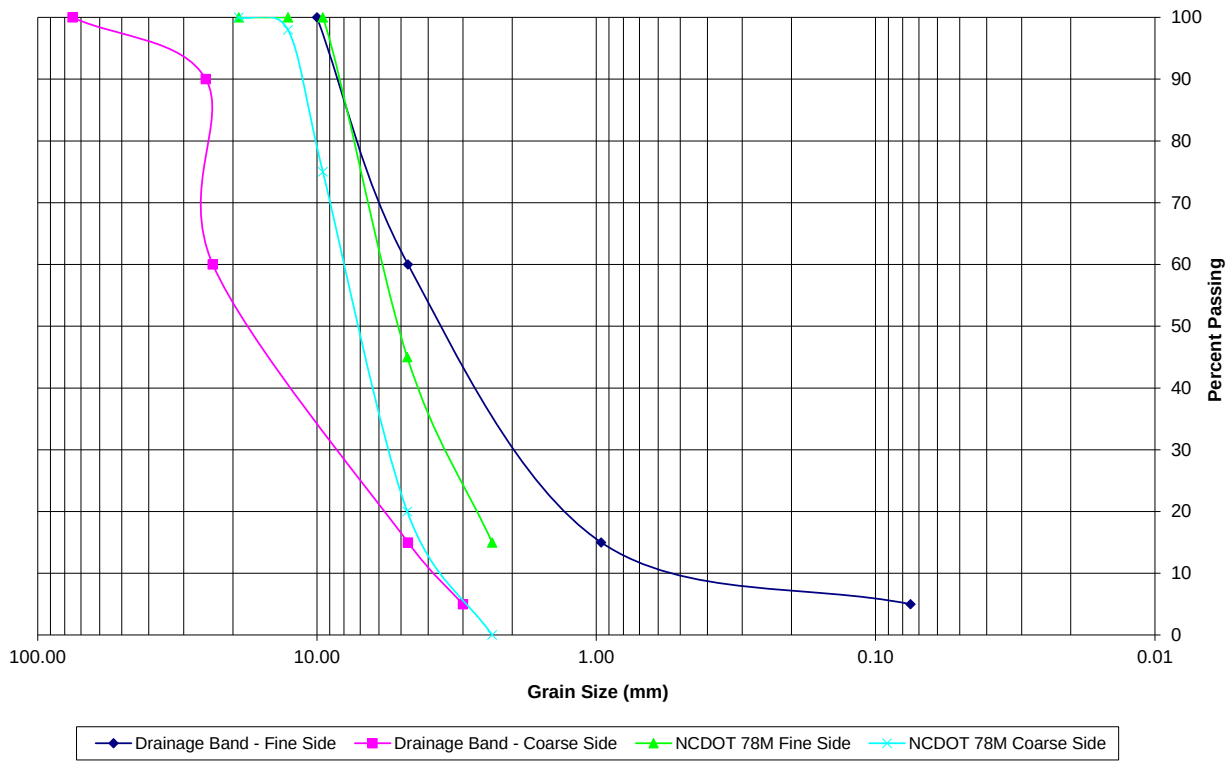
NCDOT 78M coarse aggregate conforms to the ranges given in the following table:

Table 20: Grain Size Ranges for NCDOT 78M Coarse Aggregate

Sieve	Aperture Size (mm)	Percent Passing (fine side) [Ref. 4]	Percent Passing (coarse side) [Ref. 4]
0.75 in	19.05	100	100
0.5 in	12.70	100	98
0.375 in	9.53	100	75
#4	4.750	45	20
#8	2.360	15	0

The grain size ranges for NCDOT 78M coarse aggregate relationship to the drainage band is shown in the following figure:

Figure 4: Drainage Band vs. NCDOT 78M Coarse Aggregate



NCDOT 78M falls largely within the target drainage band, indicating a grain size small enough to retain the filter soil. NCDOT 78M aggregate will serve as a suitable drainage material for retaining the proposed filter material.

21.0 Calculate the perforation size for pipe in contact with NCDOT 78M

The proposed collector pipes (i.e. chimney drains) are not anticipated to function as "critical structure drains where rapid gradient reversal (surging) is probable" [Ref. 1], therefore perforations must be smaller than the D_{85} value of the drainage material. The D_{85} value is conservatively identified from the fine side of the drainage material grain size band.

For NCDOT 78M coarse aggregate, the D_{85} value is interpolated between the #4 sieve and 0.375 inches, as shown in the following table:

Table 21: D_{85} for NCDOT 78M Coarse Aggregate

Sieve	Aperture Size (mm)	Percent Passing (fine side) [Ref. 4]	D_{85} (mm)	D_{85} (in)
0.375 in	9.525	100	8.22	0.32
#4	4.750	45		

Therefore, the maximum allowable pipe perforation diameter is 0.32 inches. Specify 0.1875 inches (3/16 inch) for actual perforation size.

DISCUSSION:

It is recommended that the fine aggregate portion of a two-stage filter adjacent to ash consist of ASTM C-33 fine aggregate.

It is recommended that the coarse aggregate portion of a two-stage filter consist of NCDOT 78M aggregate.

Perforated drainage pipe sections located within the two-stage filters should be located within the NCDOT 78M (coarse aggregate) portion of the filter and should have a maximum perforation size of 0.1875 inch (3/16 inch).

REFERENCES:

1. "Part 633 National Engineering Handbook – Chapter 26: Gradation Design of Sand and Gravel Filters", Natural Resources Conservation Service, 1994.
2. Particle Size Analyses of Ash, 2014-2015.
3. "Standard Specification for Concrete Aggregates – ASTM C 33-03", American Society for Testing and Materials, 2003.
4. "Standard Specifications for Roads and Structures", North Carolina Department of Transportation, 2006.

REFERENCE 1

“Part 633 National Engineering Handbook – Chapter 26: Gradation Design of Sand and Gravel Filters”, Natural Resources Conservation Service, 1994.

633.2602 Permeability and capacity

The laboratory filter study clearly demonstrated that graded filters designed in accordance with these criteria will seal a crack. The sealing begins when water flows through a crack or opening and carries soil particles eroded from the sides of the openings. Eroding soil particles collect on the face of the filter and seal the crack at the interface. Any subsequent flow is through the pores of the soil. If filters are designed to intercept cracks, the permeability required in the filter zone should be based on the steady state seepage flow through the pores of the base soil alone. The hydraulic capacity of any cracks need not be considered in designing the filter because the cracks have been shown to seal.

Where saturated steady-state seepage flow will not develop, for instance in dry dams for flood control having a normal drawdown time of 10 days or less, filter capacity need only be nominal. Filters designed either to protect against steady state seepage or internal erosion through cracks are to be thick enough to compensate for potential segregation and contamination of the filter zones during construction. They must also be thick enough that cracks cannot extend through the filter zone during any possible differential movements.

A zone of coarser materials immediately downstream or below the filter, or both, provides additional capacity to collect and convey seepage to a controlled outlet. In some cases a strip drain is used, and in others a perforated collector pipe is employed to outlet the collected seepage. To prevent movement of the filter materials into the coarse drain materials, the coarse drain materials must be designed for the proper gradation using procedures in this subchapter. Perforations in collector pipes must also be sized properly to prevent movement of the coarse drain materials into the perforations.

633.2603 Determining filter gradation limits

Determine filter gradation limits using the following steps:

Step 1: Plot the gradation curve (grain-size distribution) of the base soil material. Use enough samples to define the range of grain sizes for the base soil or soils. Design the filter using the base soil that requires the smallest D_{15} size for filtering purposes. Base the design for drainage purposes on the base soil that has the largest D_{15} size.

Step 2: Proceed to step 4 if the base soil contains no gravel (material larger than No. 4 sieve).

Step 3: Prepare adjusted gradation curves for base soils that have particles larger than the No. 4 (4.75 mm) sieve.

- Obtain a correction factor by dividing 100 by the percent passing the No. 4 (4.75 mm) sieve.
- Multiply the percentage passing each sieve size of the base soil smaller than No. 4 (4.75 mm) sieve by the correction factor determined above.
- Plot these adjusted percentages to obtain a new gradation curve.
- Use the adjusted curve to determine the percentage passing the No. 200 (0.075 mm) sieve in step 4.

Step 4: Place the base soil in a category determined by the percent passing the No. 200 (0.075 mm) sieve from the regraded gradation curve data according to table 26–1.

Step 5: To satisfy filtration requirements, determine the maximum allowable D_{15} size for the filter in accordance with the table 26–2.

If desired, the maximum D_{15} may be adjusted for certain noncritical uses of filters where significant hydraulic gradients are not predicted, such as bedding beneath riprap and concrete slabs. For fine clay base soil that has d_{85} sizes between 0.03 and 0.1 mm, a maximum D_{15} of ≤ 0.5 mm is still conservative. For fine-grained silt that has low sand content, plotting below the "A" line, a maximum D_{15} of 0.3 mm may be used.

Step 6: If permeability is a requirement (see section 633.2602)**, determine the minimum allowable D_{15} in accordance with table 26–3.** Note: The permeability requirement is determined from the d_{15} size of the base soil gradation before regrading.

Step 7: The width of the allowable filter design band must be kept relatively narrow to prevent the use of possibly gap-graded filters. Adjust the maximum and minimum D_{15} sizes for the filter band determined in steps 5 and 6 so that the ratio is 5 or less at any given percentage passing of 60 or less. Criteria are summarized in table 26–4.

Table 26–1 Regraded gradation curve data

Base soil category	% finer than No. 200 sieve (0.075 mm) (after regrading, where applicable)	Base soil description
1	> 85	Fine silt and clays
2	40 – 85	Sands, silts, clays, and silty & clayey sands
3	15 – 39	Silty & clayey sands and gravel
4	< 15	Sands and gravel

Table 26–2 Filtering criteria — Maximum D_{15}

Base soil category	Filtering criteria
1	$\leq 9 \times d_{85}$ but not less than 0.2 mm
2	≤ 0.7 mm
3	$\leq \left(\frac{40-A}{40-15}\right)\left[\left(4\times d_{85}\right)-0.7\text{mm}\right]+0.7\text{mm}$ A = % passing #200 sieve after regrading (If $4 \times d_{85}$ is less than 0.7 mm, use 0.7 mm)
4	$\leq 4 \times d_{85}$ of base soil after regrading

This step is required to avoid the use of gap-graded filters. The use of a broad range of particle sizes to specify a filter gradation could result in allowing the use of gap-graded (skip-graded) materials. These materials have a grain size distribution curve with sharp breaks or other undesirable characteristics. Materials that have a broad range of particle sizes may also be susceptible to segregation during placement. The requirements of step 9 should prevent segregation, but other steps are needed to eliminate the use of any gap-graded filters.

Gap-graded materials generally can be recognized by simply looking at their grain size distribution curve. However, for specification purposes, more precise controls are needed. In designing an acceptable filter band using the preliminary control points obtained in steps 1 through 6, the following additional requirements should be followed to decrease the probability of using a gap-graded filter.

Table 26–3 Permeability criteria

Base soil category	Minimum D_{15}
All categories	$\geq 4 \times d_{15}$ of the base soil before regrading, but not less than 0.1 mm

Table 26–4 Other filter design criteria

Design element	Criteria
To prevent gap-graded filters	The width of the designed filter band should be such that the ratio of the maximum diameter to the minimum diameter at any given percent passing value ≤ 60% is ≤ 5.
Filter band limits	Coarse and fine limits of a filter band should each have a coefficient of uniformity of 6 or less.

First, calculate the ratio of the maximum D_{15} to the minimum D_{15} sizes determined in steps 5 and 6. If this ratio is greater than 5, adjust the values of these control points so that the ratio of the maximum D_{15} to the minimum D_{15} is no greater than 5. If the ratio is 5 or less, no adjustments are necessary. Label the maximum D_{15} size as Control point 1 and the minimum D_{15} size as Control point 2. Proceed to step 8.

The decision on where to locate the final D_{15} sizes within the range established with previous criteria should be based on one of the following considerations:

1. Locate the design filter band at the maximum D_{15} side of the range if the filter will be required to transmit large quantities of water (serve as a drain as well as a filter). With the maximum D_{15} size as the control point, establish a new minimum D_{15} size by dividing the maximum D_{15} size by 5, and locate a new minimum D_{15} size. Label the maximum D_{15} size Control point 1 and the minimum D_{15} size Control point 2.

2. Locate the band at the minimum D_{15} side of the range if it is probable there are finer base materials than those sampled and filtering is the most important function of the zone. With the minimum D_{15} size as the control point, establish a new maximum D_{15} size by multiplying the minimum D_{15} size by 5, and locate a new maximum D_{15} size. Label the maximum D_{15} size Control point 1 and the minimum D_{15} size Control point 2.

3. The most important consideration may be to locate the maximum and minimum D_{15} sizes, within the acceptable range of sizes determined in steps 5 and 6, so that a standard gradation available from a commercial source or other gradations from a natural source near the site would fall within the limits. Locate a new maximum D_{15} and minimum D_{15} within the permissible range to coincide with the readily available material. Ensure that the ratio of these sizes is 5 or less. Label the maximum D_{15} size Control point 1 and the minimum D_{15} size Control point 2.

Step 8: The designed filter band must not have an extremely broad range of particle sizes to prevent the use of possibly gap-graded filters. Adjust the limits of the design filter band so that the coarse and fine sides have a coefficient of uniformity of 6 or less. The width of the filter band should be such that the ratio of maximum to minimum diameters is less than or equal to 5 for all percent passing values of 60 or less.

Other filter design criteria in step 8

To prevent gap-graded filters—Both sides of the design filter band will have a coefficient of uniformity, defined as:

$$CU = \frac{D_{60}}{D_{10}} \leq 6$$

Initial design filter bands by this step will have CU values of 6. For final design, filter bands may be adjusted to a steeper configuration, with CU values less than 6, if needed. This is acceptable so long as other filter and permeability criteria are satisfied.

Calculate a maximum D_{10} value equal to the maximum D_{15} size divided by 1.2. (This factor of 1.2 is based on the assumption that the slope of the line connecting D_{15} and D_{10} should be on a coefficient of uniformity of about 6.) Calculate the maximum permissible D_{60} size by multiplying the maximum D_{10} value by 6. Label this Control point 3.

Determine the minimum allowable D_{60} size for the fine side of the band by dividing the determined maximum D_{60} size by 5. Label this Control point 4.

Step 9: Determine the minimum D_5 and maximum D_{100} sizes of the filter according to table 26–5. Label as Control points 5 and 6, respectively.

Table 26–5 Maximum and minimum particle size criteria*

Base soil category	Maximum D_{100}	Minimum D_5, mm
All categories	≤ 3 inches (75 mm)	0.075 mm (No. 200 sieve)

* The minus No. 40 (.425 mm) material for all filters must be nonplastic as determined in accordance with ASTM D4318.

Step 10: To minimize segregation during construction, the relationship between the maximum D_{90} and the minimum D_{10} of the filter is important. Calculate a preliminary minimum D_{10} size by dividing the minimum D_{15} size by 1.2. (This factor of 1.2 is based on the assumption that the slope of the line connecting D_{15} and D_{10} should be on a coefficient of uniformity of about 6.) Determine the maximum D_{90} using table 26–6. Label this as Control point 7.

Sand filters that have a D_{90} less than about 20 mm generally do not require special adjustments for the broadness of the filter band. For coarser filters and gravel zones that serve both as filters and drains, the ratio of D_{90}/D_{10} should decrease rapidly with increasing D_{10} sizes.

Step 11: Connect Control points 4, 2, and 5 to form a partial design for the fine side of the filter band. Connect Control points 6, 7, 3, and 1 to form a design for the coarse side of the filter band. This results in a preliminary design for a filter band. Complete the design by extrapolating the coarse and fine curves to the 100 percent finer value. For purposes of writing specifications, select appropriate sieves and corresponding percent finer values that best reconstruct the design band and tabulate the values.

Step 12: Design filters adjacent to perforated pipe to have a D_{85} size no smaller than shown in table 26–7. For critical structure drains where rapid gradient reversal (surging) is probable, it is recommended that the D_{15} size of the material surrounding the pipe be no smaller than the perforation size.

Additional design considerations: Note that these steps provide a filter band design that is as well graded as possible and still meets criteria. This generally provides the most desirable filter characteristics. However, in some cases a more poorly graded filter band may be preferable; for example, if more readily available standard gradations are needed or where onsite filters are used for economy.

The design filter band obtained in steps 1 through 12 may be adjusted to a steeper configuration in such cases. The width of the filter band should be maintained so that the ratio of the maximum diameters to the minimum diameters at a given percent finer is no greater than 5 below the 60 percent finer value.

Only the portion of the design filter band above the previously established minimum and maximum D_{15} sizes should be adjusted. The design band may be adjusted so that the coefficients of uniformity of both the coarse and fine sides of the design band are less than 6, but not less than 2, to prevent use of very poorly graded filters.

Table 26–6 Segregation criteria

Base soil category	If D_{10} is :	Then maximum D_{90} is:
	(mm)	(mm)
All categories	< 0.5	20
	0.5 – 1.0	25
	1.0 – 2.0	30
	2.0 – 5.0	40
	5.0 – 10	50
	> 10	60

Table 26–7 Criteria for filters used adjacent to perforated collector pipe

Noncritical drains where surging or gradient reversal is not anticipated	The filter D_{85} must be greater than or equal to the perforation size
Critical drains where surging or gradient reversal is anticipated	The filter D_{15} must be greater than or equal to the perforation size.

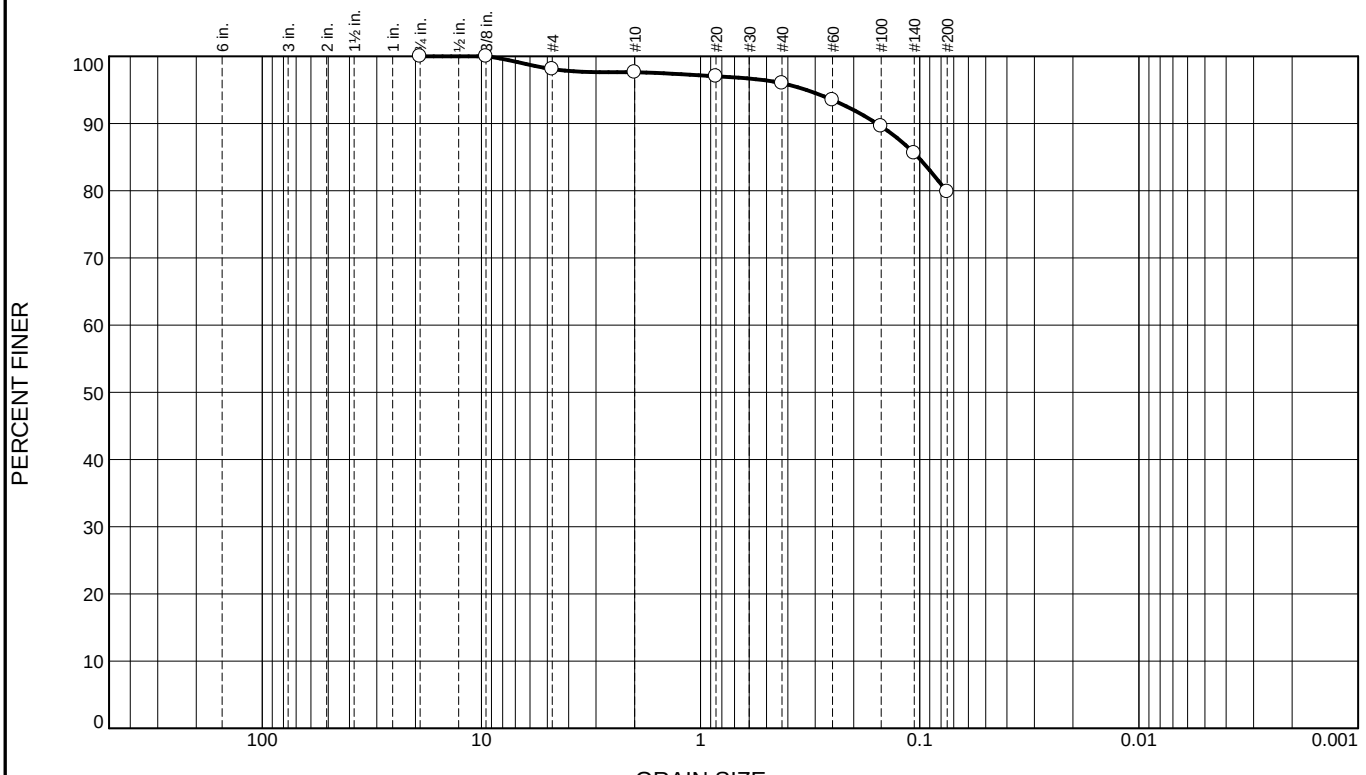
Note that the requirements for coefficient of uniformity apply only to the coarse and fine limits of the design filter band. It is possible that an individual, acceptable filter whose gradation plots completely within the specified limits could have a coefficient of uniformity greater than 6 and still be perfectly acceptable. The design steps of this procedure will prevent acceptance of gap-graded filters, which is the main concern associated with filters having a high coefficient of uniformity, and it is not necessary to closely examine the coefficient of uniformity of a particular filter as long as it plots within the design filter band.

Illustrations of these filter design steps are in the following examples. The steps in the filter design process are summarized in appendix 26A. The summary is useful to follow as the example problems are reviewed.

REFERENCE 2

Particle Size Analyses of Ash, 2014-2015.

Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.9	0.5	1.6	16.2	79.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
3/8	100.0		
#4	98.1		
#10	97.6		
#20	97.0		
#40	96.0		
#60	93.5		
#100	89.6		
#140	85.6		
#200	79.8		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.1569 D_{85}= 0.1019 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Ash Fill 1

Source of Sample: B316 **Depth:** 1' - 10'
Sample Number: B316 **Date:** 12-12-14

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

12/18/2014

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B316
Depth: 1' - 10'
Sample Number: B316
Material Description: Black CCR Material
Date: 12-12-14 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML
AASHTO Classification: A-4(0)
Testing Remarks: Ash from Ash Fill 1
Tested by: D. Kopitsky
Checked by: T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
154.91	0.00	0.00	3/4	0.00	100.0
			3/8	0.00	100.0
			#4	2.95	98.1
			#10	3.70	97.6
			#20	4.63	97.0
			#40	6.22	96.0
			#60	10.07	93.5
			#100	16.14	89.6
			#140	22.34	85.6
			#200	31.22	79.8

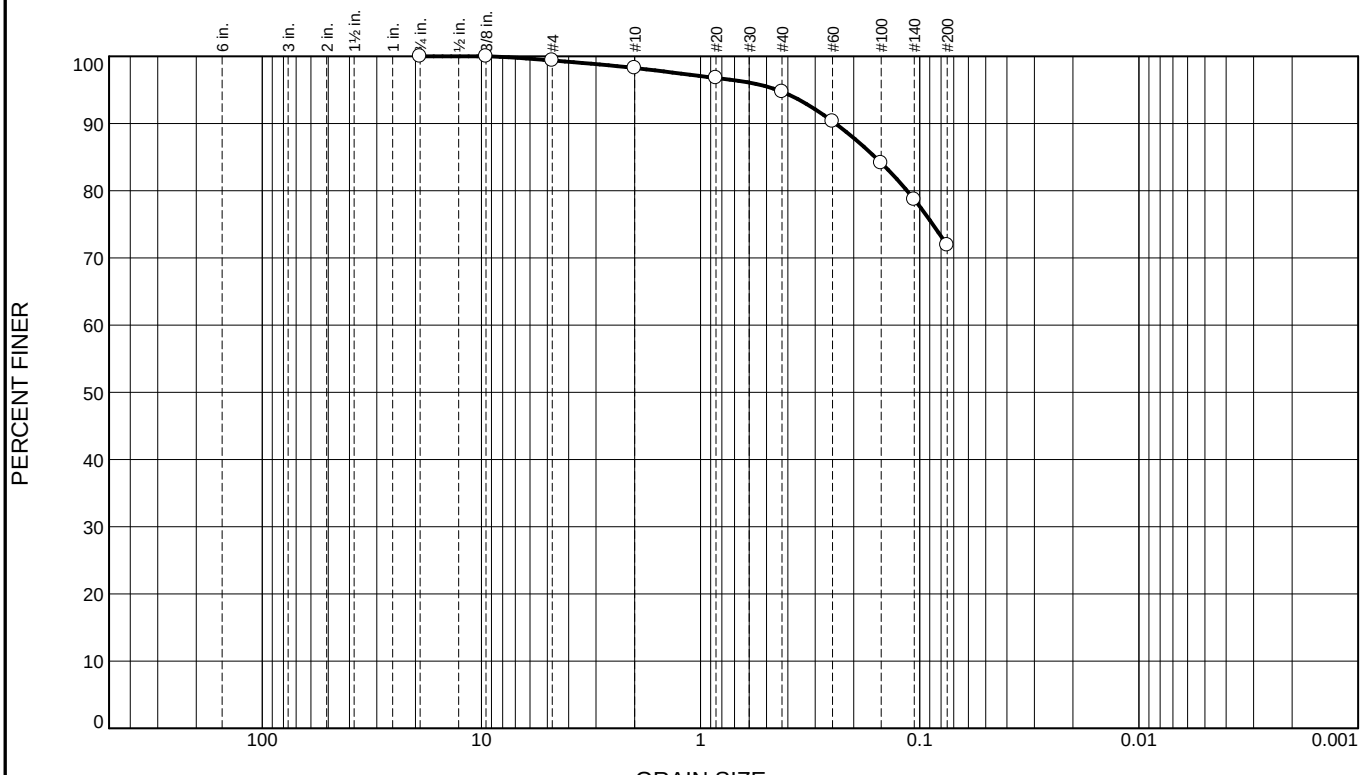
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	1.9	1.9	0.5	1.6	16.2	18.3			79.8

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
						0.0757	0.1019	0.1569	0.3294

Fineness Modulus
0.26

Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.6	1.1	3.6	22.8	71.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
3/8	100.0		
#4	99.4		
#10	98.3		
#20	96.8		
#40	94.7		
#60	90.3		
#100	84.1		
#140	78.7		
#200	71.9		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.2426 D_{85}= 0.1598 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Ash Fill 2 (wet)

Source of Sample: B317 **Depth:** 18.5 - 20
Sample Number: B317 **Date:** 12-12-14

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

12/18/2014

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B317
Depth: 18.5 - 20 **Sample Number:** B317
Material Description: Black CCR Material
Date: 12-12-14 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Testing Remarks: Ash from Ash Fill 2 (wet)
Tested by: D. Kopitsky **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
86.66	0.00	0.00	3/4	0.00	100.0
			3/8	0.00	100.0
			#4	0.54	99.4
			#10	1.51	98.3
			#20	2.80	96.8
			#40	4.57	94.7
			#60	8.39	90.3
			#100	13.75	84.1
			#140	18.46	78.7
			#200	24.34	71.9

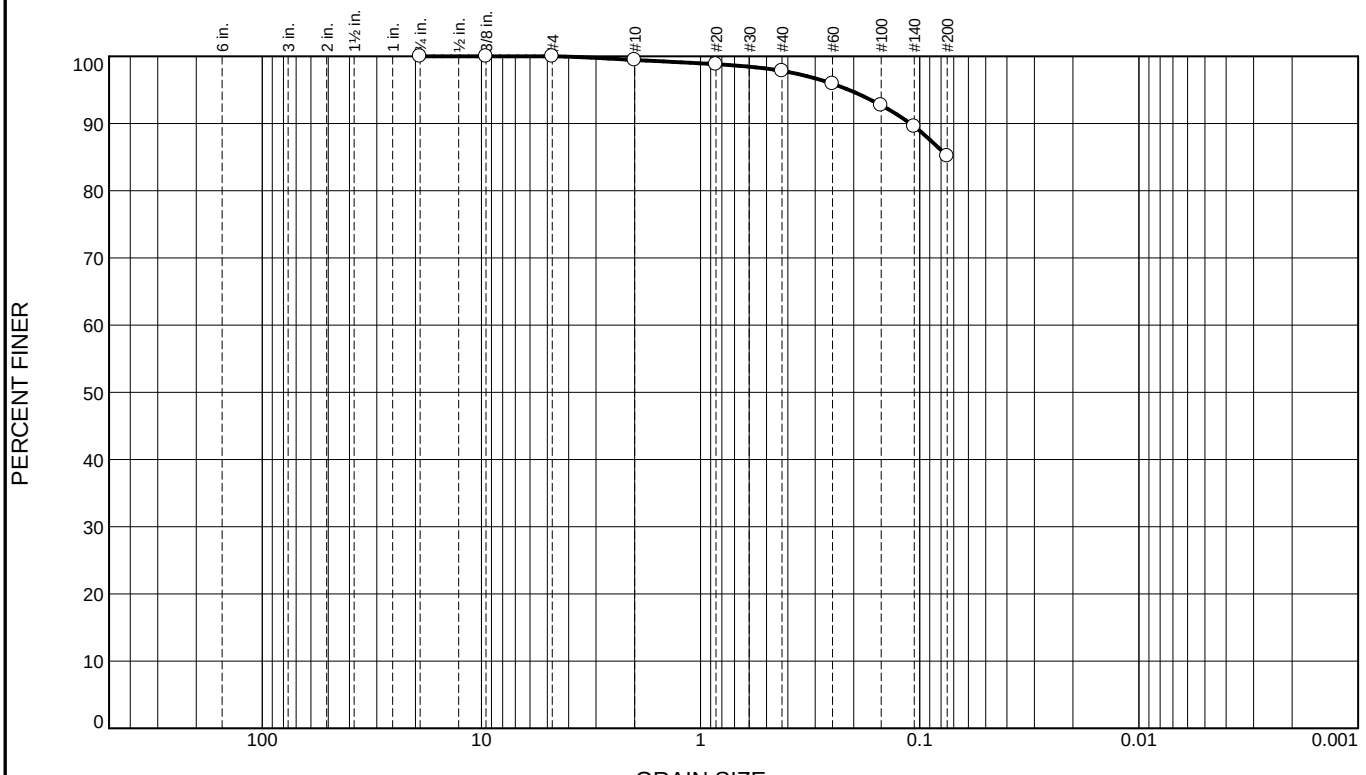
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.6	0.6	1.1	3.6	22.8	27.5			71.9

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
						0.1143	0.1598	0.2426	0.4473

Fineness Modulus
0.32

Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.6	1.6	12.6	85.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
3/8	100.0		
#4	100.0		
#10	99.4		
#20	98.8		
#40	97.8		
#60	95.9		
#100	92.7		
#140	89.6		
#200	85.2		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.1104 D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Ash Fill 2
Specific Gravity = 2.258

Source of Sample: B318 **Depth:** 8.5 - 10
Sample Number: B318 **Date:** 12-12-14

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

12/29/2014

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B318
Depth: 8.5 - 10 **Sample Number:** B318
Material Description: Black CCR Material
Date: 12-12-14 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Testing Remarks: Ash from Ash Fill 2
Specific Gravity = 2.258
Tested by: D. Kopitsky **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
121.16	0.00	0.00	3/4	0.00	100.0
			3/8	0.00	100.0
			#4	0.00	100.0
			#10	0.67	99.4
			#20	1.43	98.8
			#40	2.64	97.8
			#60	4.95	95.9
			#100	8.83	92.7
			#140	12.65	89.6
			#200	17.97	85.2

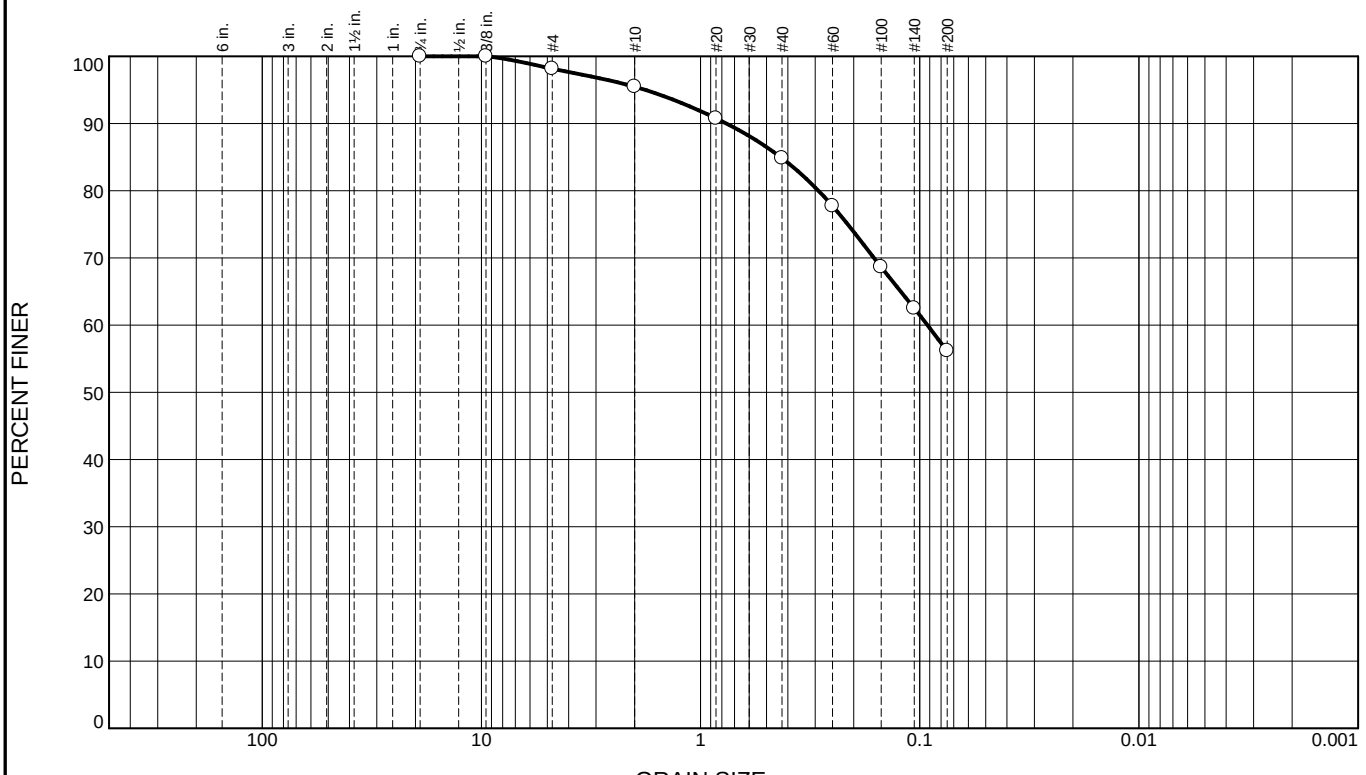
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.6	1.6	12.6	14.8			85.2

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
								0.1104	0.2108

Fineness Modulus
0.13

Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.9	2.6	10.7	28.6	56.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
3/8	100.0		
#4	98.1		
#10	95.5		
#20	90.8		
#40	84.8		
#60	77.7		
#100	68.6		
#140	62.5		
#200	56.2		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.7636 D_{85}= 0.4315 D_{60}= 0.0923
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Ash Fill 2
Specific Gravity = 2.277

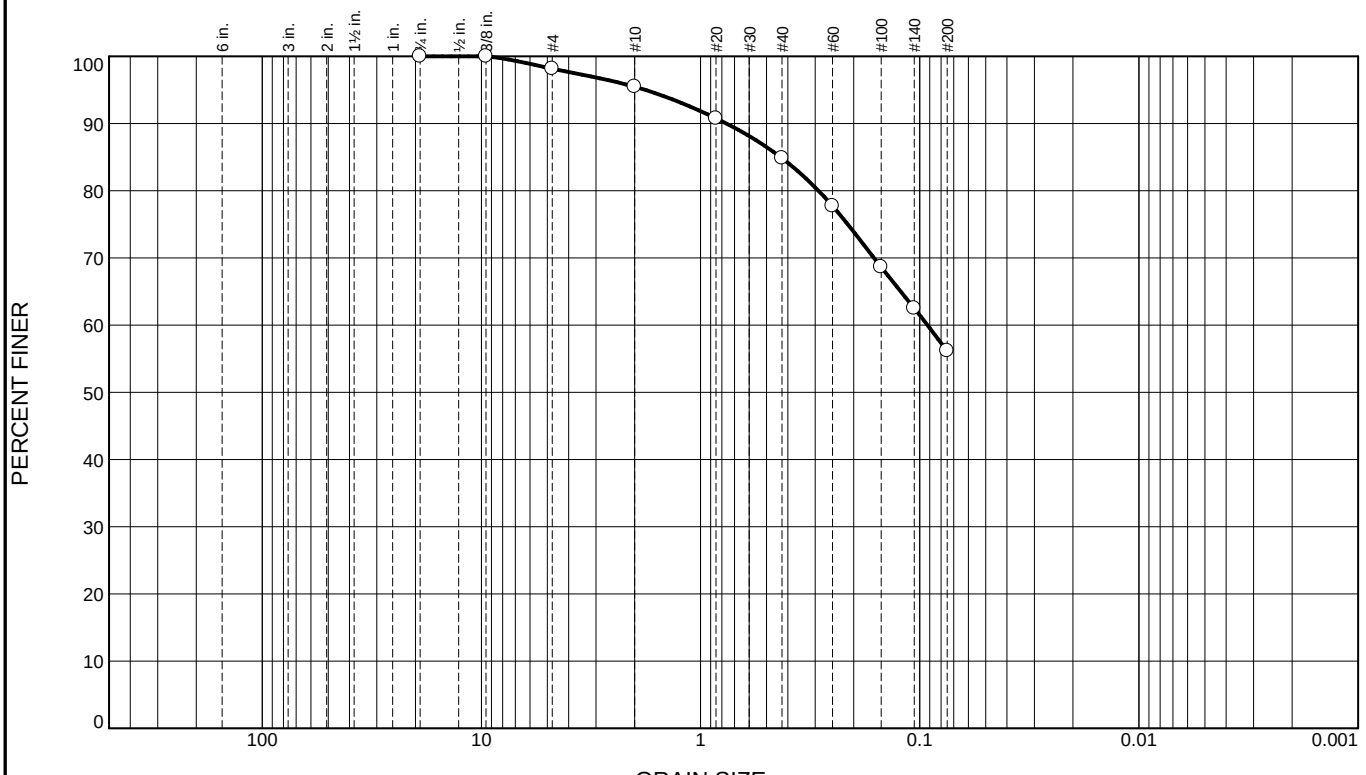
Source of Sample: B318 **Depth:** 23.5 - 25
Sample Number: B318 **Date:** 12-12-14

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.9	2.6	10.7	28.6	56.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
3/8	100.0		
#4	98.1		
#10	95.5		
#20	90.8		
#40	84.8		
#60	77.7		
#100	68.6		
#140	62.5		
#200	56.2		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.7636 D_{85}= 0.4315 D_{60}= 0.0923
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Ash Fill 2
Specific Gravity = 2.277

Source of Sample: B318 **Depth:** 23.5 - 25
Sample Number: B318 **Date:** 12-12-14

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

12/18/2014

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B318
Depth: 23.5 - 25 **Sample Number:** B318
Material Description: Black CCR Material
Date: 12-12-14 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Testing Remarks: Ash from Ash Fill 2
Specific Gravity = 2.277
Tested by: D. Kopitsky **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
124.83	0.00	0.00	3/4	0.00	100.0
			3/8	0.00	100.0
			#4	2.31	98.1
			#10	5.66	95.5
			#20	11.54	90.8
			#40	18.93	84.8
			#60	27.82	77.7
			#100	39.16	68.6
			#140	46.81	62.5
			#200	54.72	56.2

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	1.9	1.9	2.6	10.7	28.6	41.9			56.2

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.0923	0.2900	0.4315	0.7636	1.7901

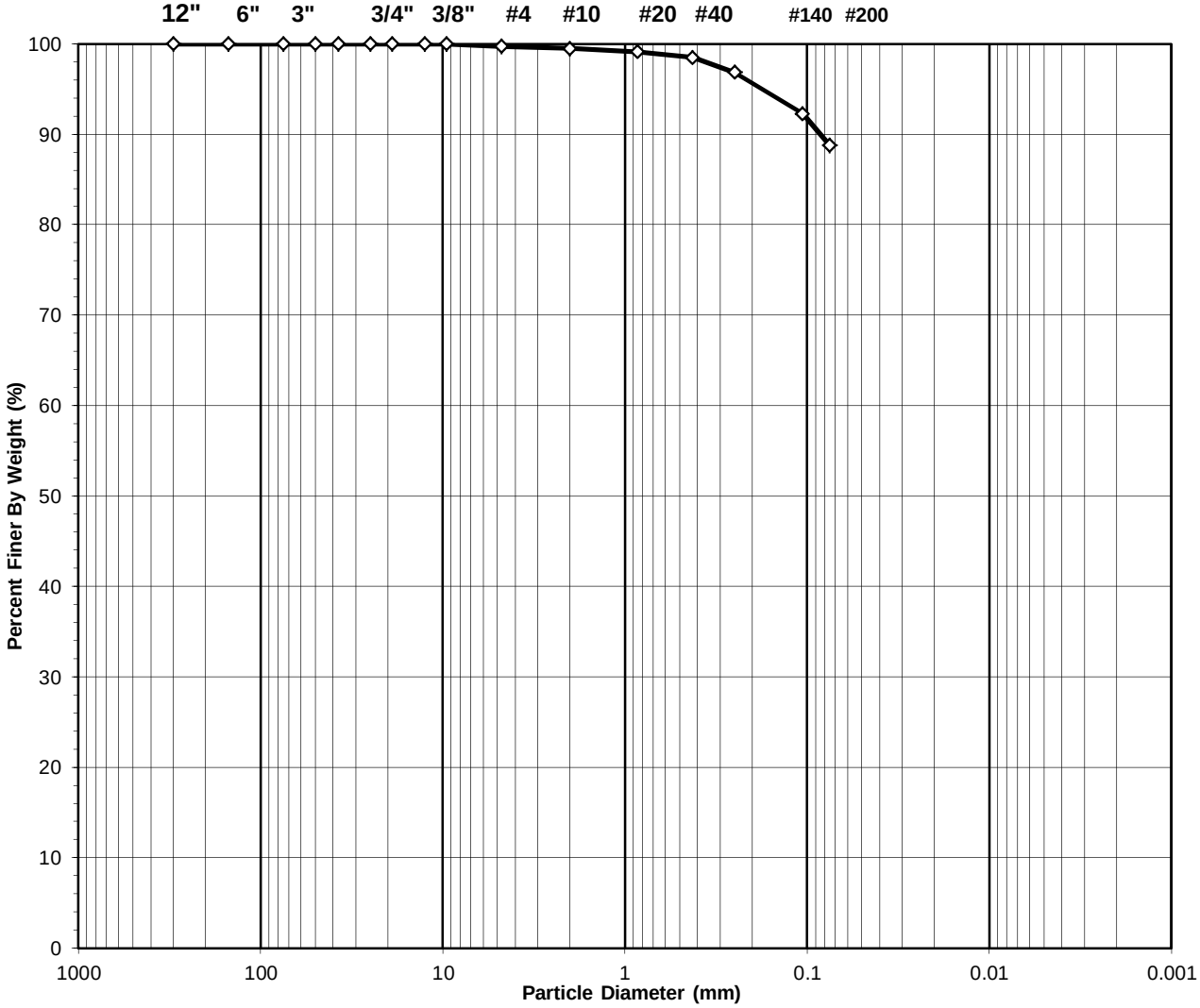
Fineness Modulus
0.76

SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client:	AMEC FOSTER WHEELER	Boring No.:	B319
Client Reference:	DAN RIVER Steam Station Ash Removal	Depth (ft):	10-20
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-01	Soil Color:	BLACK

	SIEVE ANALYSIS		*HYDROMETER*
USCS	**gravel**	**sand**	**silt and clay**



USCS Symbol: ***ML, TESTED (NON PLASTIC FINES)***

USCS Classification SILT

Tested By SFS Date 12/12/14 Checked By GEM Date 12/15/14

DCN: CT-S3C DATE 3/20/13 REVISION: 3

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client:	AMEC FOSTER WHEELER	Boring No.:	B319
Client Reference:	DAN RIVER Steam Station Ash Removal	Depth (ft):	10-20
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-01	Soil Color:	BLACK

Moisture Content of Passing 3/4" Sample		Water Content of Retained 3/4" Sample	
Tare No.	831	Tare No.	NA
Wt. of Tare & Wet Sample (g)	857.21	Weight of Tare & Wet Sample (g)	NA
Wt. of Tare & Dry Sample (g)	689.59	Weight of Tare & Dry Sample (g)	NA
Weight of Tare (g)	262.48	Weight of Tare (g)	NA
Weight of Water (g)	167.62	Weight of Water (g)	NA
Weight of Dry Sample (g)	427.11	Weight of Dry Sample (g)	NA
Moisture Content (%)	**39.2**	**Moisture Content (%)**	**NA**

Wet Weight of -3/4" Sample (g)	NA	Weight of the Dry Sample (g)	427.11
Dry Weight of - 3/4" Sample (g)	48.0	Weight of - #200 Sample (g)	379.07
Wet Weight of +3/4" Sample (g	NA	Weight of + #200 Sample (g)	48.04
Dry Weight of + 3/4" Sample (g	0.00		
Total Dry Weight of Sample (g)	NA		

Sieve Size	Sieve Opening (mm)	Weight of Soil Retained (g)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	Accumulated Percent Finer (%)
12"	300	0.00	0.00	0.00	100.00	**100.00**
6"	150	0.00	0.00	0.00	100.00	**100.00**
3"	75	0.00	0.00	0.00	100.00	**100.00**
2"	50	0.00	0.00	0.00	100.00	**100.00**
1 1/2"	37.5	0.00	0.00	0.00	100.00	**100.00**
1"	25.0	0.00	0.00	0.00	100.00	**100.00**
3/4"	19.0	0.00	0.00	0.00	100.00	**100.00**
1/2"	12.50	0.00	0.00	0.00	100.00	**100.00**
3/8"	9.50	0.00	0.00	0.00	100.00	**100.00**
#4	4.75	1.15	0.27	0.27	99.73	**99.73**
#10	2.00	1.07	0.25	0.52	99.48	**99.48**
#20	0.850	1.50	0.35	0.87	99.13	**99.13**
#40	0.425	2.76	0.65	1.52	98.48	**98.48**
#60	0.250	6.98	1.63	3.15	96.85	**96.85**
#140	0.106	19.62	4.59	7.75	92.25	**92.25**
#200	0.075	14.96	3.50	11.25	88.75	**88.75**
Pan	-	379.07	88.75	100.00	-	**-**

Tested By SFS Date 12/12/14 Checked By GEM Date 12/15/14

DCN: CT-S3C DATE 3/20/13 REVISION: 3

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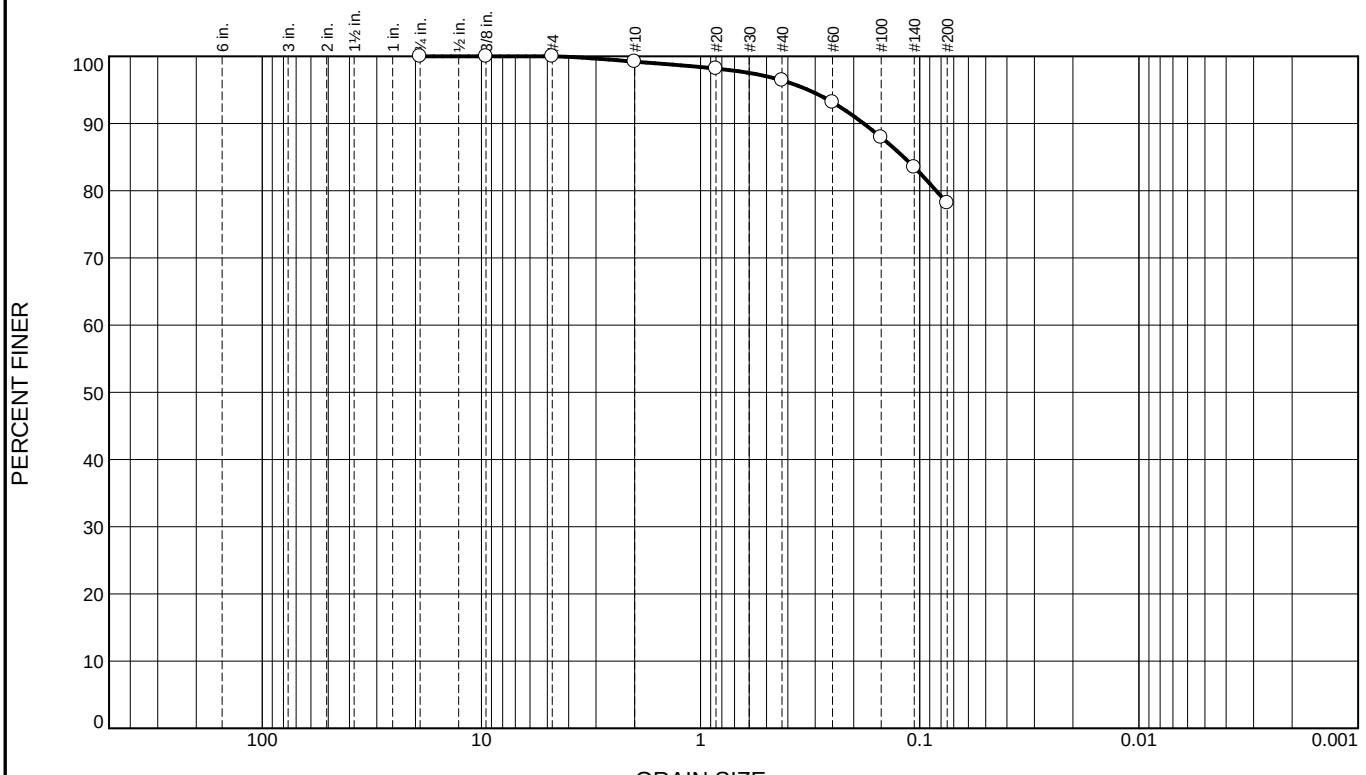
Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.8	2.8	18.2	78.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
3/8	100.0		
#4	100.0		
#10	99.2		
#20	98.2		
#40	96.4		
#60	93.1		
#100	87.9		
#140	83.5		
#200	78.2		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.1803 D_{85}= 0.1184 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Ash Fill 1

Source of Sample: B320 **Depth:** 58.5 - 60
Sample Number: SS-14 **Date:** 12-12-14

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

12/29/2014

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B320
Depth: 58.5 - 60 **Sample Number:** SS-14
Material Description: Black CCR Material
Date: 12-12-14 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Testing Remarks: Ash from Ash Fill 1
Tested by: D. Kopitsky **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
106.36	0.00	0.00	3/4	0.00	100.0
			3/8	0.00	100.0
			#4	0.00	100.0
			#10	0.85	99.2
			#20	1.95	98.2
			#40	3.81	96.4
			#60	7.29	93.1
			#100	12.84	87.9
			#140	17.56	83.5
			#200	23.23	78.2

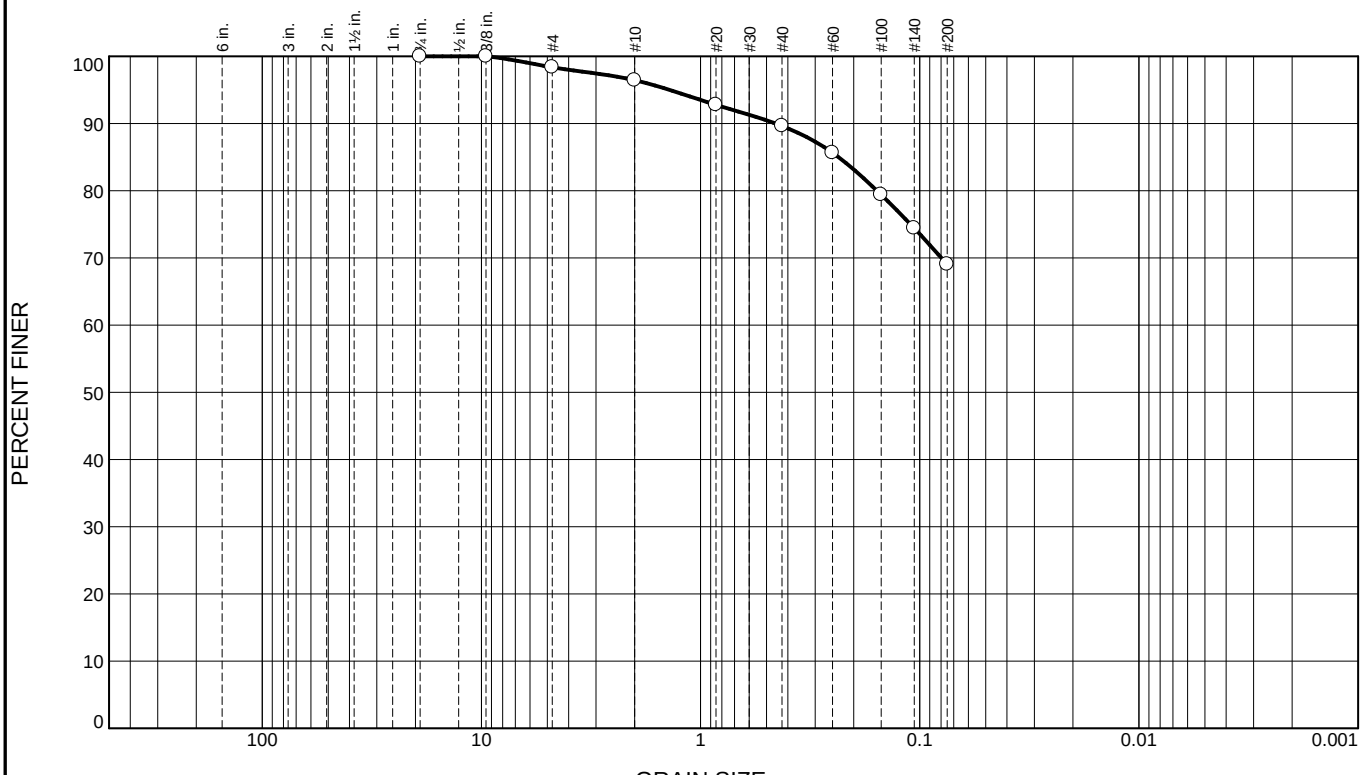
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.8	2.8	18.2	21.8			78.2

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
						0.0842	0.1184	0.1803	0.3230

Fineness Modulus
0.22

Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.6	2.0	6.8	20.5	69.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
3/8	100.0		
#4	98.4		
#10	96.4		
#20	92.8		
#40	89.6		
#60	85.6		
#100	79.4		
#140	74.4		
#200	69.1		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= 29 LL= 38 PI= 9

Coefficients

D_{90}= 0.4558 D_{85}= 0.2350 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(6)

Remarks

Ash from Ash Fill 2
Specific Gravity = 2.412

Source of Sample: B322 **Depth:** 38.5 - 48.5
Sample Number: B322 **Date:** 12-9-14

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

12/18/2014

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B322
Depth: 38.5 - 48.5 **Sample Number:** B322
Material Description: Black CCR Material
Date: 12-9-14 **PL:** 29 **LL:** 38 **PI:** 9
USCS Classification: ML **AASHTO Classification:** A-4(6)
Testing Remarks: Ash from Ash Fill 2
Specific Gravity = 2.412
Tested by: D. Kopitsky **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
128.58	0.00	0.00	3/4	0.00	100.0
			3/8	0.00	100.0
			#4	2.10	98.4
			#10	4.58	96.4
			#20	9.30	92.8
			#40	13.34	89.6
			#60	18.46	85.6
			#100	26.50	79.4
			#140	32.89	74.4
			#200	39.79	69.1

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	1.6	1.6	2.0	6.8	20.5	29.3			69.1

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
						0.1569	0.2350	0.4558	1.3850

Fineness Modulus
0.52

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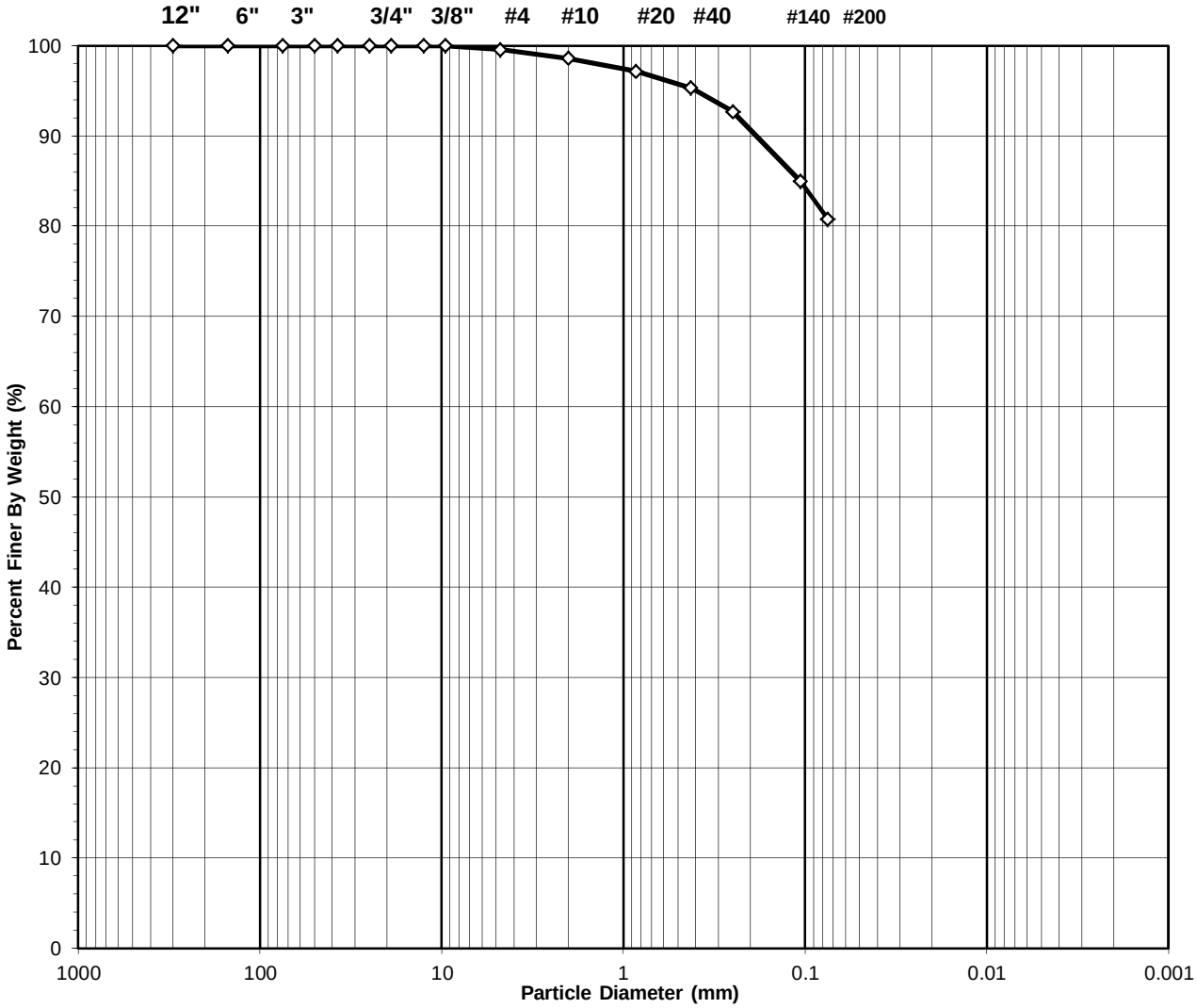
SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client:	AMEC FOSTER WHEELER	Boring No.:	B322
Client Reference:	DAN RIVER Steam Station Ash Removal	Depth (ft):	48.6-58.5
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-02	Soil Color:	BLACK

	SIEVE ANALYSIS		*HYDROMETER*
USCS	**gravel**	**sand**	**silt and clay**



USCS Symbol: ***ML, TESTED***

USCS Classification SILT WITH SAND

Tested By SFS Date 12/12/14 Checked By GEM Date 12/16/14

 DCN: CT-S3C DATE 3/20/13 REVISION: 3

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client:	AMEC FOSTER WHEELER	Boring No.:	B322
Client Reference:	DAN RIVER Steam Station Ash Removal	Depth (ft):	48.6-58.5
Project No.:	2014-813-01	Sample No.:	BULK
Lab ID:	2014-813-01-02	Soil Color:	BLACK

Moisture Content of Passing 3/4" Sample		Water Content of Retained 3/4" Sample	
Tare No.	842	Tare No.	NA
Wt. of Tare & Wet Sample (g)	1243.40	Weight of Tare & Wet Sample (g)	NA
Wt. of Tare & Dry Sample (g)	999.93	Weight of Tare & Dry Sample (g)	NA
Weight of Tare (g)	256.05	Weight of Tare (g)	NA
Weight of Water (g)	243.47	Weight of Water (g)	NA
Weight of Dry Sample (g)	743.88	Weight of Dry Sample (g)	NA
Moisture Content (%)	**32.7**	**Moisture Content (%)**	**NA**

Wet Weight of -3/4" Sample (g)	NA	Weight of the Dry Sample (g)	743.88
Dry Weight of - 3/4" Sample (g)	142.9	Weight of - #200 Sample (g)	600.94
Wet Weight of +3/4" Sample (g	NA	Weight of + #200 Sample (g)	142.94
Dry Weight of + 3/4" Sample (g	0.00		
Total Dry Weight of Sample (g)	NA		

Sieve Size	Sieve Opening (mm)	Weight of Soil Retained (g)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	Accumulated Percent Finer (%)
12"	300	0.00	0.00	0.00	100.00	**100.00**
6"	150	0.00	0.00	0.00	100.00	**100.00**
3"	75	0.00	0.00	0.00	100.00	**100.00**
2"	50	0.00	0.00	0.00	100.00	**100.00**
1 1/2"	37.5	0.00	0.00	0.00	100.00	**100.00**
1"	25.0	0.00	0.00	0.00	100.00	**100.00**
3/4"	19.0	0.00	0.00	0.00	100.00	**100.00**
1/2"	12.50	0.00	0.00	0.00	100.00	**100.00**
3/8"	9.50	0.00	0.00	0.00	100.00	**100.00**
#4	4.75	3.41	0.46	0.46	99.54	**99.54**
#10	2.00	7.03	0.95	1.40	98.60	**98.60**
#20	0.850	10.84	1.46	2.86	97.14	**97.14**
#40	0.425	13.56	1.82	4.68	95.32	**95.32**
#60	0.250	19.73	2.65	7.34	92.66	**92.66**
#140	0.106	57.41	7.72	15.05	84.95	**84.95**
#200	0.075	30.96	4.16	19.22	80.78	**80.78**
Pan	-	600.94	80.78	100.00	-	**-**

Tested By SFS Date 12/12/14 Checked By GEM Date 12/16/14

DCN: CT-S3C DATE 3/20/13 REVISION: 3

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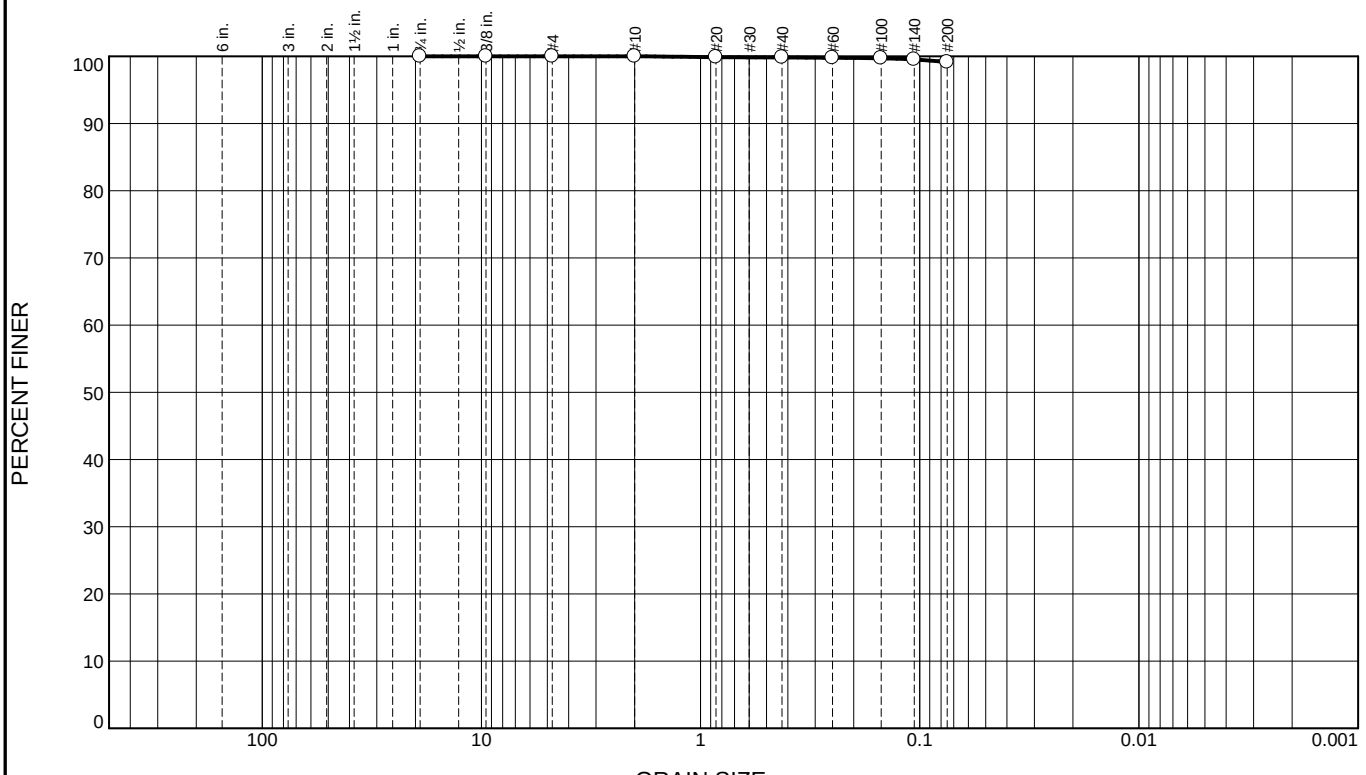
Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	0.7	99.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
3/8	100.0		
#4	100.0		
#10	100.0		
#20	99.9		
#40	99.8		
#60	99.8		
#100	99.7		
#140	99.5		
#200	99.1		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Ash Fill 1

Source of Sample: B322 **Depth:** 68.5 - 70
Sample Number: SS-16 **Date:** 12-12-14

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

12/29/2014

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B322
Depth: 68.5 - 70 **Sample Number:** SS-16
Material Description: Black CCR Material
Date: 12-12-14 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Testing Remarks: Ash from Ash Fill 1
Tested by: D. Kopitsky **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
82.91	0.00	0.00	3/4	0.00	100.0
			3/8	0.00	100.0
			#4	0.00	100.0
			#10	0.00	100.0
			#20	0.11	99.9
			#40	0.15	99.8
			#60	0.19	99.8
			#100	0.25	99.7
			#140	0.39	99.5
			#200	0.72	99.1

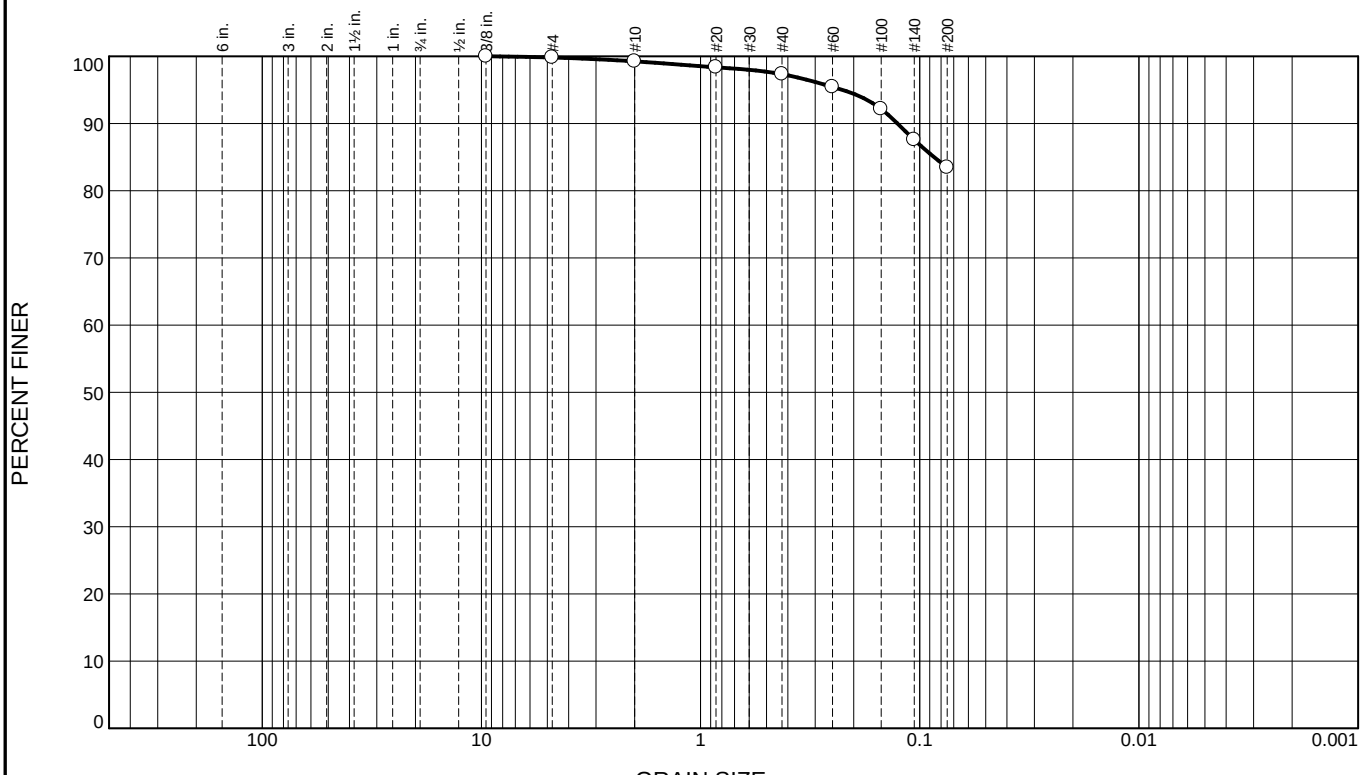
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.2	0.7	0.9			99.1

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}

Fineness Modulus
0.01

Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.6	1.9	13.8	83.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.8		
#10	99.2		
#20	98.4		
#40	97.3		
#60	95.4		
#100	92.2		
#140	87.6		
#200	83.5		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.1264 D_{85}= 0.0860 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Ash Fill 1
Specific Gravity = 2.226

Source of Sample: B324 **Depth:** 25 - 35

Date: 1-7-15

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal

Project No: 7810140065 **Figure**

Tested By: M. Hamilton **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

1/15/2015

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B324
Depth: 25 - 35
Material Description: Black CCR Material
Date: 1-7-15 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Testing Remarks: Ash from Ash Fill 1
Specific Gravity = 2.226
Tested by: M. Hamilton **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
123.51	0.00	0.00	3/4		
			3/8	0.00	100.0
			#4	0.23	99.8
			#10	0.93	99.2
			#20	2.03	98.4
			#40	3.29	97.3
			#60	5.63	95.4
			#100	9.69	92.2
			#140	15.36	87.6
			#200	20.43	83.5

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.2	0.2	0.6	1.9	13.8	16.3			83.5

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
							0.0860	0.1264	0.2253

Fineness Modulus
0.16

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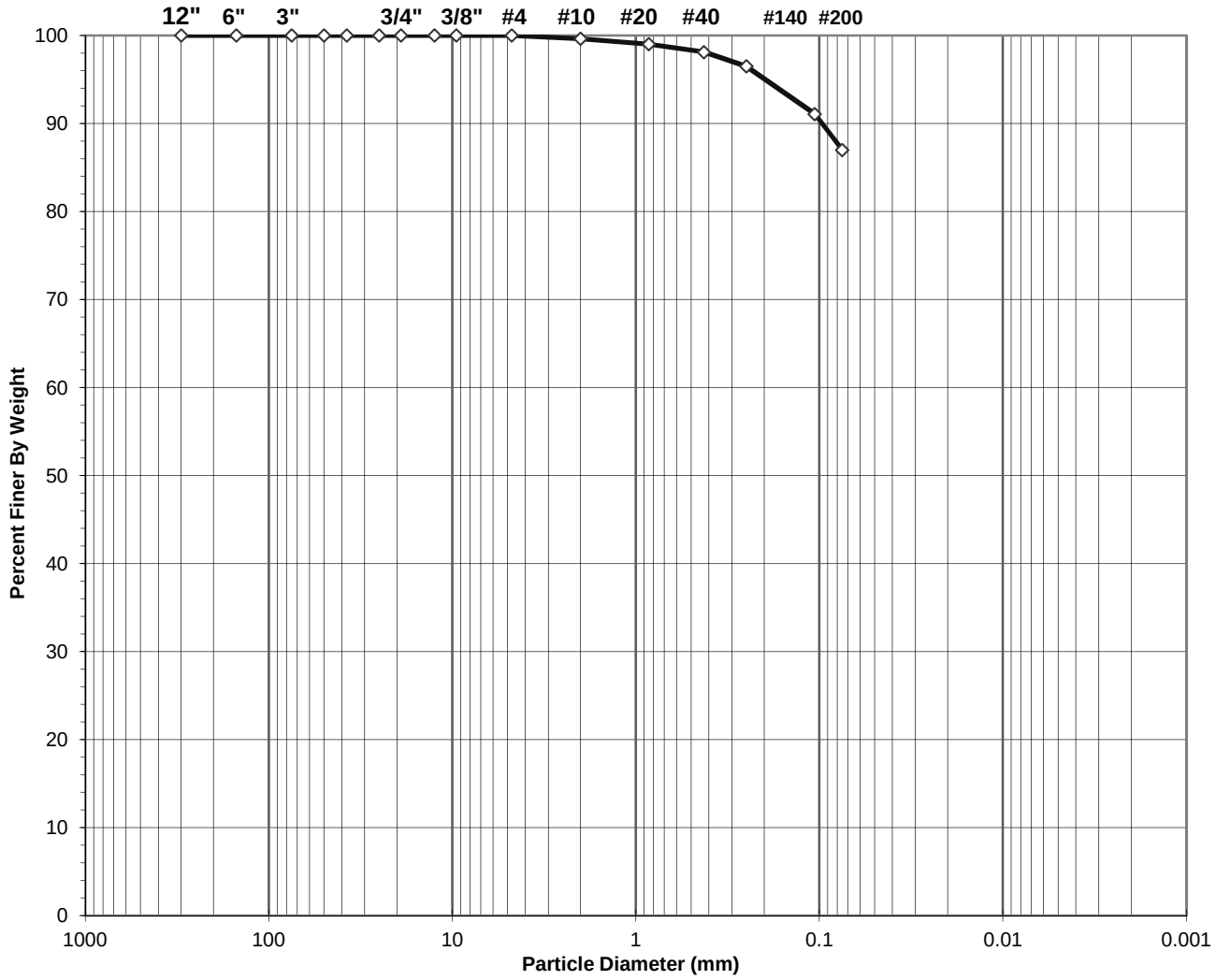
SIEVE ANALYSIS
ASTM D 422-63 (2007)

Client	AMEC FOSTER WHEELER	Boring No.	B324
Client Reference	Dan River Steam Station Ash Removal	Depth (ft)	25-35
Project No.	2014-813-02	Sample No.	BULK
Lab ID	2014-813-02-01	Soil Color	**GRAY**

	SIEVE ANALYSIS		*HYDROMETER*
USCS	**gravel**	**sand**	**silt and clay**



USCS Symbol ***ML, TESTED***

USCS Classification SILT

Tested By BW Date 1/8/15 Checked By GEM Date 1/12/15

DCN: CT-S3C DATE 6-25-98 REVISION: 2 *T:\2014 PROJECTS\2014-813 AMEC - DAN RIVER STEAM\[2014-813-02-01 SIEVON REV 4.xls]Sheet1*

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	AMEC FOSTER WHEELER	Boring No.	B324
Client Reference	Dan River Steam Station Ash Removal	Depth (ft)	25-35
Project No.	2014-813-02	Sample No.	BULK
Lab ID	2014-813-02-01	Soil Color	**GRAY**

Moisture Content of Passing 3/4" Material		Water Content of Retained 3/4" Material	
Tare No.	838	Tare No.	NA
Wgt.Tare + Wet Specimen (gm)	610.93	Wgt.Tare + Wet Specimen (gm)	NA
Wgt.Tare + Dry Specimen (gm)	521.94	Wgt.Tare + Dry Specimen (gm)	NA
Weight of Tare (gm)	261.93	Weight of Tare (gm)	NA
Weight of Water (gm)	88.99	Weight of Water (gm)	NA
Weight of Dry Soil (gm)	260.01	Weight of Dry Soil (gm)	NA
Moisture Content (%)	**34.2**	**Moisture Content (%)**	**NA**

Wet Weight -3/4" Sample (gm)	NA	Weight of the Dry Specimen (gm)	260.01
Dry Weight - 3/4" Sample (gm)	33.8	Weight of minus #200 material (gm)	226.19
Wet Weight +3/4" Sample (gm)	NA	Weight of plus #200 material (gm)	33.82
Dry Weight + 3/4" Sample (gm)	0.00		
Total Dry Weight Sample (gm)	NA		

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.0	0.0	100.0	**100.0**
6"	150	0.00	0.0	0.0	100.0	**100.0**
3"	75	0.00	0.0	0.0	100.0	**100.0**
2"	50	0.00	0.0	0.0	100.0	**100.0**
1 1/2"	37.5	0.00	0.0	0.0	100.0	**100.0**
1"	25.0	0.00	0.0	0.0	100.0	**100.0**
3/4"	19.0	0.00	0.0	0.0	100.0	**100.0**
1/2"	12.50	0.00	0.0	0.0	100.0	**100.0**
3/8"	9.50	0.00	0.0	0.0	100.0	**100.0**
#4	4.75	0.00	0.0	0.0	100.0	**100.0**
#10	2.00	0.95	0.4	0.4	99.6	**99.6**
#20	0.850	1.61	0.6	1.0	99.0	**99.0**
#40	0.425	2.32	0.9	1.9	98.1	**98.1**
#60	0.250	4.22	1.6	3.5	96.5	**96.5**
#140	0.106	14.10	5.4	8.9	91.1	**91.1**
#200	0.075	10.62	4.1	13.0	87.0	**87.0**
Pan	-	226.19	87.0	100.0	-	**-**

Tested By BW Date 1/8/15 Checked By GEM Date 1/12/15

DCN: CT-S3C DATE 6-25-98 REVISION: 2 *T:\2014 PROJECTS\2014-813 AMEC - DAN RIVER STEAM\[2014-813-02-01 SIEVON REV 4.xls]Sheet1*

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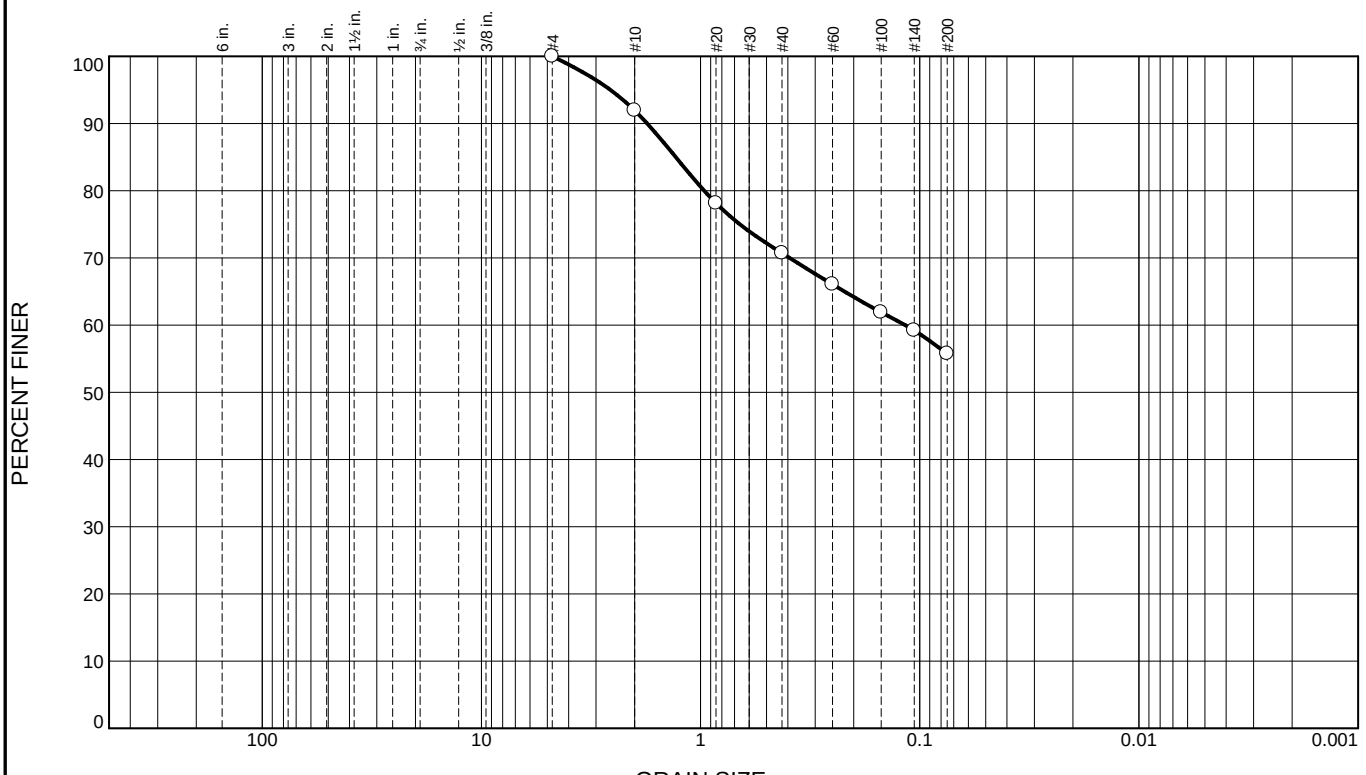
Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	8.1	21.2	15.0	55.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	91.9		
#20	78.1		
#40	70.7		
#60	66.1		
#100	61.9		
#140	59.2		
#200	55.7		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 1.7534 D_{85}= 1.2985 D_{60}= 0.1167
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Ash Fill 1

Source of Sample: B324 **Depth:** 43.5 - 45

Date: 1-7-15

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project No: 7810140065 **Figure**

Tested By: M. Hamilton **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

1/15/2015

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B324
Depth: 43.5 - 45
Material Description: Black CCR Material
Date: 1-7-15 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Testing Remarks: Ash from Ash Fill 1
Tested by: M. Hamilton **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
122.54	0.00	0.00	3/4		
			3/8		
			#4	0.00	100.0
			#10	9.88	91.9
			#20	26.80	78.1
			#40	35.90	70.7
			#60	41.60	66.1
			#100	46.68	61.9
			#140	50.00	59.2
			#200	54.23	55.7

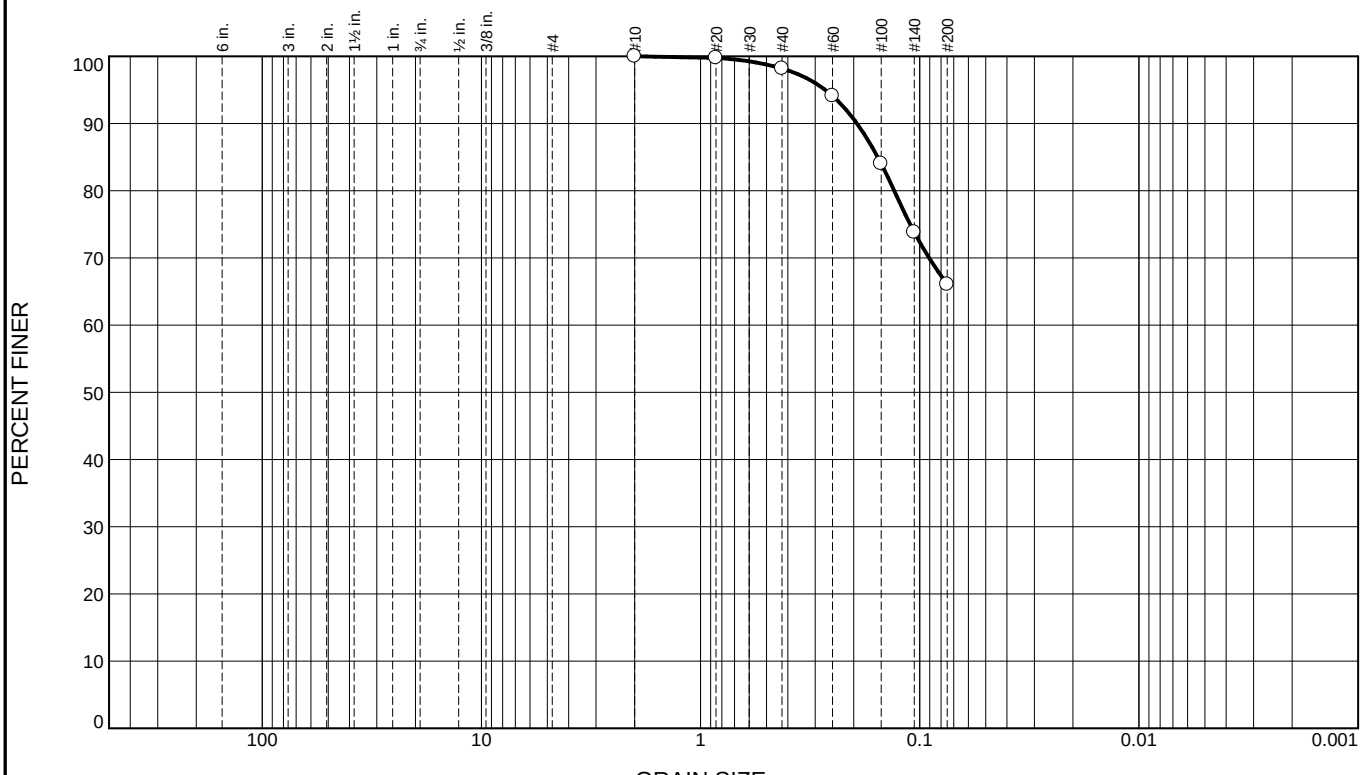
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	8.1	21.2	15.0	44.3			55.7

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.1167	0.9630	1.2985	1.7534	2.5806

Fineness Modulus
1.19

Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.8	32.2	66.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.8		
#40	98.2		
#60	94.1		
#100	84.0		
#140	73.8		
#200	66.0		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.1934 D_{85}= 0.1555 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash Underneath Intermediate Dike

Source of Sample: B327 **Depth:** 19 - 20.5

Date: 1-7-15

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project No: 7810140065 **Figure**

Tested By: M. Hamilton **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

1/15/2015

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B327
Depth: 19 - 20.5
Material Description: Black CCR Material
Date: 1-7-15 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Testing Remarks: Ash Underneath Intermediate Dike
Tested by: M. Hamilton **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
71.04	0.00	0.00	3/4		
			3/8		
			#4		
			#10	0.00	100.0
			#20	0.17	99.8
			#40	1.30	98.2
			#60	4.19	94.1
			#100	11.35	84.0
			#140	18.61	73.8
			#200	24.12	66.0

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	1.8	32.2	34.0			66.0

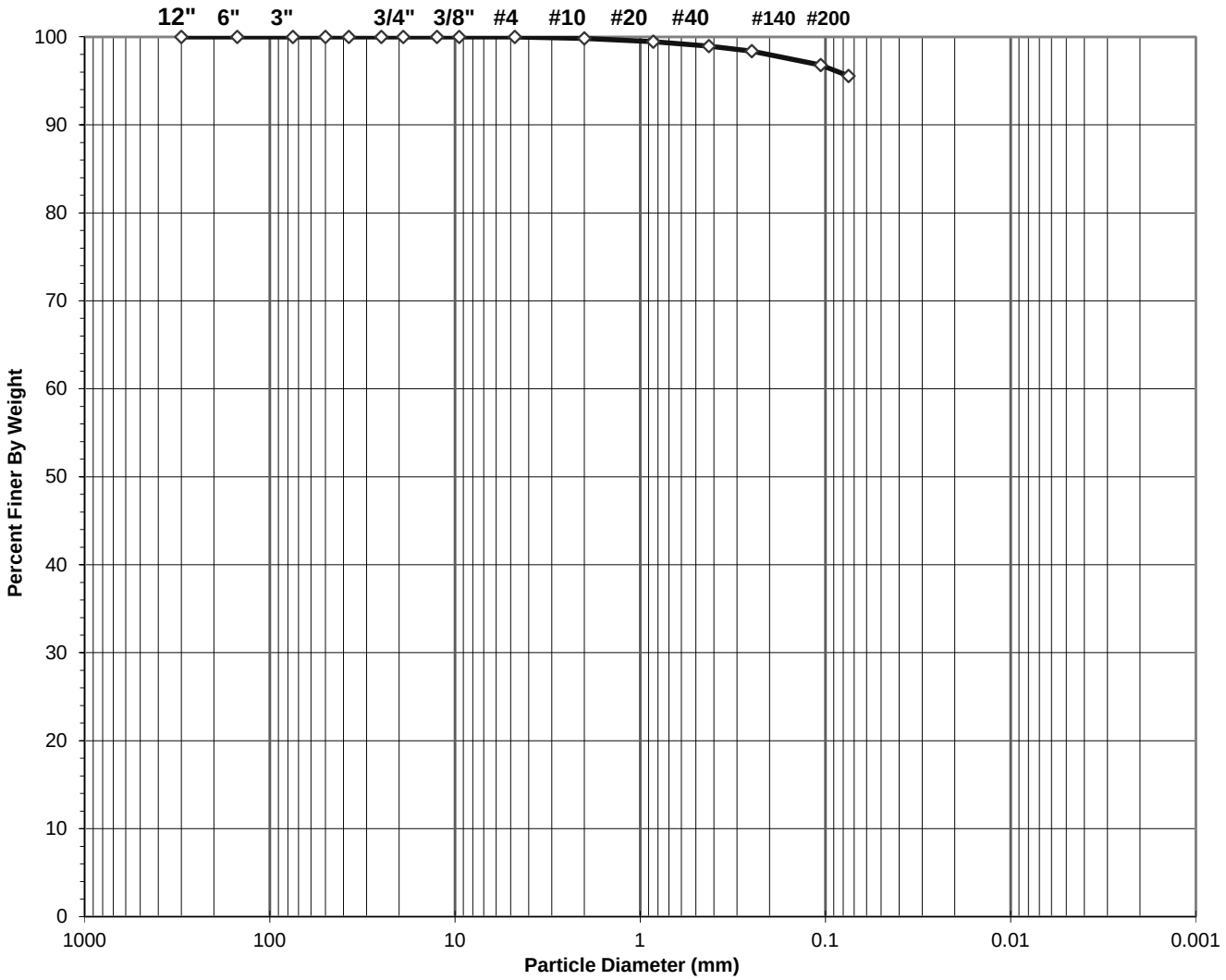
D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
						0.1308	0.1555	0.1934	0.2699

Fineness Modulus
0.21

SIEVE ANALYSIS
ASTM D 422-63 (2007)

Client	AMEC FOSTER WHEELER	Boring No.	B328
Client Reference	Dan River Steam Station Ash Removal	Depth (ft)	14.0-20.0
Project No.	2015-616-01	Sample No.	BULK
Lab ID	2015-616-01-01	Soil Color	**BLACK**

	SIEVE ANALYSIS		***HYDROMETER***
USCS	**gravel**	**sand**	**silt and clay**



USCS Symbol ***ML, TESTED***

USCS Classification ***SILT***

Tested By BW Date 2/11/15 Checked By GEM Date 2/13/15

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *Z:\2015 PROJECTS\2015-616 AMEC - DAN RIVER\[2015-616-01-01 SIEVON REV 4.xls]Sheet1*

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	AMEC FOSTER WHEELER	Boring No.	B328
Client Reference	Dan River Steam Station Ash Removal	Depth (ft)	14.0-20.0
Project No.	2015-616-01	Sample No.	BULK
Lab ID	2015-616-01-01	Soil Color	**BLACK**

Moisture Content of Passing 3/4" Material		Water Content of Retained 3/4" Material	
Tare No.	837	Tare No.	NA
Wgt.Tare + Wet Specimen (gm)	887.00	Wgt.Tare + Wet Specimen (gm)	NA
Wgt.Tare + Dry Specimen (gm)	722.15	Wgt.Tare + Dry Specimen (gm)	NA
Weight of Tare (gm)	260.82	Weight of Tare (gm)	NA
Weight of Water (gm)	164.85	Weight of Water (gm)	NA
Weight of Dry Soil (gm)	461.33	Weight of Dry Soil (gm)	NA
Moisture Content (%)	**35.7**	**Moisture Content (%)**	**NA**

Wet Weight -3/4" Sample (gm)	NA	Weight of the Dry Specimen (gm)	461.33
Dry Weight - 3/4" Sample (gm)	20.5	Weight of minus #200 material (gm)	440.88
Wet Weight +3/4" Sample (gm)	NA	Weight of plus #200 material (gm)	20.45
Dry Weight + 3/4" Sample (gm)	0.00		
Total Dry Weight Sample (gm)	NA		

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.0	0.0	100.0	**100.0**
6"	150	0.00	0.0	0.0	100.0	**100.0**
3"	75	0.00	0.0	0.0	100.0	**100.0**
2"	50	0.00	0.0	0.0	100.0	**100.0**
1 1/2"	37.5	0.00	0.0	0.0	100.0	**100.0**
1"	25.0	0.00	0.0	0.0	100.0	**100.0**
3/4"	19.0	0.00	0.0	0.0	100.0	**100.0**
1/2"	12.50	0.00	0.0	0.0	100.0	**100.0**
3/8"	9.50	0.00	0.0	0.0	100.0	**100.0**
#4	4.75	0.00	0.0	0.0	100.0	**100.0**
#10	2.00	0.81	0.2	0.2	99.8	**99.8**
#20	0.850	1.71	0.4	0.5	99.5	**99.5**
#40	0.425	2.34	0.5	1.1	98.9	**98.9**
#60	0.250	2.64	0.6	1.6	98.4	**98.4**
#140	0.106	7.32	1.6	3.2	96.8	**96.8**
#200	0.075	5.63	1.2	4.4	95.6	**95.6**
Pan	-	440.88	95.6	100.0	-	**-**

Tested By BW Date 2/11/15 Checked By GEM Date 2/13/15

DCN: CT-S3C DATE 6-25-98 REVISION: 2 *Z:\2015 PROJECTS\2015-616 AMEC - DAN RIVER\[2015-616-01-01 SIEVON REV 4.xls]Sheet1*

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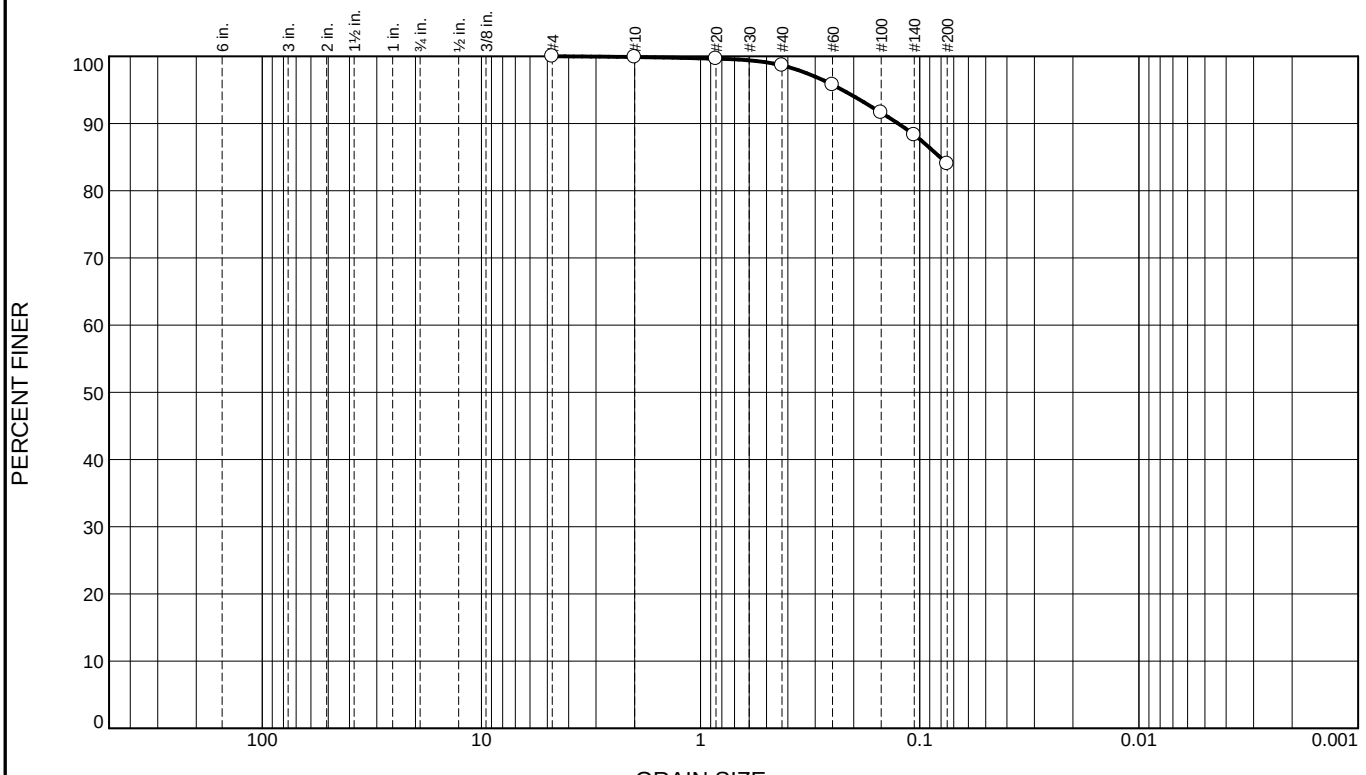
Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	1.3	14.6	84.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.6		
#40	98.6		
#60	95.8		
#100	91.6		
#140	88.3		
#200	84.0		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.1255 D_{85}= 0.0809 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Primary Ash Basin
Specific Gravity = 2.239

Source of Sample: B328 **Depth:** 20 - 29.5'

Date: 2-4-15

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal

Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

2/13/2015

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B328
Depth: 20 - 29.5'
Material Description: Black CCR Material
Date: 2-4-15 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Testing Remarks: Ash from Primary Ash Basin
Specific Gravity = 2.239
Tested by: D. Kopitsky **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
198.15	0.00	0.00	3/4		
			3/8		
			#4	0.00	100.0
			#10	0.22	99.9
			#20	0.73	99.6
			#40	2.69	98.6
			#60	8.40	95.8
			#100	16.64	91.6
			#140	23.19	88.3
			#200	31.69	84.0

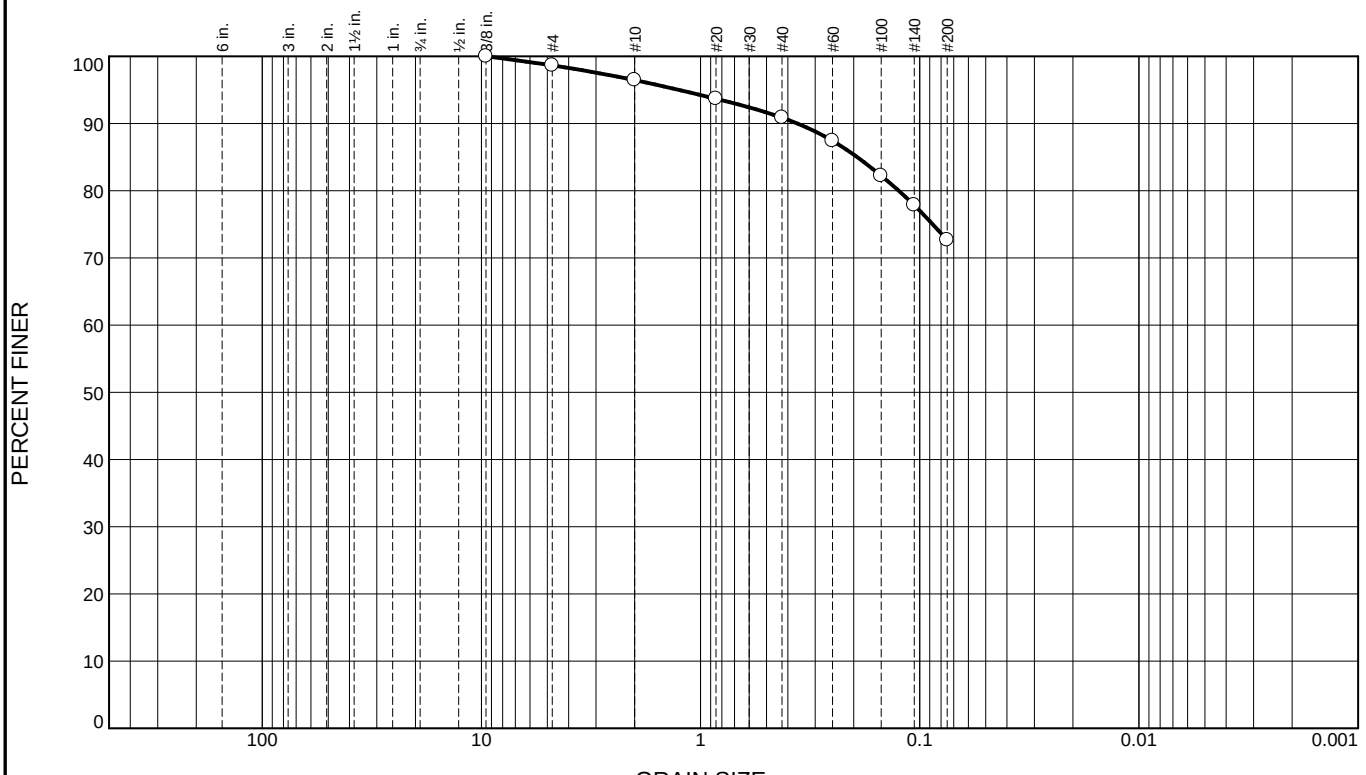
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.1	1.3	14.6	16.0			84.0

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
							0.0809	0.1255	0.2256

Fineness Modulus
0.12

Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.4	2.2	5.5	18.2	72.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	98.6		
#10	96.4		
#20	93.7		
#40	90.9		
#60	87.4		
#100	82.2		
#140	77.8		
#200	72.7		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= 30 LL= 38 PI= 8

Coefficients

D_{90}= 0.3620 D_{85}= 0.1931 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(6)

Remarks

Ash from Primary Ash Basin
Specific Gravity = 2.433

Source of Sample: B330 **Depth:** 0 - 10

Date: 2-4-15

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal

Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

2/13/2015

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B330
Depth: 0 - 10
Material Description: Black CCR Material
Date: 2-4-15 **PL:** 30 **LL:** 38 **PI:** 8
USCS Classification: ML **AASHTO Classification:** A-4(6)
Testing Remarks: Ash from Primary Ash Basin
Specific Gravity = 2.433
Tested by: D. Kopitsky **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
163.29	0.00	0.00	3/4		
			3/8	0.00	100.0
			#4	2.21	98.6
			#10	5.80	96.4
			#20	10.34	93.7
			#40	14.92	90.9
			#60	20.54	87.4
			#100	29.03	82.2
			#140	36.18	77.8
			#200	44.64	72.7

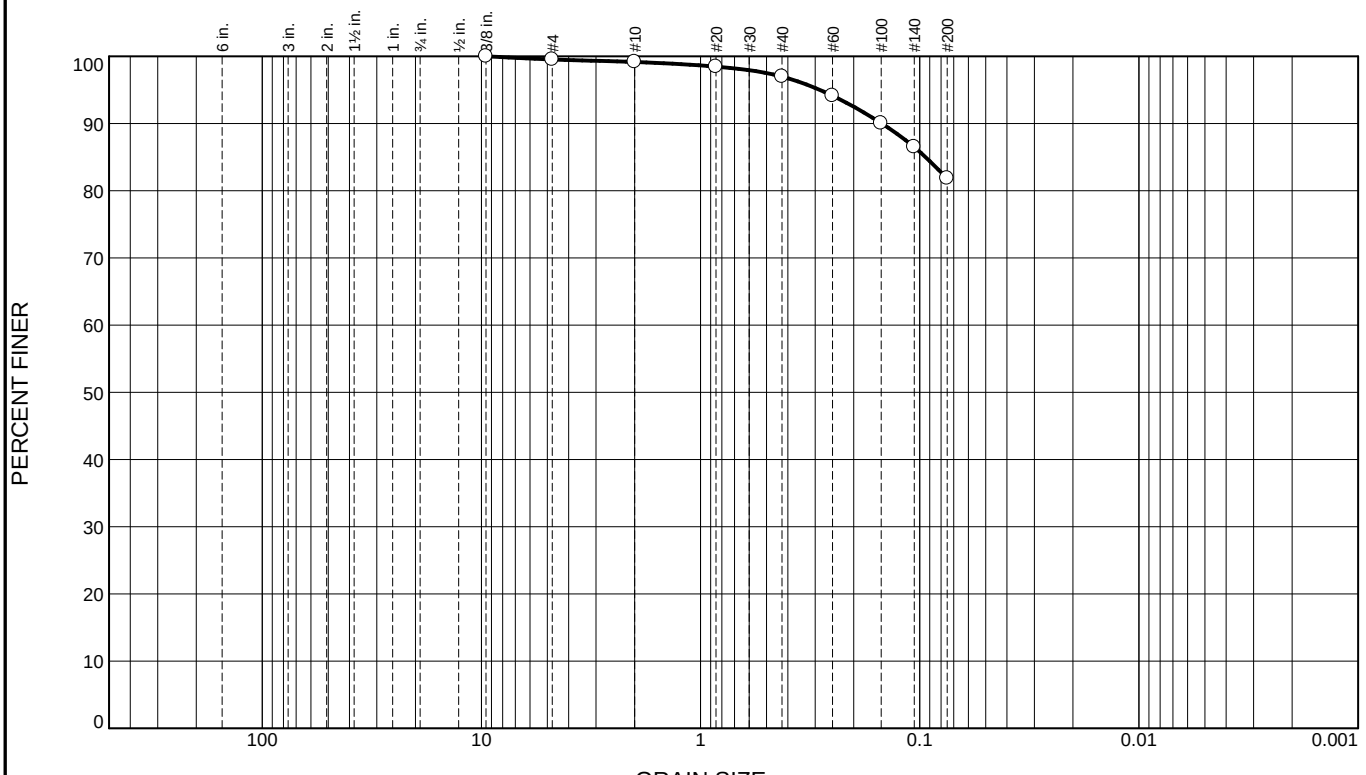
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	1.4	1.4	2.2	5.5	18.2	25.9			72.7

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
						0.1248	0.1931	0.3620	1.2579

Fineness Modulus
0.46

Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	0.3	2.2	15.2	81.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.5		
#10	99.2		
#20	98.5		
#40	97.0		
#60	94.1		
#100	90.0		
#140	86.5		
#200	81.8		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.1493 D_{85}= 0.0942 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Primary Ash Basin
Specific Gravity = 2.268

Source of Sample: B331 **Depth:** 10' - 20'

Date: 2-4-15

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal

Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

2/10/2015

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B331
Depth: 10' - 20'
Material Description: Black CCR Material
Date: 2-4-15 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Testing Remarks: Ash from Primary Ash Basin
Specific Gravity = 2.268
Tested by: D. Kopitsky **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
123.66	0.00	0.00	3/4		
			3/8	0.00	100.0
			#4	0.59	99.5
			#10	1.05	99.2
			#20	1.91	98.5
			#40	3.75	97.0
			#60	7.26	94.1
			#100	12.31	90.0
			#140	16.71	86.5
			#200	22.46	81.8

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.5	0.5	0.3	2.2	15.2	17.7			81.8

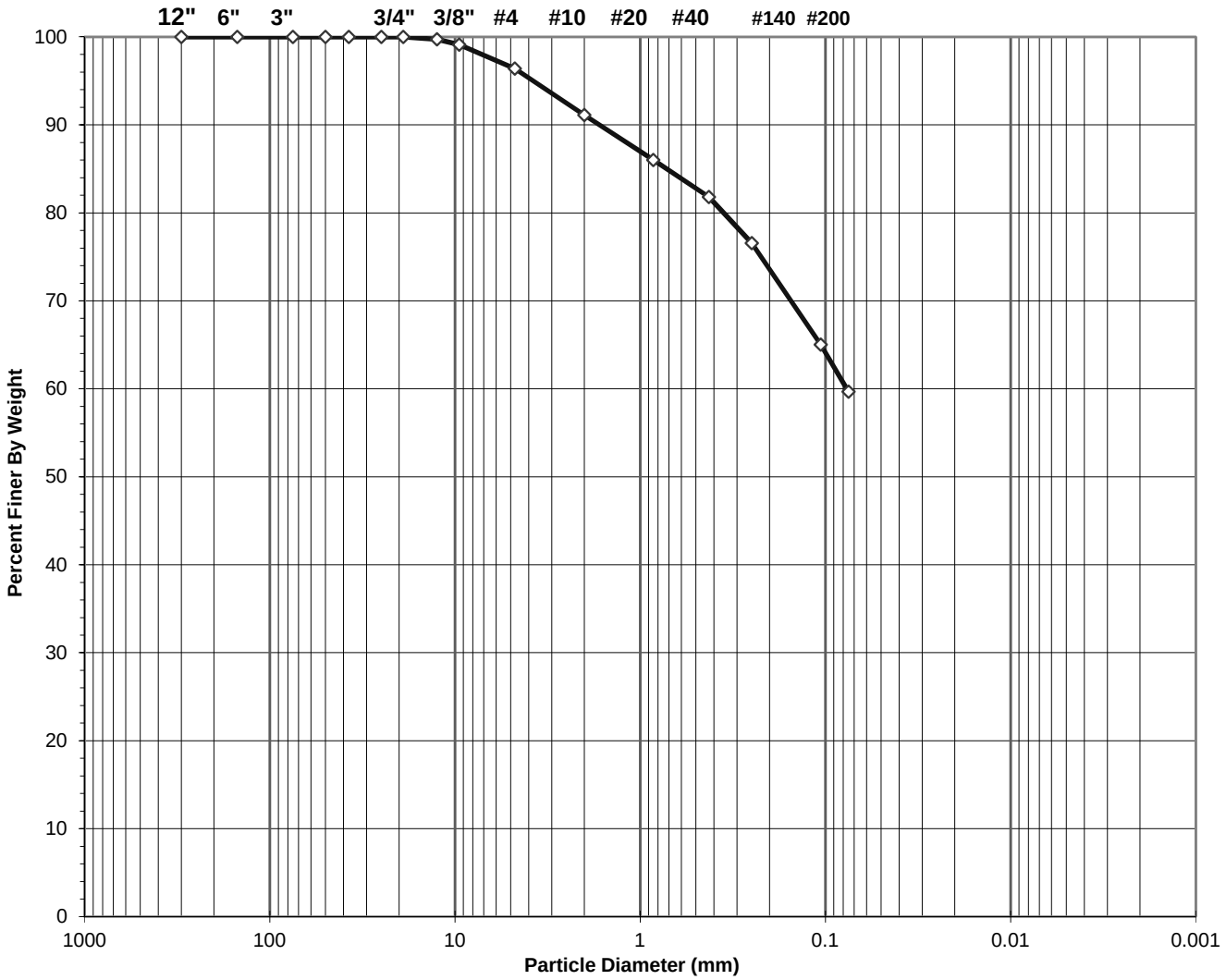
D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
							0.0942	0.1493	0.2860

Fineness Modulus
0.19

SIEVE ANALYSIS
ASTM D 422-63 (2007)

Client	AMEC FOSTER WHEELER	Boring No.	B331
Client Reference	Dan River Steam Station Ash Removal	Depth (ft)	40.0-50.0
Project No.	2015-616-01	Sample No.	BULK
Lab ID	2015-616-01-03	Soil Color	**GRAY**

	SIEVE ANALYSIS		*HYDROMETER*
USCS	**gravel**	**sand**	**silt and clay**



USCS Symbol ***ML, TESTED (NON-PLASTIC FINES)***

USCS Classification ***SANDY SILT***

Tested By BW Date 2/12/15 Checked By GEM Date 2/13/15

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *Z:\2015 PROJECTS\2015-616 AMEC - DAN RIVER\[2015-616-01-03 SIEVON REV 4.xls]Sheet1*

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	AMEC FOSTER WHEELER	Boring No.	B331
Client Reference	Dan River Steam Station Ash Removal	Depth (ft)	40.0-50.0
Project No.	2015-616-01	Sample No.	BULK
Lab ID	2015-616-01-03	Soil Color	**GRAY**

Moisture Content of Passing 3/4" Material		Water Content of Retained 3/4" Material	
Tare No.	831	Tare No.	NA
Wgt.Tare + Wet Specimen (gm)	1264.85	Wgt.Tare + Wet Specimen (gm)	NA
Wgt.Tare + Dry Specimen (gm)	1029.36	Wgt.Tare + Dry Specimen (gm)	NA
Weight of Tare (gm)	262.58	Weight of Tare (gm)	NA
Weight of Water (gm)	235.49	Weight of Water (gm)	NA
Weight of Dry Soil (gm)	766.78	Weight of Dry Soil (gm)	NA
Moisture Content (%)	**30.7**	**Moisture Content (%)**	**NA**

Wet Weight -3/4" Sample (gm)	NA	Weight of the Dry Specimen (gm)	766.78
Dry Weight - 3/4" Sample (gm)	309.3	Weight of minus #200 material (gm)	457.50
Wet Weight +3/4" Sample (gm)	NA	Weight of plus #200 material (gm)	309.28
Dry Weight + 3/4" Sample (gm)	0.00		
Total Dry Weight Sample (gm)	NA		

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.0	0.0	100.0	**100.0**
6"	150	0.00	0.0	0.0	100.0	**100.0**
3"	75	0.00	0.0	0.0	100.0	**100.0**
2"	50	0.00	0.0	0.0	100.0	**100.0**
1 1/2"	37.5	0.00	0.0	0.0	100.0	**100.0**
1"	25.0	0.00	0.0	0.0	100.0	**100.0**
3/4"	19.0	0.00	0.0	0.0	100.0	**100.0**
1/2"	12.50	2.02	0.3	0.3	99.7	**99.7**
3/8"	9.50	4.82	0.6	0.9	99.1	**99.1**
#4	4.75	20.77	2.7	3.6	96.4	**96.4**
#10	2.00	40.47	5.3	8.9	91.1	**91.1**
#20	0.850	39.09	5.1	14.0	86.0	**86.0**
#40	0.425	32.44	4.2	18.2	81.8	**81.8**
#60	0.250	40.21	5.2	23.5	76.5	**76.5**
#140	0.106	88.41	11.5	35.0	65.0	**65.0**
#200	0.075	41.05	5.4	40.3	59.7	**59.7**
Pan	-	457.50	59.7	100.0	-	**-**

Tested By BW Date 2/12/15 Checked By GEM Date 2/13/15

DCN: CT-S3C DATE 6-25-98 REVISION: 2 *Z:\2015 PROJECTS\2015-616 AMEC - DAN RIVER\[2015-616-01-03 SIEVON REV 4.xls]Sheet1*

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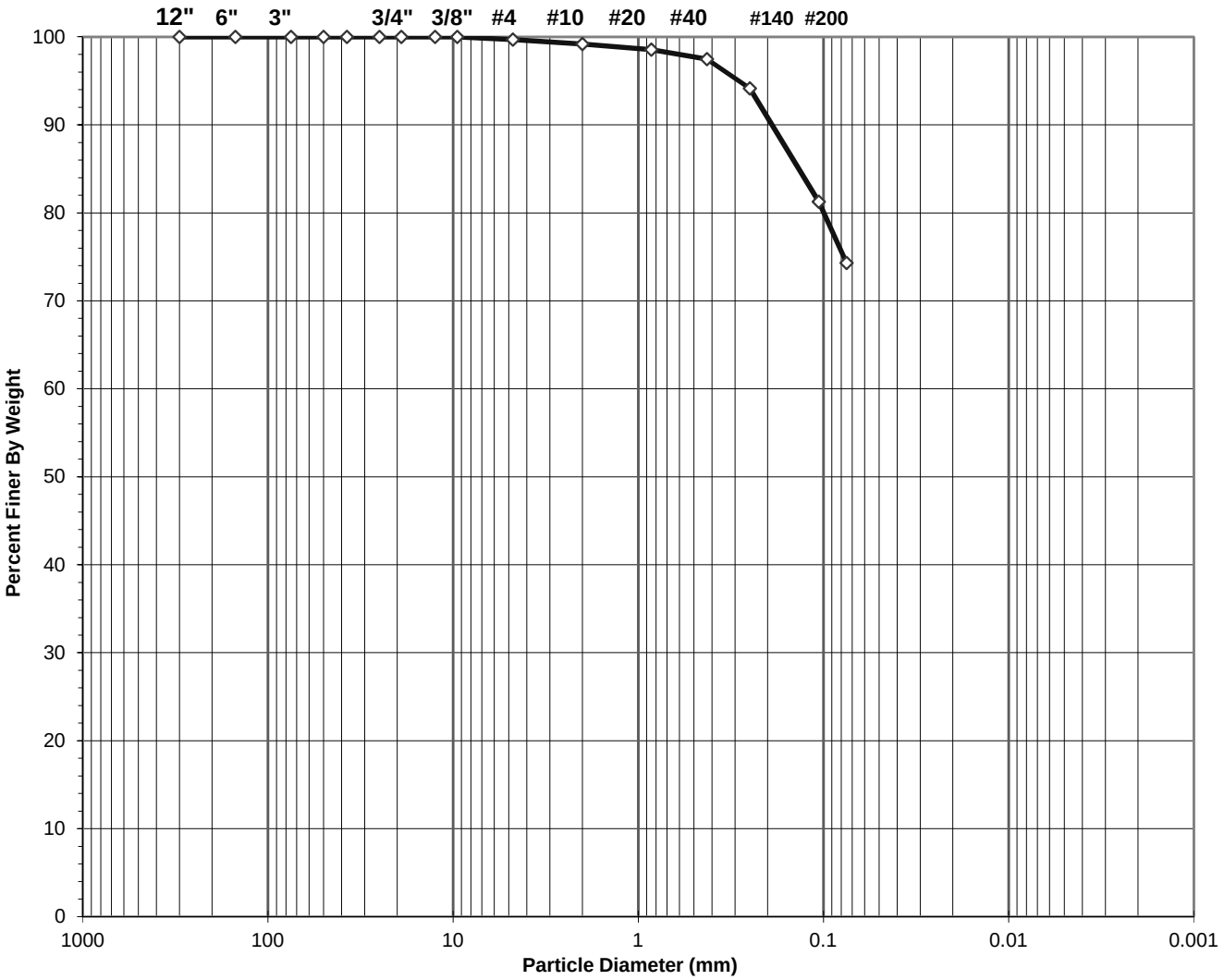
SIEVE ANALYSIS
ASTM D 422-63 (2007)

Client	AMEC FOSTER WHEELER	Boring No.	B333
Client Reference	Dan River Steam Station Ash Removal	Depth (ft)	0.0-10.0
Project No.	2015-616-01	Sample No.	BULK
Lab ID	2015-616-01-04	Soil Color	**BLACK**

	SIEVE ANALYSIS		***HYDROMETER***
USCS	**gravel**	**sand**	**silt and clay**



USCS Symbol ***ML, TESTED (NON-PLASTIC FINES)***

USCS Classification ***SILT WITH SAND***

Tested By BW Date 2/12/15 Checked By GEM Date 2/13/15

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *Z:\2015 PROJECTS\2015-616 AMEC - DAN RIVER\[2015-616-01-04 SIEVON REV 4.xls]Sheet1*

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	AMEC FOSTER WHEELER	Boring No.	B333
Client Reference	Dan River Steam Station Ash Removal	Depth (ft)	0.0-10.0
Project No.	2015-616-01	Sample No.	BULK
Lab ID	2015-616-01-04	Soil Color	**BLACK**

Moisture Content of Passing 3/4" Material		Water Content of Retained 3/4" Material	
Tare No.	841	Tare No.	NA
Wgt.Tare + Wet Specimen (gm)	863.60	Wgt.Tare + Wet Specimen (gm)	NA
Wgt.Tare + Dry Specimen (gm)	682.14	Wgt.Tare + Dry Specimen (gm)	NA
Weight of Tare (gm)	259.27	Weight of Tare (gm)	NA
Weight of Water (gm)	181.46	Weight of Water (gm)	NA
Weight of Dry Soil (gm)	422.87	Weight of Dry Soil (gm)	NA
Moisture Content (%)	**42.9**	**Moisture Content (%)**	**NA**

Wet Weight -3/4" Sample (gm)	NA	Weight of the Dry Specimen (gm)	422.87
Dry Weight - 3/4" Sample (gm)	108.7	Weight of minus #200 material (gm)	314.19
Wet Weight +3/4" Sample (gm)	NA	Weight of plus #200 material (gm)	108.68
Dry Weight + 3/4" Sample (gm)	0.00		
Total Dry Weight Sample (gm)	NA		

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.0	0.0	100.0	**100.0**
6"	150	0.00	0.0	0.0	100.0	**100.0**
3"	75	0.00	0.0	0.0	100.0	**100.0**
2"	50	0.00	0.0	0.0	100.0	**100.0**
1 1/2"	37.5	0.00	0.0	0.0	100.0	**100.0**
1"	25.0	0.00	0.0	0.0	100.0	**100.0**
3/4"	19.0	0.00	0.0	0.0	100.0	**100.0**
1/2"	12.50	0.00	0.0	0.0	100.0	**100.0**
3/8"	9.50	0.00	0.0	0.0	100.0	**100.0**
#4	4.75	1.27	0.3	0.3	99.7	**99.7**
#10	2.00	2.11	0.5	0.8	99.2	**99.2**
#20	0.850	2.75	0.7	1.4	98.6	**98.6**
#40	0.425	4.54	1.1	2.5	97.5	**97.5**
#60	0.250	14.06	3.3	5.8	94.2	**94.2**
#140	0.106	54.55	12.9	18.7	81.3	**81.3**
#200	0.075	29.40	7.0	25.7	74.3	**74.3**
Pan	-	314.19	74.3	100.0	-	**-**

Tested By BW Date 2/12/15 Checked By GEM Date 2/13/15

DCN: CT-S3C DATE 6-25-98 REVISION: 2 *Z:\2015 PROJECTS\2015-616 AMEC - DAN RIVER\[2015-616-01-04 SIEVON REV 4.xls]Sheet1*

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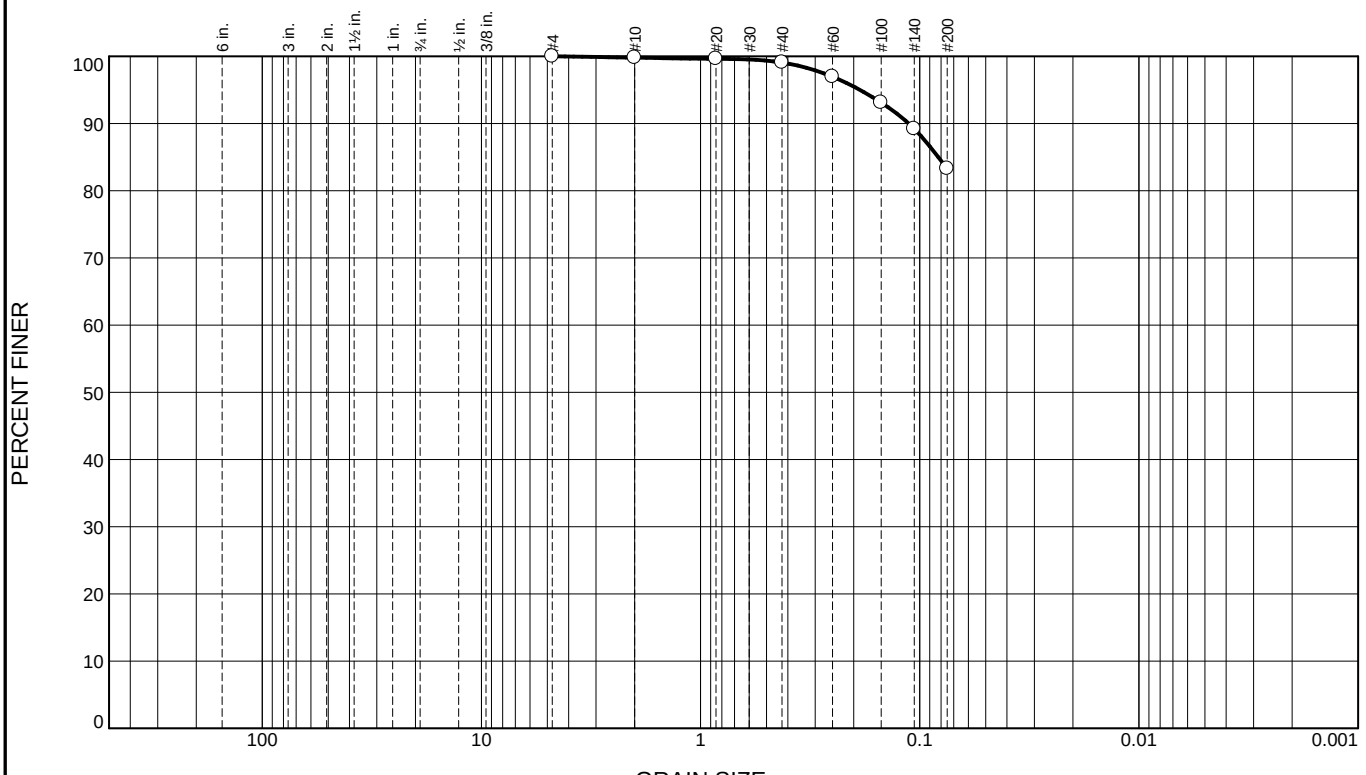
Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	0.7	15.8	83.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#20	99.6		
#40	99.1		
#60	97.0		
#100	93.1		
#140	89.2		
#200	83.3		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.1124 D_{85}= 0.0823 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Primary Ash Basin
Specific Gravity = 2.207

Source of Sample: B333 **Depth:** 10 - 20'

Date: 2-4-15

Client: Duke Energy
Project: Dan River Steam Station Ash Removal

Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

2/13/2015

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B333
Depth: 10 - 20'
Material Description: Black CCR Material
Date: 2-4-15 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Testing Remarks: Ash from Primary Ash Basin
Specific Gravity = 2.207
Tested by: D. Kopitsky **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
128.82	0.00	0.00	3/4		
			3/8		
			#4	0.00	100.0
			#10	0.26	99.8
			#20	0.49	99.6
			#40	1.20	99.1
			#60	3.92	97.0
			#100	8.88	93.1
			#140	13.91	89.2
			#200	21.52	83.3

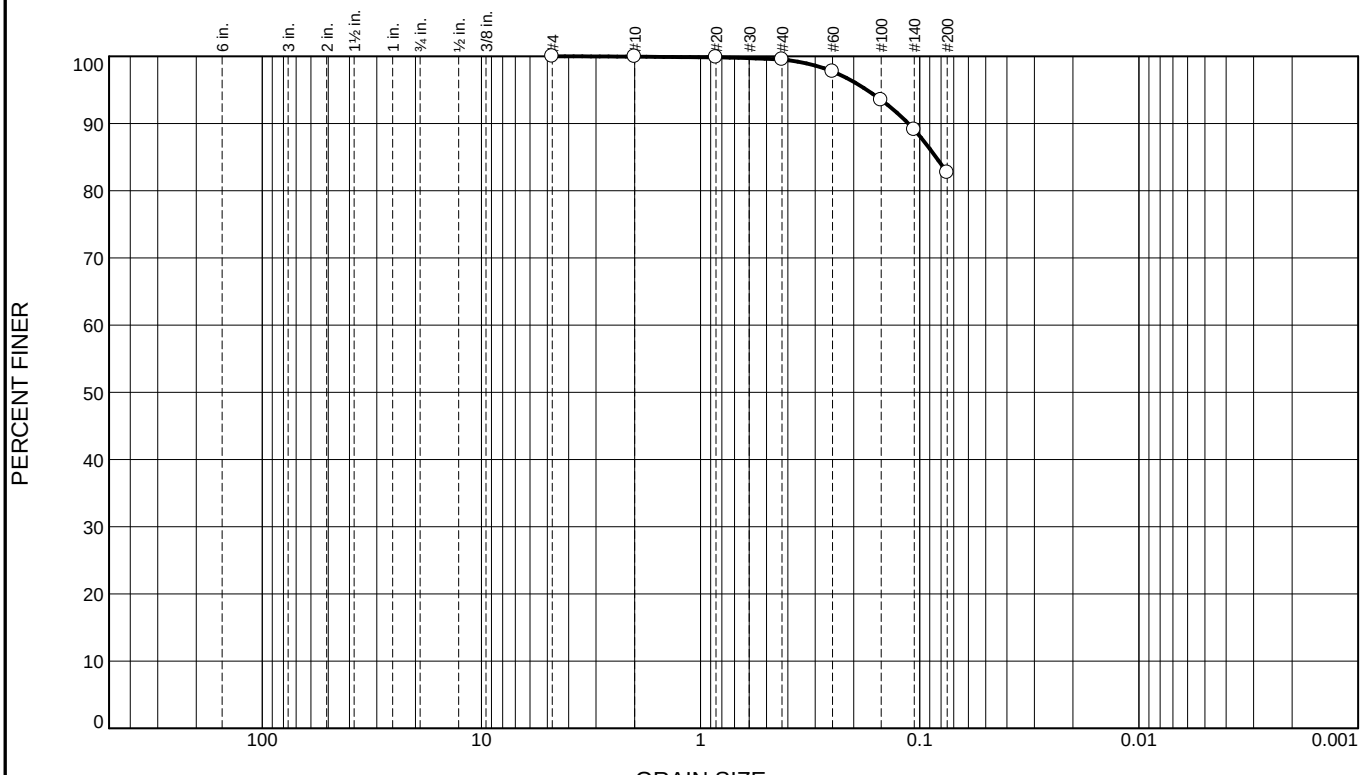
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.2	0.7	15.8	16.7			83.3

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
							0.0823	0.1124	0.1875

Fineness Modulus
0.10

Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.4	16.8	82.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.9		
#40	99.5		
#60	97.7		
#100	93.5		
#140	89.1		
#200	82.7		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.1128 D_{85}= 0.0844 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Primary Ash Basin
Specific Gravity = 2.190

Source of Sample: B335 **Depth:** 0 - 10'

Date: 2-4-15

amec

Client: Duke Energy
Project: Dan River Steam Station Ash Removal

Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

2/13/2015

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B335
Depth: 0 - 10'
Material Description: Black CCR Material
Date: 2-4-15 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Testing Remarks: Ash from Primary Ash Basin
Specific Gravity = 2.190
Tested by: D. Kopitsky **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
156.36	0.00	0.00	3/4		
			3/8		
			#4	0.00	100.0
			#10	0.09	99.9
			#20	0.23	99.9
			#40	0.74	99.5
			#60	3.54	97.7
			#100	10.17	93.5
			#140	17.10	89.1
			#200	27.06	82.7

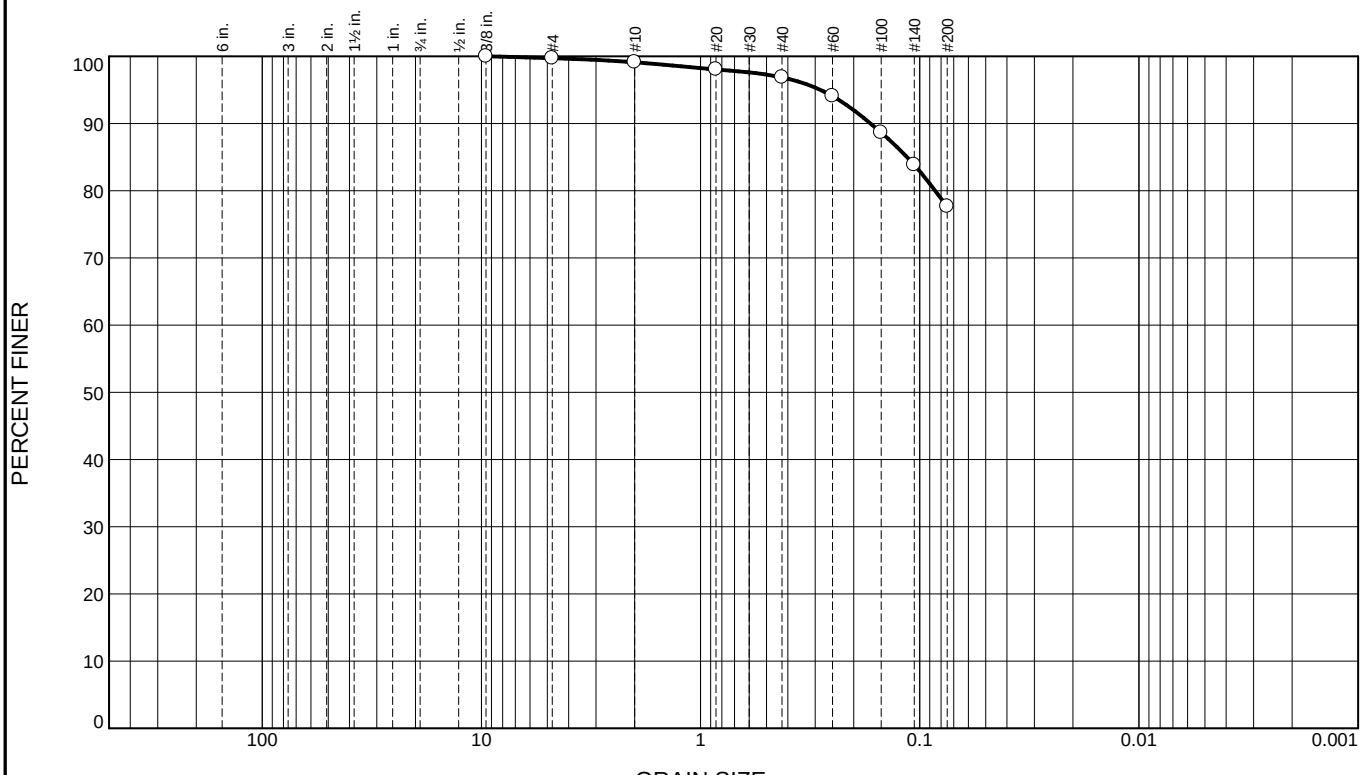
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.1	0.4	16.8	17.3			82.7

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
							0.0844	0.1128	0.1745

Fineness Modulus
0.08

Particle Size Analysis ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	0.6	2.3	19.2	77.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.7		
#10	99.1		
#20	98.0		
#40	96.8		
#60	94.1		
#100	88.6		
#140	83.8		
#200	77.6		

* (no specification provided)

Material Description

Black CCR Material

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.1677 D_{85}= 0.1143 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Ash from Primary Ash Basin
Specific Gravity = 2.180

Source of Sample: B335 **Depth:** 10' - 20'

Date: 2-4-15

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project No: 7810140065 **Figure**

Tested By: D. Kopitsky **Checked By:** T. Landis

GRAIN SIZE DISTRIBUTION TEST DATA

2/10/2015

Client: Duke Energy
Project: Dan River Steam Station Ash Removal
Project Number: 7810140065
Location: B335
Depth: 10' - 20'
Material Description: Black CCR Material
Date: 2-4-15 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Testing Remarks: Ash from Primary Ash Basin
Specific Gravity = 2.180
Tested by: D. Kopitsky **Checked by:** T. Landis

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
121.79	0.00	0.00	3/4		
			3/8	0.00	100.0
			#4	0.34	99.7
			#10	1.09	99.1
			#20	2.39	98.0
			#40	3.84	96.8
			#60	7.22	94.1
			#100	13.83	88.6
			#140	19.68	83.8
			#200	27.23	77.6

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.3	0.3	0.6	2.3	19.2	22.1			77.6

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
						0.0850	0.1143	0.1677	0.2840

Fineness Modulus
0.21

REFERENCE 3

“Standard Specification for Concrete Aggregates – ASTM C 33-03”, American Society for Testing and Materials, 2003.

aggregate to obtain a desired grading, provided that the gradings are not otherwise restricted by the project specifier and the nominal maximum size indicated by the size number is not exceeded,

4.3.3.2 The class designation (see 11.1 and Table 3),

4.3.3.3 Whether the restriction on reactive materials in 11.2 applies,

4.3.3.4 In the case of the sulfate soundness test (see Table 3), which salt is to be used. If none is stated, either sodium sulfate or magnesium sulfate shall be used, and

4.3.4 The person responsible for selecting the concrete proportions if other than the concrete producer.

4.3.5 Any exceptions or additions to this specification (see Note 1).

FINE AGGREGATE

5. General Characteristics

5.1 Fine aggregate shall consist of natural sand, manufactured sand, or a combination thereof.

6. Grading

6.1 *Sieve Analysis*—Fine aggregate, except as provided in 6.2 and 6.3 shall be graded within the following limits:

Sieve (Specification E 11)	Percent Passing
9.5-mm (⅜-in.)	100
4.75-mm (No. 4)	95 to 100
2.36-mm (No. 8)	80 to 100
1.18-mm (No. 16)	50 to 85
600-µm (No. 30)	25 to 60
300-µm (No. 50)	5 to 30
150-µm (No. 100)	0 to 10

NOTE 2—Concrete with fine aggregate gradings near the minimums for percent passing the 300 µm (No.50) and 150 µm (No.100) sometimes have difficulties with workability, pumping or excessive bleeding. The addition of entrained air, additional cement, or the addition of an approved mineral admixture to supply the deficient fines, are methods used to alleviate such difficulties.

6.2 The fine aggregate shall have not more than 45 % passing any sieve and retained on the next consecutive sieve of those shown in 6.1, and its fineness modulus shall be not less than 2.3 nor more than 3.1.

6.3 Fine aggregate failing to meet these grading requirements shall meet the requirements of this section provided that the supplier can demonstrate to the purchaser or specifier that concrete of the class specified, made with fine aggregate under consideration, will have relevant properties (see Note 4) at least equal to those of concrete made with the same ingredients, with the exception that the reference fine aggregate shall be selected from a source having an acceptable performance record in similar concrete construction.

NOTE 3—Fine aggregate that conforms to the grading requirements of a specification, prepared by another organization such as a state transportation agency, which is in general use in the area, should be considered as having a satisfactory service record with regard to those concrete properties affected by grading.

NOTE 4—Relevant properties are those properties of the concrete that are important to the particular application being considered. STP 169C[8] provides a discussion of important concrete properties.

6.4 For continuing shipments of fine aggregate from a given source, the fineness modulus shall not vary more than 0.20 from the base fineness modulus. The base fineness modulus shall be that value that is typical of the source. The purchaser or specifier has the authority to approve a change in the base fineness modulus.

NOTE 5—The base fineness modulus should be determined from previous tests, or if no previous tests exist, from the average of the fineness modulus values for the first ten samples (or all preceding samples if less than ten) on the order. The proportioning of a concrete mixture may be dependent on the base fineness modulus of the fine aggregate to be used. Therefore, when it appears that the base fineness modulus is considerably different from the value used in the concrete mixture, a suitable adjustment in the mixture may be necessary.

7. Deleterious Substances

7.1 The amount of deleterious substances in fine aggregate shall not exceed the limits prescribed in Table 1.

7.2 *Organic Impurities*:

7.2.1 Fine aggregate shall be free of injurious amounts of organic impurities. Except as herein provided, aggregates subjected to the test for organic impurities and producing a color darker than the standard shall be rejected.

7.2.2 Use of a fine aggregate failing in the test is not prohibited, provided that the discoloration is due principally to the presence of small quantities of coal, lignite, or similar discrete particles.

7.2.3 Use of a fine aggregate failing in the test is not prohibited, provided that, when tested for the effect of organic impurities on strength of mortar, the relative strength at 7 days, calculated in accordance with Test Method C 87, is not less than 95 %.

7.3 Fine aggregate for use in concrete that will be subject to wetting, extended exposure to humid atmosphere, or contact with moist ground shall not contain any materials that are deleteriously reactive with the alkalies in the cement in an amount sufficient to cause excessive expansion of mortar or concrete, except that if such materials are present in injurious amounts, use of the fine aggregate is not prohibited when used with a cement containing less than 0.60 % alkalies calculated as sodium oxide equivalent ($Na_2O + 0.658K_2O$) or with the addition of a material that has been shown to prevent harmful expansion due to the alkali-aggregate reaction. (See Appendix X1.)

8. Soundness

8.1 Except as provided in 8.2 and 8.3, fine aggregate subjected to five cycles of the soundness test shall have a weighted average loss not greater than 10 % when sodium sulfate is used or 15 % when magnesium sulfate is used.

8.2 Fine aggregate failing to meet the requirements of 8.1 shall be regarded as meeting the requirements of this section provided that the supplier demonstrates to the purchaser or

[8] *Significance of Tests and Properties of Concrete and Concrete Making Materials, STP 169C*, ASTM, 1994.

REFERENCE 4

“Standard Specifications for Roads and Structures”, North Carolina Department of Transportation, 2006.

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LIZER
DIFIED*

SODIUM SULFATE

Materials and Tests Unit

TABLE 1005-1
AGGREGATE GRADATION, COARSE AGGREGATE

STD. SIZE #	PERCENTAGE OF TOTAL BY WEIGHT OF PASSING (mm sieve)																REMARKS
	2" (50.0)	1 1/2" (37.5)	1" (25.0)	3/4" (19.0)	1/2" (12.5)	3/8" (9.5)	#4 (4.75)	#8 (2.36)	#10 (2.00)	#16 (1.18)	#30 (0.600)	#40 (0.425)	#50 (0.300)	#80 (0.180)	#100 (0.150)	#200 (0.075)	
4	100	90-100	20-55	0-15		0-5										0-*0.6	Asphalt Plant Mix Pavement
467M	100	95-100		35-70		0-30	0-5									0-*0.6	Asphalt Plant Mix Pavement
5		100	90-100	20-55	0-10	0-5										0-*0.6	AST Mat coat, Sediment Control Stone
57		100	95-100		25-60		0-10	0-5								0-*0.6	Str. Conc., Shldr. Drain, Sediment Control Stone
57M		100	95-100		25-45		0-10	0-5								0-*0.6	P. C. Concrete Pavement
6			100	90-100	20-55	0-15	0-5									*	AST
67			100	90-100		20-55	0-10	0-5								0-*0.6	Str. Conc., Asphalt Plant Mix Pvmt.
78M				100	98-100	75-100	20-45	0-15								0-*0.6	Asphalt Plant Mix Pvmt., AST Weep Hole Drains, Str. Concrete
14M						100	35-70	5-20		0-8						*	* AST
ABC		100	75-97		55-80		35-55		25-45			14-30				4-12**	Aggr. Stabilization Aggr/ Base Course Asph. Plant Mix Pvmt
ABC(M)		100	75-100		45-79		20-40		0-25							0-12**	Maintenance Stabilization

, asphalt treatment, and

; follows:

aterial passing through the No.

amount of material passing
weight and use material that
g of the aggregate.

l passing the No. 200

tland cement concrete or

halt plant mix.
handling of the aggregate.

e specified amount of material
er may approve its use

, the total percentage by
mbined coarse and fine
ded no increase in water-
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al percentage by weight of
ing produced, as determined
its allowed by the job mix

No. 40 (0.425mm) sieve
cess of 6. For size ABC
ction, in a stockpile at the
ing the No. 200 (0.075mm)
ements for material passing
10 for aggregate base course
nt mix, the gradation
tary will be as shown in
5% passing the No. 200

TABLE 1005-2
AGGREGATE GRADATION FINE AGGREGATE

STD. SIZE #	PERCENTAGE OF TOTAL BY WEIGHT PASSING (mm)											REMARKS
	3/8" (9.5)	#4 (4.75)	#8 (2.36)	#10 (2.00)	#16 (1.18)	#30 (0.600)	#40 (0.425)	#50 (0.300)	#80 (0.180)	#100 (0.150)	#200 (0.075)	
1S	100	90-100			40-85			0-20			0-3	Blotting Sand, Asphalt Retreatment
2S	100	95-100	80-100		45-95	25-75		8-30		0.5-10	0-3	Concrete, Sub-surface Drainage, Blotting Sand
2MS		95-100	84-100		45-95	25-75		8-35		0.5-20	0-*8	Concrete
4S		100	95-100					15-45		0-10	0-5	Mortar

* FOR MANUFACTURED FINE AGGREGATE USED IN PORTLAND CEMENT CONCRETE:

When tested during production the amount of material passing the No. 200 (0.075 mm)sieve must not be greater than 8%. When tested at the job site prior to use, the amountof material passing the No. 200 (0.075 mm) sieve must not be greater than 10% andmust consist of the dust of fracture, and be essentially free from clay or shale. The minimum percent shown for material passing the No. 50 (0.300 mm) and No. 100(0.15mm) sieves may be reduced to 5 and 0, respectively, if the aggregate is to be usedin air-entrained concrete containing more than 400 pounds of cementitious material per cubic yard (237 kg per cubic meter) or in non-air entrained concrete containing more than 500 pounds of cementitious material per cubic yard (297 kg per cubic meter) or as subdrain fine aggregate.

Section 1005

APPENDIX V

Calculations Addressing Geosynthetics

APPENDIX V-1

Composite Liner Hydraulic Equivalency Calculation

Calculation Title:
Composite Liner Hydraulic Equivalency Calculation

Summary:
A GCL with a thickness of 0.2 inches (0.5 cm) and a hydraulic conductivity of less than 2.48×10^{-9} cm/s is hydraulically equivalent to two feet of compacted soil with a hydraulic conductivity of 1×10^{-7} cm/s.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal		Cedric H Ruhl	Thomas B Maier
		Tryambak Kaushik	**Cedric H. Ruhl**	**Thomas B. Maier**

OBJECTIVE:

The objective of this calculation is to estimate the required hydraulic conductivity for a geosynthetic clay liner (GCL) to satisfy Environmental Protection Agency (EPA) coal combustion residual (CCR) rules for an alternative composite liner.

METHOD:

The required conductivity for a GCL to be hydraulically equivalent to two feet of compacted soil with a conductivity of $1x10^{-7}$ cm/s will be estimated using Darcy's Law as described in Article 257.70(c) of the EPA CCR rules [Ref. 1].

DEFINITION OF VARIABLES:

h = hydraulic head;
k = hydraulic conductivity;
q = flow rate per unit area; and
t = thickness.

CALCULATIONS:

1.0 Estimate required hydraulic conductivity for GCL

The liquid flow rate through porous media is evaluated using Darcy's law as defined in the following equation:

$$q = k[\frac{h}{t} + 1]$$ [Ref. 1]

The maximum allowable unit flow rate is defined as the flow that will pass through two feet of compacted soil with a conductivity of $1x10^{-7}$ cm/s. For the purposes of this calculation, the head on the liner system was assumed to be 30 centimeters, the maximum allowable by EPA CCR rules [Ref. 1]. The maximum allowable unit flow rate was calculated as shown in the following table:

Table 1: Maximum Allowable Unit Flow Rate

Description	Hydraulic Conductivity {k} (cm/s) [Ref. 1]	Thickness {t} (ft) [Ref. 1]	Thickness {t} (cm)	Hydraulic Head {h} (cm) [Ref. 1]	Maximum Allowable Unit Flow Rate {q_{max}} (cm/s)
two feet of compacted soil	1.00E-07	2	60.96	30	1.49E-07

A GCL is hydraulically equivalent to two feet of compacted soil with a conductivity of $1x10^{-7}$ cm/s if the unit flow rate through the GCL is less than or equal to the unit flow rate through the compacted soil. The maximum allowable hydraulic conductivity of the GCL can be estimated by rearranging the terms in the equation presented above as follows:

$$k = \frac{q_{max}}{\frac{h}{t}+1}$$

GCLs range in thickness from 0.2 to 0.3 inches [Ref. 2]. The maximum allowable hydraulic conductivity of the GCL was calculated as shown in the following table:

Table 2: Maximum Allowable GCL Hydraulic Conductivity					
Description	**Maximum Allowable Unit Flow Rate {q_{max}} (cm/s)**	**Thickness {t} (in) [Ref. 2]**	**Thickness {t} (cm)**	**Hydraulic Head {h} (cm) [Ref. 1]**	**Maximum Allowable GCL Hydraulic Conductivity {k_{max}} (cm/s) [Ref. 1]**
geosynthetic clay liner	1.49E-07	0.20	0.508	30	2.48E-09

DISCUSSION:

A GCL with a thickness of 0.2 inches (0.5 cm) and a hydraulic conductivity of less than 2.48×10^{-9} cm/s is hydraulically equivalent to two feet of compacted soil with a conductivity of 1×10^{-7} cm/s.

REFERENCES:

1. Environmental Protection Agency, “Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule”, Federal Register Vol. 80, No. 74, April 17, 2015.
2. Environmental Protection Agency, “Geosynthetic Clay Liners Used in Municipal Solid Waste Landfills”, EPA530-F-97-002, December 2001.

REFERENCE 1

Environmental Protection Agency, “Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule”, Federal Register Vol. 80, No. 74, April 17, 2015.

required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of § 257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit.

(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e).

§ 257.63 Seismic impact zones.

(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in seismic impact zones unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site.

(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section.

(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of § 257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit.

(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e).

§ 257.64 Unstable areas.

(a) An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted.

(b) The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:

(1) On-site or local soil conditions that may result in significant differential settling;

(2) On-site or local geologic or geomorphologic features; and

(3) On-site or local human-made features or events (both surface and subsurface).

(c) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section.

(d) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (d)(1) or (2) of this section.

(1) For an existing CCR landfill or existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment or existing CCR landfill who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (d)(1) of this section is subject to the requirements of § 257.101(b)(1) or (d)(1), respectively.

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit.

(e) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e).

Design Criteria

§ 257.70 Design criteria for new CCR landfills and any lateral expansion of a CCR landfill.

(a)(1) New CCR landfills and any lateral expansion of a CCR landfill must be designed, constructed, operated, and maintained with either a composite liner that meets the requirements of paragraph (b) of this section or an alternative composite liner that meets the requirements in paragraph (c) of this section, and a leachate collection and removal system that meets the requirements of paragraph (d) of this section.

(2) Prior to construction of an overfill the underlying surface impoundment must meet the requirements of § 257.102(d).

(b) A *composite liner* must consist of two components; the upper component

consisting of, at a minimum, a 30-mil geomembrane liner (GM), and the lower component consisting of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} centimeters per second (cm/sec). GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. The GM or upper liner component must be installed in direct and uniform contact with the compacted soil or lower liner component. The composite liner must be:

(1) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;

(2) Constructed of materials that provide appropriate shear resistance of the upper and lower component interface to prevent sliding of the upper component including on slopes;

(3) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and

(4) Installed to cover all surrounding earth likely to be in contact with the CCR or leachate.

(c) If the owner or operator elects to install an alternative composite liner, all of the following requirements must be met:

(1) An *alternative composite liner* must consist of two components; the upper component consisting of, at a minimum, a 30-mil GM, and a lower component, that is not a geomembrane, with a liquid flow rate no greater than the liquid flow rate of two feet of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec. GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. If the lower component of the alternative liner is compacted soil, the GM must be installed in direct and uniform contact with the compacted soil.

(2) The owner or operator must obtain certification from a qualified professional engineer that the liquid flow rate through the lower component of the alternative composite liner is no greater than the liquid flow rate through two feet of compacted soil with a hydraulic conductivity of 1×10^{-7} cm/sec. The hydraulic conductivity for the two feet of compacted soil used in the comparison shall be no greater than 1×10^{-7} cm/sec. The hydraulic conductivity of any alternative to the two feet of compacted soil must be determined using recognized and generally accepted methods. The liquid flow rate comparison must be made using Equation 1 of this section, which is derived from Darcy's Law for gravity flow through porous media.

$$\text{(Eq. 1)} \qquad \frac{Q}{A} = q = k\left(\frac{h}{t} + 1\right)$$

Where,

Q = flow rate (cubic centimeters/second);
A = surface area of the liner (squared centimeters);
q = flow rate per unit area (cubic centimeters/second/squared centimeter);
k = hydraulic conductivity of the liner (centimeters/second);
h = hydraulic head above the liner (centimeters); and
t = thickness of the liner (centimeters).

(3) The alternative composite liner must meet the requirements specified in paragraphs (b)(1) through (4) of this section.

(d) The *leachate collection and removal system* must be designed, constructed, operated, and maintained to collect and remove leachate from the landfill during the active life and post-closure care period. The leachate collection and removal system must be:

(1) Designed and operated to maintain less than a 30-centimeter depth of leachate over the composite liner or alternative composite liner;

(2) Constructed of materials that are chemically resistant to the CCR and any non-CCR waste managed in the CCR unit and the leachate expected to be generated, and of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying waste, waste cover materials, and equipment used at the CCR unit; and

(3) Designed and operated to minimize clogging during the active life and post-closure care period.

(e) Prior to construction of the CCR landfill or any lateral expansion of a CCR landfill, the owner or operator must obtain a certification from a qualified professional engineer that the design of the composite liner (or, if applicable, alternative composite liner) and the leachate collection and removal system meets the requirements of this section.

(f) Upon completion of construction of the CCR landfill or any lateral expansion of a CCR landfill, the owner or operator must obtain a certification from a qualified professional engineer that the composite liner (or, if applicable, alternative composite liner) and the leachate collection and removal system has been constructed in accordance with the requirements of this section.

(g) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(f), the notification requirements specified in § 257.106(f), and the Internet requirements specified in § 257.107(f).

§ 257.71 Liner design criteria for existing CCR surface impoundments.

(a)(1) No later than October 17, 2016, the owner or operator of an existing CCR surface impoundment must document whether or not such unit was constructed with any one of the following:

(i) A liner consisting of a minimum of two feet of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec;

(ii) A composite liner that meets the requirements of § 257.70(b); or

(iii) An alternative composite liner that meets the requirements of § 257.70(c).

(2) The hydraulic conductivity of the compacted soil must be determined using recognized and generally accepted methods.

(3) An existing CCR surface impoundment is considered to be an existing unlined CCR surface impoundment if either:

(i) The owner or operator of the CCR unit determines that the CCR unit is not constructed with a liner that meets the requirements of paragraphs (a)(1)(i), (ii), or (iii) of this section; or

(ii) The owner or operator of the CCR unit fails to document whether the CCR unit was constructed with a liner that meets the requirements of paragraphs (a)(1)(i), (ii), or (iii) of this section.

(4) All existing unlined CCR surface impoundments are subject to the requirements of § 257.101(a).

(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer attesting that the documentation as to whether a CCR unit meets the requirements of paragraph (a) of this section is accurate.

(c) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(f), the notification requirements specified in § 257.106(f), and the Internet requirements specified in § 257.107(f).

§ 257.72 Liner design criteria for new CCR surface impoundments and any lateral expansion of a CCR surface impoundment.

(a) New CCR surface impoundments and lateral expansions of existing and new CCR surface impoundments must

REFERENCE 2

Environmental Protection Agency, “Geosynthetic Clay Liners Used in Municipal Solid Waste Landfills”, EPA530-F-97-002, December 2001.

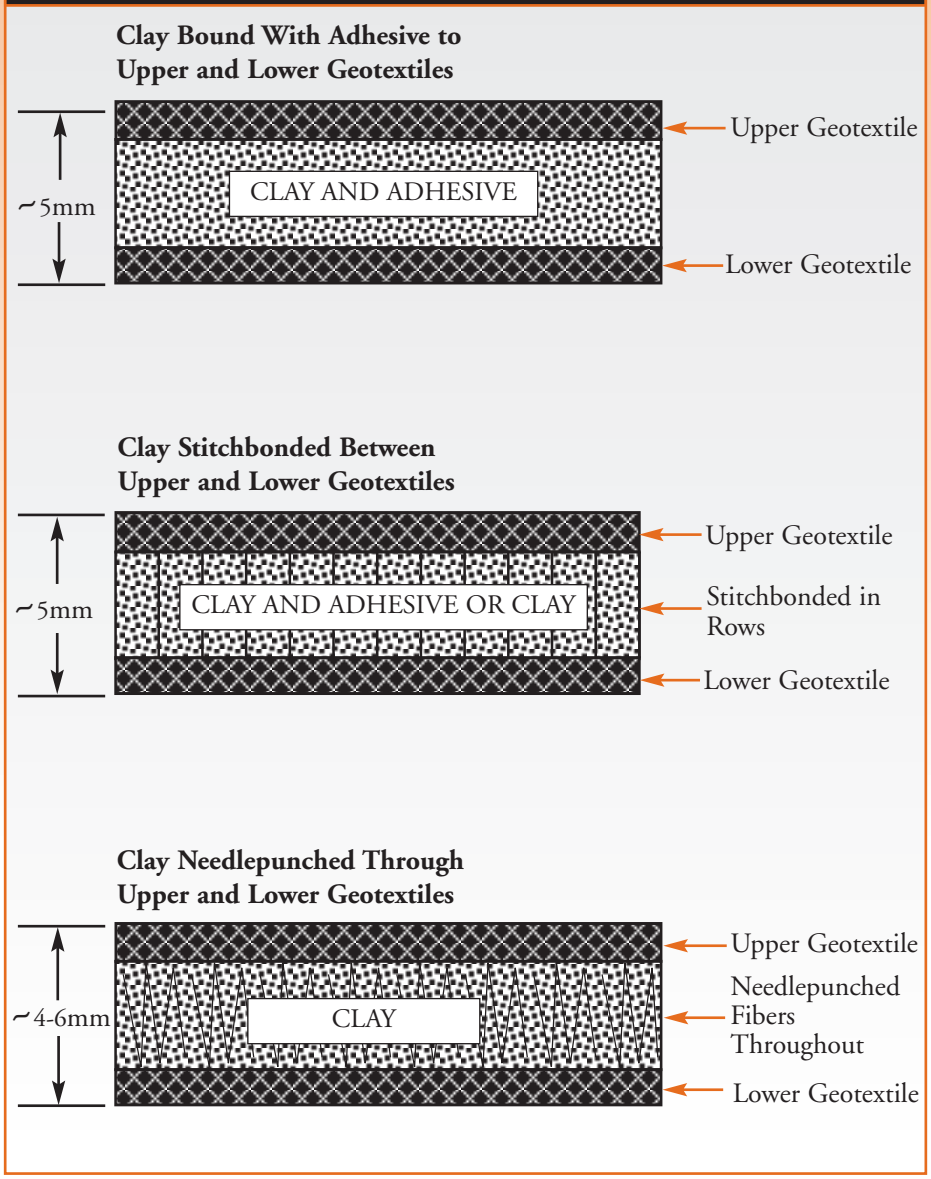
Testing

GCL configurations for barrier systems are based on the design specifications of each specific project. The American Society for Testing and Materials (ASTM) developed standardized laboratory tests for assessing mass per unit area (ASTM D-3776), hydraulic conductivity (ASTM D-5084), and direct shear (ASTM D-5321).

Researchers at the Geosynthetic Research Institute at Drexel University (in Philadelphia, Pennsylvania) and the Geotechnical Engineering Department at the University of Texas (in Austin) developed tests to measure shear strength, as well as confined swelling, rate of creep, and seam overlap permeability. These test methods have been adopted by ASTM. Additionally, the bentonite industry developed a test to measure free swell (USP-NF-XVII).

Test values for hydraulic conductivity depend on the degree of effective overburden stress around the GCL during testing. The higher the effective overburden stress, the lower the hydraulic conductivity. When comparing two different bentonite products, both must be subjected to the same degree of effective overburden stress.

Figure 2. Affixing Bentonite to Geotextiles



Available GCL Products

Product Types

The following types of GCL products are currently available:

- Geotextile type:
  - — Bentofix® (activated sodium bentonite as primary ingredient and affixed by needlepunching to a woven or nonwoven upper geotextile and a nonwoven lower geotextile).
  - — Bentomat® (sodium bentonite as primary ingredient and affixed by needlepunching to a woven or nonwoven upper geotextile and a nonwoven lower geotextile).
  - — Claymax® (sodium bentonite as primary ingredient mixed with water-soluble adhesive and bonded or stitchbonded to a woven upper and lower geotextile).
- Geomembrane type:
  - — Gundseal® (sodium bentonite as the primary ingredient mixed with an adhesive and bonded to a blend of high density polyethylene and very low density polyethylene).

Table 1 lists information on variations of these product types by manufacturer, and Figure 3 presents cross-section views of these product configurations.

In general, manufacturers ship GCL products in rolled sheets ranging from 13 to 18 feet wide and from 100 to 200 feet long. GCLs range in thickness from 0.2 to 0.3 inches.

APPENDIX V-2

Liner System Geocomposite Capacity Calculation

Calculation Title:
Liner System Geocomposite Capacity Calculation

Summary:
Assuming a flow length in geocomposite of 500 feet and a slope in the direction of flow of 2 percent, the leachate collection geocomposite transmissivity as tested in a laboratory must be greater than 3.77×10^{-4} m^2/sec and the leakage detection geocomposite transmissivity as tested in a laboratory must be greater than 3.27×10^{-4} m^2/sec to provide adequate geocomposite capacity. Laboratory test conditions are presented in the discussion portion of this calculation.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal		Jessica Ketchum	Thomas B Maier
		Tryambak Kaushik	**Jessica Ketchum**	**Thomas B. Maier**

OBJECTIVE:

The objective of this calculation is to estimate the required geocomposite transmissivity for the leachate collection geocomposite and the leakage detection geocomposite layers.

METHOD:

The leachate collection geocomposite transmissivity will be specified to pass the maximum average daily percolation rate as calculated in the "Leachate Generation Calculation".

The leakage detection geocomposite transmissivity will be specified to pass two times the Action Leakage Rate. The Action Leakage Rate was defined to be 500 gallons per acre per day (gpad) which is consistent with other double-lined coal combustion residual (CCR) landfills in Duke Energy's fleet.

DEFINITION OF VARIABLES:

β = slope angle;
θ = transmissivity;
FS = safety factor;
k = hydraulic conductivity;
L = length;
Q = flow; and
RF = reduction factor

CALCULATIONS:

1.0 Estimate geocomposite peak flow

The peak flow to the geocomposites are estimated per unit foot between leachate laterals spaced at horizontal length "L" as shown in the following equation:

$$Q = k_s L$$ [Ref. 1]

The impingement rate to the leachate collection geocomposite was assumed to be the average daily percolation rate for 10-feet of waste as calculated in the "Leachate Generation Calculation". The impingement rate to the leakage detection geocomposite was assumed to be 1,000 gpad, which is two times the action leakage rate of 500 gpad. The distance between leachate collection laterals was assumed to be 500 feet. The geocomposite design flows were calculated as shown in the following table:

Table 1: Geocomposite Design Flow

Geocomposite Location	Impingement Rate (gpad)	Impingement Rate {k_s} (ft/s)	Geocomposite Outlet Spacing {L} (ft) [assumed]	Geocomposite Design Flow {Q} (cfs/ft)
Leachate Collection Geocomposite	1,155	4.10E-08	500	2.05E-05
Leakage Detection Geocomposite	1,000	3.55E-08	500	1.78E-05

2.0 Estimate geocomposite required capacity

The geocomposites must have a capacity equal to or greater than the design flow. Geocomposite capacity is measured in terms of transmissivity "θ". The required transmissivity "θ_{req}" of the geocomposite was estimated with the following equation:

$$\theta_{req} = \frac{Q}{sin\beta}$$ [Ref. 1]

The required transmissivity of the geocomposites were estimated as shown in the following table:

Table 2: Geocomposite Required Transmissivity

Geocomposite Location	Geocomposite Design Flow {Q} (cfs/ft)	Minimum Landfill Floor Slope (percent) [assumed]	Minimum Landfill Floor Slope {β} (degrees)	Required Geocomposite Transmissivity {θ_{req}} (ft^2/s)	Required Geocomposite Transmissivity {θ_{req}} (m^2/s)
Leachate Collection Geocomposite	2.05E-05	2.0%	1.15	1.03E-03	9.53E-05
Leakage Detection Geocomposite	1.78E-05	2.0%	1.15	8.88E-04	8.25E-05

The transmissivity required to convey the design flow was estimated as shown above and can be converted into an allowable transmissivity (i.e. a specified value for transmissivity testing) by applying a drainage safety factor and reduction factors for long-term creep, chemical clogging, and biological clogging as shown in the following equation:

$$\theta_{allow} = \theta_{req} FS_D RF_{CR} RF_{CC} RF_{BC}$$ [Ref. 1]

The safety factor and reduction factors were selected based on recommended values for liner systems from Bachus et. al. [Ref. 1]. The waste will consist of fly ash; therefore, reduction factors for chemical and biological clogging were anticipated to be relatively low. Published values for creep reduction factors [Ref. 1] vary from 1.12 to 1.19. A value of 1.2 was selected for this analysis. The allowable transmissivity for specification purposes was estimated as shown in the following table:

Table 3: Geocomposite Allowable Transmissivity

Geocomposite Location	Required Geocomposite Transmissivity {θ_{req}} (m^2/s)	Safety Factor for Drainage {FS_D} [Ref. 1]	Reduction Factor for Long-Term Creep {RF_{CR}} [assumed]	Reduction Factor for Chemical Clogging {RF_{CC}} [Ref. 1]	Reduction Factor for Biological Clogging {RF_{BC}} [Ref. 1]	Allowable Geocomposite Transmissivity {θ_{allow}} (m^2/s)
Leachate Collection Geocomposite	9.53E-05	2.0	1.2	1.5	1.1	3.77E-04
Leakage Detection Geocomposite	8.25E-05	2.0	1.2	1.5	1.1	3.27E-04

DISCUSSION:

The leachate collection geocomposite transmissivity as tested in a laboratory must be greater than 3.77×10^{-4} m^2/sec to provide adequate capacity. The leakage detection geocomposite

transmissivity as tested in a laboratory must be greater than 3.27×10^{-4} m^2/sec to provide adequate capacity. The transmissivity testing parameters should be consistent with the proposed liner system design. Recommended liner system geocomposite transmissivity testing parameters are listed as follows:

- Upper material = protective cover soil compacted to 90 percent of Standard Proctor maximum dry density and within 3 percent of optimum moisture content;
- Lower material = geomembrane proposed for liner system;
- Seating time = 100 hours;
- Hydraulic gradient = 0.02; and
- Normal load = 15,000 psf.

Note that these testing requirements apply to the geocomposite proposed for the liner system. Refer to the "Cover System Stormwater Calculation" package for transmissivity testing requirements for geocomposite proposed for the cover system.

REFERENCES:

1. Bachus, Robert et. al. "The GSE Drainage Design Manual", second edition, June 2007.

REFERENCE 1

Bachus, Robert et. al. “The GSE Drainage Design Manual”, second edition, June 2007.

4.2.1 Final Cover Drainage Layer

The final cover geocomposite is relatively close to the surface of the landfill, and is therefore directly affected by short-term inputs from precipitation. The geocomposite is typically overlain by approximately 2-ft (0.6 m) of protective and vegetative soil. The properties of this soil layer can significantly influence how much precipitation impinges on the drainage layer.

Thiel and Stewart [1993] describe a relatively simple and conservative method of estimating the amount of liquid that may percolate into the drainage layer. Their approach has since been labeled the "unit gradient" method. The basis for this method is that for the critical condition it can be assumed that the cover soil is saturated, and water from continued rains will percolate vertically through the cover soil. Since the head on top of the cover soil is practically zero (due to runoff), the gradient through the cover soil is unity. Therefore Darcy's law gives the inflow percolation as (see also Figure 4.1):

$$Q_{in} = k_{cover} \times i_{in} \times A \tag{4.1}$$

where Q_{in} = inflow percolation rate (m^3/sec); i_{in} = inflow gradient = 1; and A = area (m^2).

If we examine a unit width of the cover slope, the area would be equal to the slope length (or distance between drainage outlets), L, times the unit width. Therefore,

$$Q_{in} = k_{cover} \times L \tag{4.2}$$

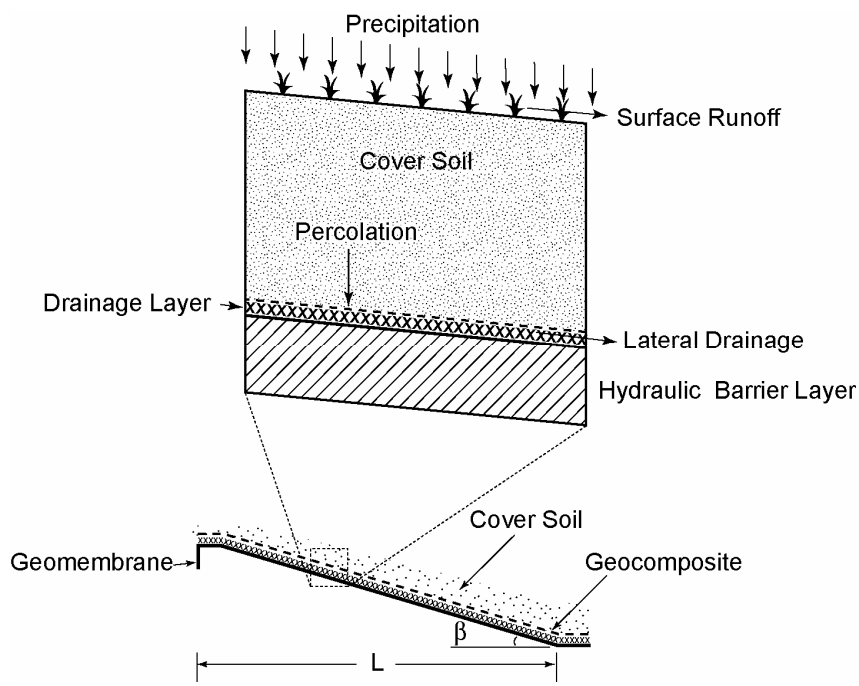


Figure 4.1. Disposition of precipitation in a typical final cover system.

If we desire that all flow that infiltrates down to the drainage geocomposite is carried entirely by the geocomposite (i.e., head above the geomembrane is less than or equal to thickness of the geocomposite), then the limiting flow condition at the downstream end of the geocomposite (per unit width) would be:

$$Q_{out} = \theta_{req} \times i_{out} \tag{4.3}$$

where Q_{out} = the flow rate coming out of the drainage geocomposite (m^3/sec-m); θ_{req} is the transmissivity of the geocomposite (m^3/sec-m); and i_{out} = the gradient of the flow within geocomposite = $\sin\beta$, where β = the slope angle.

By establishing that $Q_{in} = Q_{out}$, an equation can be written solving for the required transmissivity of the geocomposite, as follows:

$$\theta_{req} = \frac{k_{cover} . L}{\sin \beta} \tag{4.4}$$

Note that Equation 4.4 assumes infiltration rate equal to the permeability of the cover soil. In certain dry climates this assumption may be considered overly conservative. In such cases an alternative approach is provided by Soong and Koerner [1997], who describe a method for the calculation of percolation rate - q_i - by estimating rainfall runoff from the cover system. They suggest that an estimate of the percolation rate into the cover drainage layer can be obtained according to:

$$q_i = P(1-RC) \tag{4.5}$$

where q_i = infiltration or percolation rate (m/hr); P = probable maximum precipitation (m/hr); and RC = runoff coefficient (dimensionless, see Table 4.1).

Table 4.1. Typical run-off coefficients for various surface conditions [Daniel, 1993].

Description of the Grass-covered Soil	Slope of Ground Surface	Runoff Coefficient
Sandy soil	Flat (<2%)	0.05 – 0.10
	Mild (2 – 7%)	0.10 – 0.15
	Steep (>7%)	0.15 – 0.20
Clayey soil	Flat (<2%)	0.13 – 0.17
	Mild (2 – 7%)	0.18 – 0.22
	Steep (>7%)	0.25 – 0.35

Required transmissivity (θ_{req}) can then be calculated by substituting k_{cover} in Equation 4.4 with q_i, as follows:

$$\theta_{req} = \frac{q_i . L}{\sin \beta} \tag{4.6}$$

However, Thiel and Stewart [1993] suggest that percolation rate into the drainage layer (q_i) is essentially equal to permeability of cover soil (k_{cover}) when $P(1-RC)>k_{cover}$, i.e.,

factors for each component. The magnitude of each reduction factor (which should be equal to or greater than 1) should reflect a correction that provides a best estimate of the anticipated reduction. It should not be inflated to a larger value to account for uncertainty, since this has already been accounted for in the factor of safety (FS_D). The allowable transmissivity is shown in Equation 4.24 below (see also GRI procedure GC8):

$$\theta_{\text{allow}} = \theta_{\text{req}} \cdot FS_D \cdot RF_{CR} \cdot RF_{CC} \cdot RF_{BC} \tag{4.24}$$

where:
θ_{allow} = allowable transmissivity of geocomposites or geonet (m^2/sec),
FS_D = overall factor of safety for drainage (dimensionless),
RF_{CR} = reduction factor for long-term creep (dimensionless),
RF_{CC} = reduction factor for chemical clogging (dimensionless),
RF_{BC} = reduction factor for biological clogging (dimensionless).

The allowable transmissivity (θ_{allow}) in Equation 4.24 should be compared with the 100-hour transmissivity value obtained from a test. The specified 100-hour transmissivity value should be equal to or higher than the allowable value of transmissivity. Typical 100-hour transmissivity data for some products is presented in Appendix A. The designer should contact manufacturers for the most up-to-date information on their products.

In addition to the reduction factors in Equation 4.24, a review of the chemical compatibility of the resin used in the geonet to the fluid that the geonet will be exposed to, should be performed. Most geonets are made of HDPE, which is very resistant in most environments where they are used; therefore, this is seldom an issue. Ultimately, the engineer's review should result in a "go no-go" determination, in which the designer decides that the material is acceptable for use or not. If it is deemed acceptable, no reduction in the required transmissivity is applied due to the chemical degradation associated with chemical compatibility issues.

The allowable transmissivity discussed here should not be confused with the index transmissivity used for purposes of quality control or conformance testing. The latter is typically performed between steel plates for 15 minutes at a pressure of 10,000 or 15,000 psf and is completely unsuitable for the purpose of design. Project specifications can include both performance and index transmissivity requirements, provided that a clear distinction is made between them.

4.3.1 Drainage Factor of Safety, FS_D

The overall drainage factor of safety should be applied to take into account possible uncertainties in the selection and determination of the design parameters. When selecting an appropriate factor of safety for drainage, the designer should evaluate the criticality of the project, considering such factors as: (i) the cost of repair; (ii) the potential for loss of life; (iii) the certainty of the design parameters; and (iv) the probability of failure. Recommended values of FS_D are typically between 2.0 to 3.0 [Giroud, et al., 2000a], with a larger value resulting in a larger required geocomposite transmissivity, and therefore, higher cost. The authors of this design manual believe that lower-end values (i.e., 2.0) are acceptable for most projects, since the performance

of geosynthetic materials is fairly well established. Narejo & Richardson [2002] propose a value of 2.0 as an overall factor of safety for drainage.

4.3.2 Chemical Clogging Reduction Factor, RF_{CC}

The chemical clogging reduction factor is intended to account for the clogging of the geocomposite due to precipitates deposited from high alkalinity soils (typically calcium and magnesium). The designer should evaluate the soils and waste he/she anticipates being placed on the drainage system. GRI-GC8 recommends using values in the range of 1.0 to 1.2 for chemical clogging in the final cover system (see Table 4.4). If the designer finds that high alkalinity soils or other precipitants are not present, use of the lower value (i.e., 1.0) should be acceptable.

The authors believe that the risk for chemical clogging in the landfill gas collection layer should be similar to that in the leak detection systems. Water vapor within the landfill gas that is collected by the landfill gas collection layer will often condense, resulting in liquid which is referred to as condensate. This condensate often has similar characteristics to landfill leachate; therefore, the authors recommend using a range similar to the LDS (Leakage Detection System) range of 1.1 to 1.5, since the layer will have a level of exposure to leachate similar to that of the LDS. In the absence of available information, the designer is urged to choose a conservative value (i.e., 1.5).

Table 4.4. Chemical clogging and biological clogging reduction factors [GRI GC8].

Application	**Reduction Factor for Chemical Clogging (RF_{CC})**	**Reduction Factor for Biological Clogging (RF_{BC})**
Cover Drainage Layer	1.0 to 1.2	1.2 to 3.5
Leachate Collection and Removal Layer	1.5 to 2.0	1.1 to 1.3
Leakage Detection Layer	1.1 to 1.5	1.1 to 1.3

The designer should evaluate the soils he/she anticipates using in the protective layer of the liner system and the materials anticipated in the overlying waste, in order to estimate the risk of chemical clogging of the primary leachate collection layer. GRI-GC8 recommends using values in the range of 1.5 to 2.0 for chemical clogging in the leachate collection system (see Table 4.4). Values at the lower end of the range should be used for municipal solid waste.

GRI-GC8 recommends using values in the range of 1.1 to 1.5 for chemical clogging in the leakage detection layer (see Table 4.4). The designer should evaluate the soils he/she anticipates using in the protective layer of the liner system and the typical materials anticipated in the waste stream, in order to evaluate the risk of chemical clogging.

4.3.3 Biological Clogging Reduction Factor, RF_{BC}

The biological clogging reduction factor accounts for the reduction of flow in the geonet due to the growth of biological organisms such as fungi or algae, or root penetration through the overlying soil. GRI-GC8 recommends using values in the range of 1.2 to 3.5 for biological

clogging in the final cover system (see Table 4.4). The authors consider the upper end of this range to constitute a condition whereby improper design of the cover allows root penetration to occur. Coordination is required with a plant biologist and the cover system designer to understand how prolific and how deep roots may develop. The reduction factor for biological clogging should then represent anticipated design conditions.

GRI-GC8 does not provide explicit recommendations for selecting a biological clogging reduction factor for a landfill gas collection layer. A comparison to the other functions described in GRI-GC8 can nonetheless be made. The authors believe that the risk for biological clogging in the landfill gas collection layer should be similar to the leakage detection layer. The authors recommend using a range similar to that in the leakage detection layer range of 1.1 to 1.3, since the layer's level of exposure to leachate will be similar to that of the LDS. In the absence of available information, the designer is urged to choose a conservative value (i.e., 1.3).

GRI-GC8 recommends using values in the range of 1.1 to 1.3 for biological clogging in the leachate collection system (see Table 4.4). The designer should evaluate the conditions anticipated in the landfill to select an appropriate value for the biological clogging reduction factor. In the absence of available information, the designer is urged to choose a conservative value (i.e., 1.3).

GRI-GC8 recommends using values in the range of 1.1 to 1.3 for biological clogging in the leakage detection system (see Table 4.4). The designer should evaluate the conditions anticipated in the landfill to select an appropriate value for the biological clogging reduction factor. In the absence of available information, the designer is urged to choose a conservative value (i.e., 1.3).

4.3.4 Creep Reduction Factors, RF_{CR}

Performance transmissivity tests are typically conducted for up to 100 hours, as required by GRI test procedure GC8. The decrease in transmissivity with time levels off within 100 hours (and usually much sooner than that), indicating that much of the initial compression and intrusion has already taken place (see Figure 2.10). Reduction factor for creep, RF_{CR}, accounts for the decrease in transmissivity beyond the first 100 hours covered by the performance transmissivity test. The quality of the geonet core, including its structure, thickness, mass and density can have a significant influence on creep reduction factors. Appendix B presents creep reduction factors for geonets manufactured by GSE Lining Technology, Inc. Products from other manufacturers can have creep factors different from those given here.

Regardless of the type of product, creep increases with increasing overburden stress. For this reason, creep reduction factors for cover applications (i.e., cover drainage and gas removal layers) are significantly smaller than those for liner system applications (i.e., LCRS and LDS). As shown in Appendix B, a creep reduction factor of 1.1 is adequate for most cover projects. Creep reduction factors should be selected on the basis of normal stress for LCRS and LDS.

4.4 Design Compression Strength of Geonets and Geocomposites

4.4.1 Introduction

APPENDIX VI

Calculations Addressing Stormwater Management

APPENDIX VI-1

Cover System Stormwater Calculation

Calculation Title:
Cover System Stormwater Calculation

Summary:
The geocomposite transmissivity as tested in a laboratory must be greater than 6.87×10^{-4} m^2/sec. Geocomposite outlets should be spaced at intervals of 90 horizontal feet.

The drainage area to the top deck underdrain and channel should be limited to 6.0 acres between outlets. The top deck channel should be matted following construction.

Tack-on benches should have a maximum length of 500 linear feet and be spaced at intervals of 90 horizontal feet (maximum drainage area = 1.03 acres). The tack-on benches should be matted following construction.

Downdrains should be 24-inch diameter dual-wall corrugated HDPE pipes. Drainage areas to downdrains should be limited to 7.50 acres.

Drop inlets should have a Nyloplast 24-inch diameter dome grate. Drainage areas to drop inlets should be limited to 1.03 acres.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal	Cedric H Ruhl		Thomas B Maier
		Cedric H. Ruhl	**Tryambak Kaushik**	**Thomas B. Maier**

OBJECTIVE:

The objective of this calculation is to provide design guidelines for the cover system stormwater components for the proposed Dan River Landfill.

METHOD:

The cover system stormwater components are anticipated to include:

- Cover system geocomposite;
- Top deck underdrain;
- Top deck channel;
- Tack-on benches;
- Downdrains; and
- Drop inlets and flared end sections.

The cover system geocomposite and top deck underdrain capacity will be evaluated using the unit gradient method and Manning's equation. The top deck channel, tack-on benches, downdrains, and drop inlet capacities will be evaluated using the SCS method and Manning's equation.

DEFINITION OF VARIABLES:

β = slope angle;
τ = shear;
θ = transmissivity;
A = area;
b = bottom width;
CN = curve number;
d = flow depth;
D = channel depth;
FS = safety factor;
i = rainfall depth;
k = hydraulic conductivity;
L = length;
n = Manning's n;
P = wetted perimeter;
Q = flow;
R = hydraulic radius;
RF = reduction factor;
S = longitudinal slope;
T = top width;
T_c = time of concentration;
V = velocity; and
Z = channel side slope.

CALCULATIONS:

1.0 Cover system geocomposite

The cover system will consist of the following components, from the top to the bottom:

- Cover soil (2 feet);
- Geocomposite drainage layer;
- Geomembrane;
- Interim soil cover (1 foot); and
- Waste.

Water which infiltrates the 2 feet of cover soil will be collected in the geocomposite drainage layer and discharged to geocomposite outlets. As shown in the "Veneer Stability Calculation" package, the cover soil on the top deck can be saturated and maintain adequate safety factors for veneer stability; while the cover soil on the landfill side slopes was assumed to be unsaturated. The capacity of the geocomposite must be large enough to prevent saturation of the cover soil on the landfill side slopes; however, it is not necessary for the capacity of the geocomposite to be large enough to prevent saturation of the cover soil on the landfill top deck. Therefore, the geocomposite will be designed based on conditions on slopes.

Design criteria for the cover system geocomposite was evaluated by first estimating the peak flow to the geocomposite on slopes then evaluating the required geocomposite capacity.

1.1 Cover system geocomposite peak flow

The cover system geocomposite peak flow was evaluated using the unit gradient method, which assumes that the cover soil is saturated but does not pond water. The peak flow to the geocomposite is estimated per unit foot between geocomposite outlets (on slopes) spaced at horizontal length "L" as shown in the following equation:

$$Q = k_{cover} L$$ [Ref. 1]

The geocomposite outlets will be located at the same spacing as tack-on benches, which will be spaced at 90-foot horizontal intervals (every 30 vertical feet) to decrease surface erosion. The cover system geocomposite peak flow is estimated as shown in the following table:

Table 1: Cover System Geocomposite Peak Flow

Hydraulic Conductivity of Cover Soils {k_{cover}} (cm/sec) [assumed]	Hydraulic Conductivity of Cover Soils {k_{cover}} (ft/sec) [assumed]	Geocomposite Outlet Spacing {L} (ft) [assumed]	Cover System Geocomposite Peak Flow {Q} (cfs/ft)
1.00E-04	3.28E-06	90	2.95E-04

1.2 Cover system geocomposite required capacity

The cover system geocomposite must have a capacity equal to or greater than the cover system geocomposite peak flow. Geocomposite capacity is measured in terms of transmissivity "θ". The required transmissivity "θ_{req}" of the geocomposite was estimated with the following equation:

$$\theta_{req} = \frac{Q}{sin\beta}$$ [Ref. 1]

The required transmissivity of the geocomposite was estimated as shown in the following table:

Table 2: Cover System Geocomposite Required Transmissivity				
Cover System Geocomposite Peak Flow {Q} (cfs/ft)	Cover System Side Slope {ZH:1V} [assumed]	Cover System Side Slope {β} (degrees)	Required Geocomposite Transmissivity {θ_{req}} (ft^2/s)	Required Geocomposite Transmissivity {θ_{req}} (m^2/s)
2.95E-04	3	18.43	9.34E-04	8.67E-05

The transmissivity required to convey the peak flow was estimated as shown above and can be converted into an allowable transmissivity (i.e. a specified value for transmissivity testing) by applying a drainage safety factor and reduction factors for long-term creep, chemical clogging, and biological clogging as shown in the following equation:

$$\theta_{allow} = \theta_{req} FS_D RF_{CR} RF_{CC} RF_{BC}$$ [Ref. 1]

The safety factor and reduction factors were selected based on recommended values for cover systems from Bachus et. al. [Ref. 1]. The allowable transmissivity for specification purposes was estimated as shown in the following table:

Table 3: Cover System Geocomposite Allowable Transmissivity					
Required Geocomposite Transmissivity {θ_{req}} (m^2/s)	Safety Factor for Drainage {FS_D} [Ref. 1]	Reduction Factor for Long-Term Creep {RF_{CR}} [Ref. 1]	Reduction Factor for Chemical Clogging {RF_{CC}} [Ref. 1]	Reduction Factor for Biological Clogging {RF_{BC}} [Ref. 1]	Allowable Geocomposite Transmissivity {θ_{allow}} (m^2/s)
8.67E-05	2.0	1.1	1.2	3.0	6.87E-04

The geocomposite transmissivity as tested in a laboratory must be greater than 6.87×10^{-4} m^2/sec to provide adequate cover system geocomposite capacity. Refer to the discussion section of this calculation for transmissivity testing considerations.

2.0 Top deck underdrain

An underdrain will be located along the low edge of the top deck of the landfill to collect infiltration from the geocomposite drainage layer. The underdrain will consist of a 6-inch diameter HDPE pipe bedded in drainage aggregate and wrapped with a non-woven geotextile.

The underdrain will be installed at the same general location as the top deck channel and will be placed at a 2 percent longitudinal slope.

Design criteria for the top deck underdrain were developed by first evaluating the underdrain capacity using Manning's equation, then estimating the maximum allowable tributary drainage area using the unit gradient method.

2.1 Top deck underdrain capacity

The top deck underdrain capacity was evaluated using Manning's equation presented as follows:

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$ [Ref. 2]

And

$$Q = AV$$ [Ref. 2]

The pipe underdrain pipe will be 6-inch diameter ADS N-12 pipe or equivalent, with properties as presented in Reference 3. For a circular pipe flowing full, the hydraulic radius "R" is equal to the pipe diameter "D" divided by 4. The top deck underdrain capacity was estimated as shown in the following table:

Table 4: Top Deck Underdrain Capacity

Pipe Inside Diameter {D} (in) [Ref. 3]	Manning's n of Pipe [Ref. 3]	Hydraulic Radius {R} (ft)	Pipe Cross-Sectional Area {A} (ft^2)	Underdrain Longitudinal Slope {S} (ft/ft) [assumed]	Flow Velocity {V} (ft/s)	Underdrain Capacity {Q} (cfs)
6	0.012	0.1250	0.1963	0.0200	4.39	0.86

2.2 Top deck underdrain maximum allowable tributary drainage area

The top deck underdrain maximum allowable tributary drainage area was estimated by using the underdrain capacity and unit gradient method presented in Section 1.1 of this calculation as shown in the following table:

Table 5: Top Deck Underdrain Maximum Allowable Drainage Area

Underdrain Capacity {Q} (cfs)	Hydraulic Conductivity of Cover Soils {k_{cover}} (cm/sec) [assumed]	Hydraulic Conductivity of Cover Soils {k_{cover}} (ft/sec) [assumed]	Maximum Allowable Tributary Drainage Area {A} (ft^2)	Maximum Allowable Tributary Drainage Area {A} (ac)
0.86	1.00E-04	3.28E-06	262,727	6.03

The maximum allowable tributary drainage area for the underdrain is approximately 6 acres for the conditions modeled.

3.0 Top deck channel

A channel will be located along the low edge of the top deck of the landfill to collect stormwater. The top deck channel will be installed at a 2 percent longitudinal slope. Because the top deck channel will be installed at the same location as the top deck underdrain, the limiting drainage area of 6 acres for the underdrain was used to calculate peak flow rates to the channel.

Design criteria for the top deck channel was evaluated by first estimating the peak flow to the channel using the SCS method, then evaluating the channel capacity using Manning's equation.

3.1 Top deck channel peak flow rates

HydroCAD software [Ref. 4] was used to calculate the peak runoff flow rate to the top deck channel for the 2-year bare soil condition and the 50-year vegetated condition. Peak runoff was estimated using the SCS method assuming a 6-minute time of concentration [Ref. 7] and hydric soil class C as summarized in the following table:

Table 6: Top Deck Channel Peak Flow Rates

Node	Description	Storm Recurrence Interval (years)	Rainfall for 24-Hour Storm {i} (in) [Ref. 5]	Curve Number {CN} [Ref. 2]	Drainage Area {A} (ac)	Time of Concentration {T_c} (min) [assumed]	Peak Runoff {Q} (cfs) [Ref. 4]
TDC-Soil	top deck channel drainage area is newly graded	2	3.40	91	6.0	6	24.20
TDC-Grass	top deck channel drainage area is vegetated	50	7.17	74	6.0	6	42.85

3.2 Top deck channel capacity

The top deck channel will consist of a v-shaped channel with relatively flat side slopes; the proposed top deck channel dimensions are presented in the following table:

Table 7: Top Deck Channel Dimensions

Bottom Width {b} (ft)	Depth {D} (ft)	Left Side Slope {Z_1H:V}	Right Side Slope {Z_2H:V}	Top Width {T} (ft)	Longitudinal Slope {S} (ft/ft)
0	2	12.5	12.5	50	0.0200

The top deck channel capacity was evaluated using Manning's equation, previously presented in Section 2.1 of this calculation.

The flow area "A" and wetted perimeter "P" were calculated using the following relationships based on the geometry of a trapezoidal channel with a flow depth "d", bottom width "b", left side slope "Z_1", and right side slope "Z_2":

$$A = bd + 0.5Z_1d^2 + 0.5Z_2d^2$$
$$P = b + \sqrt{[(Z_1d)^2 + d^2]} + \sqrt{[(Z_2d)^2 + d^2]}$$

The top deck channel capacity was evaluated assuming a soil channel lining for the 2-year storm and a vegetated channel lining for the 50-year storm. The trial flow depth and Manning's n were iteratively modified until the channel capacity exceeded the peak runoff for the conditions modeled. A vegetative retardance class "C" was assumed for the grass channel lining condition. Channel capacity was estimated as shown in the following table:

Table 8: Top Deck Channel Capacity

Channel Lining	Storm Recurrence Interval (years)	Manning's n {n} [Ref. 2]	Trial Flow Depth {d} (ft)	Flow Area {A} (ft^2)	Wetted Perimeter {P} (ft)	Hydraulic Radius {R} (ft)	Velocity {V} (ft/s)	Channel Capacity {Q} (cfs)	Peak Runoff {Q} (cfs)	Channel Capacity > Peak Runoff?	Freeboard (in)
soil	2	0.020	0.64	5.12	16.05	0.32	4.92	25.18	24.20	yes	16
grass	50	0.070	1.25	19.53	31.35	0.62	2.20	42.89	42.85	yes	9

The permissible velocity for a channel with grass lining (tall fescue), slope of 0-5 percent, and easily erodible soils is 4.5 feet per second [Ref. 2] which is greater than the calculated channel velocity of 2.20 feet per second for the conditions modeled. The top deck channel is anticipated to be stable when vegetated for the conditions modeled. The estimated freeboard for the vegetated condition is 6 inches, indicating that the channel has excess flow capacity.

The permissible velocity for a channel with soil lining is 2.5 feet per second [Ref. 2] which is less than the calculated channel velocity of 4.92 feet per second for the conditions modeled; therefore, a temporary channel lining should be installed until vegetation is established. Assuming a straw with net rolled erosion control product is used, the Manning's n and flow regime will be different than the bare soil condition. The top deck channel capacity with matting was estimated as shown in the following table:

Table 9: Top Deck Channel Capacity with Matting

Channel Lining	Storm Recurrence Interval (years)	Manning's n {n} [Ref. 2]	Trial Flow Depth {d} (ft)	Flow Area {A} (ft^2)	Wetted Perimeter {P} (ft)	Hydraulic Radius {R} (ft)	Velocity {V} (ft/s)	Channel Capacity {Q} (cfs)	Peak Runoff {Q} (cfs)	Channel Capacity > Peak Runoff?	Freeboard (in)
straw with net	2	0.033	0.77	7.41	19.31	0.38	3.37	24.99	24.20	yes	15

Channel matting is typically specified by its permissible shear. Actual flow shear is calculated using the following equation:

$$\tau = \gamma_{water} dS$$ [Ref. 2]

The minimum permissible shear for matting stability was estimated as shown in the following table:

Table 10: Top Deck Channel Matting Requirements

Channel Lining	Unit Weight of Water {γ_{water}} (pcf)	Flow Depth {d} (ft)	Longitudinal Slope {S} (ft/ft)	Minimum Permissible Shear for Matting {τ} (psf)
straw with net	62.4	0.77	0.0200	0.96

A rolled erosion control product with a minimum permissible shear in excess of 0.96 psf should be installed within the top deck channel following construction.

4.0 Tack-on Benches

Tack-on benches are soil berms that will be installed along the side slopes of the landfill to intercept stormwater runoff and outlet the geocomposite drainage layer.

Design criteria for the tack-on benches was evaluated by first estimating the peak flow to the tack-on bench using the SCS method, then evaluating the tack-on bench capacity using Manning's equation.

4.1 Tack-on bench peak flow rates

For the purposes of constructability it was assumed that the maximum tack-on bench length is 500 linear feet. As previously stated in Section 1.1 of this calculation, the tack-on benches will be spaced at 90-foot horizontal intervals (every 30 vertical feet) to prevent surface erosion. Thus, the maximum drainage area to a tack-on bench is 500 ft x 90 ft = 45,000 ft^2 = 1.03 acres.

A portion of the flow to tack-on benches will consist of infiltration flow collected from the geocomposite outlets. The contribution of flow from geocomposite outlets was estimated using the unit gradient method presented in Section 1.1 of this calculate and shown in the following table:

Table 11: Contribution of Flow to Tack-On Bench from Geocomposite Outlet

Hydraulic Conductivity of Cover Soils {k_{cover}} (cm/sec) [assumed]	Hydraulic Conductivity of Cover Soils {k_{cover}} (ft/sec) [assumed]	Maximum Drainage Area {A} (ac) [assumed]	Contribution of Flow from Geocomposite Outlet {Q} (cfs)
1.00E-04	3.28E-06	1.03	0.15

HydroCAD software [Ref. 4] was used to calculate the peak runoff flow rate to a typical tack-on bench for the 2-year bare soil condition and the 50-year vegetated condition. Peak runoff was estimated using the SCS method assuming a 6-minute time of concentration [Ref. 7] and hydric soil class C as summarized in the following table:

Table 12: Tack-On Bench Peak Flow Rates

Node	Description	Storm Recurrence Interval (years)	Rainfall for 24-Hour Storm {i} (in) [Ref. 5]	Curve Number {CN} [Ref. 2]	Drainage Area {A} (ac)	Time of Concentration {T_c} (min) [assumed]	Peak Runoff {Q} (cfs) [Ref. 4]	Contribution of Flow from Geocomposite Outlet {Q} (cfs)	Peak Flow {Q} (cfs) [Ref. 4]
TOB-Soil	tack-on bench drainage area is newly graded	2	3.40	91	1.03	6	4.17	0.15	4.32
TOB-Grass	tack-on bench drainage area is vegetated	50	7.17	74	1.03	6	7.38	0.15	7.53

4.2 Tack-on bench capacity

The tack-on benches will consist of a v-shaped channel with dimensions as presented in the following table:

Table 13: Tack-On Bench Dimensions					
Bottom Width {b} (ft)	Depth {D} (ft)	Left Side Slope {Z_1H:V}	Right Side Slope {Z_2H:V}	Top Width {T} (ft)	Longitudinal Slope {S} (ft/ft)
0	1.5	3	3	9	0.0200

The tack-on bench capacity was evaluated using Manning's equation previously presented in Section 2.1 of this calculation, and the flow area "A" and wetted perimeter "P" previously presented in Section 3.2 of this calculation.

The tack-on bench capacity was evaluated assuming a soil channel lining for the 2-year storm and a vegetated channel lining for the 50-year storm. The trial flow depth and Manning's n were iteratively modified until the channel capacity exceeded the peak runoff for the conditions modeled. A vegetative retardance class "C" was assumed for the grass channel lining condition. Tack-on bench capacity was estimated as shown in the following table:

Table 14: Tack-On Bench Capacity											
Channel Lining	Storm Recurrence Interval (years)	Manning's n {n} [Ref. 2]	Trial Flow Depth {d} (ft)	Flow Area {A} (ft^2)	Wetted Perimeter {P} (ft)	Hydraulic Radius {R} (ft)	Velocity {V} (ft/s)	Channel Capacity {Q} (cfs)	Peak Runoff {Q} (cfs)	Channel Capacity > Peak Runoff?	Freeboard (in)
soil	2	0.020	0.58	1.01	3.67	0.28	4.46	4.50	4.32	yes	11
grass	50	0.085	1.22	4.47	7.72	0.58	1.72	7.69	7.53	yes	3

The permissible velocity for a channel with grass lining (tall fescue), slope of 0-5 percent, and easily erodible soils is 4.5 feet per second [Ref. 2] which is greater than the calculated tack-on bench velocity of 1.72 feet per second for the conditions modeled. The tack-on benches are anticipated to be stable when vegetated for the conditions modeled. The estimated freeboard for the vegetated condition is 3 inches, indicating that the channel has excess flow capacity.

The permissible velocity for a channel with soil lining is 2.5 feet per second [Ref. 2] which is less than the calculated channel velocity of 4.46 feet per second for the conditions modeled; therefore, a temporary channel lining should be installed until vegetation is established. Assuming a straw with net rolled erosion control product is used, the Manning's n and flow regime will be different from the bare soil condition. The tack-on bench capacity with matting was estimated as shown in the following table:

Table 15: Tack-On Bench Capacity with Matting											
Channel Lining	Storm Recurrence Interval (years)	Manning's n {n} [Ref. 2]	Trial Flow Depth {d} (ft)	Flow Area {A} (ft^2)	Wetted Perimeter {P} (ft)	Hydraulic Radius {R} (ft)	Velocity {V} (ft/s)	Channel Capacity {Q} (cfs)	Peak Runoff {Q} (cfs)	Channel Capacity > Peak Runoff?	Freeboard (in)
straw with net	2	0.033	0.69	1.43	4.36	0.33	3.03	4.33	4.32	yes	10

The minimum permissible shear for matting stability was estimated using the equations presented in Section 3.2 of this calculation as shown in the following table:

Table 16: Tack-On Bench Matting Requirements				
Channel Lining	Unit Weight of Water {γ_{water}} (pcf)	Flow Depth {d} (ft)	Longitudinal Slope {S} (ft/ft)	Minimum Permissible Shear for Matting {τ} (psf)
straw with net	62.4	0.69	0.0200	0.86

A rolled erosion control product with a minimum permissible shear in excess of 0.86 psf should be installed within the tack-on benches following construction.

5.0 Downdrains

Dual-wall corrugated HDPE downdrains will collect flow from tack-on benches, the top deck underdrain, and the top deck channel and convey the flow to channels located around the perimeter of the landfill. Landfill perimeter channel capacity is evaluated in the "Landfill Perimeter Stormwater Calculation" package.

Design criteria for the downdrains was evaluated by first evaluating the downdrain capacity using Manning's equation, then estimating the maximum allowable tributary drainage area using the SCS method.

5.1 Downdrain capacity

Downdrain capacity was evaluated using Manning's equation previously presented in Section 2.1 of this calculation as shown in the following table:

Table 17: Downdrain Capacity						
Pipe Inside Diameter {D} (in) [Ref. 3]	Manning's n of Pipe [Ref. 3]	Hydraulic Radius {R} (ft)	Pipe Cross-Sectional Area {A} (ft^2)	Downdrain Longitudinal Slope {S} (ft/ft) [assumed]	Flow Velocity {V} (ft/s)	Downdrain Capacity {Q} (cfs)
24	0.012	0.5000	3.1416	0.0500	17.49	54.95

5.2 Downdrain maximum allowable tributary drainage area

HydroCAD software [Ref. 4] was used to estimate the maximum allowable tributary drainage area to a typical downdrain for the 2-year bare soil condition and the 50-year vegetated condition. Peak runoff was estimated using the SCS method assuming a 6-minute time of concentration [Ref. 7] and hydric soil class C.

A portion of the flow to the downdrains will consist of infiltration flow collected from the geocomposite outlets. The contribution of flow from geocomposite outlets was estimated using the unit gradient method presented in Section 1.1 of this calculation.

The maximum allowable tributary drainage area to a typical downdrain was estimated using the following iterative approach:

1. Using HydroCAD, modify the tributary drainage area until the calculated runoff is approximately equal to the downdrain capacity;
2. Estimate contribution of flow from geocomposite outlet drainage for the tributary drainage area calculated in Step 1 (lowest area controls);
3. Using HydroCAD, modify the tributary drainage area until the calculated runoff is approximately equal to the downdrain capacity less the flow from geocomposite outlet drainage.

The iterative approach is summarized as shown in the following tables:

Table 18: Peak Runoff to Downdrains

Node	Description	Storm Recurrence Interval (years)	Rainfall for 24-Hour Storm {i} (in) [Ref. 5]	Curve Number {CN} [Ref. 2]	Drainage Area {A} (ac)	Time of Concentration {T_c} (min) [assumed]	Peak Runoff {Q} (cfs) [Ref. 4]
DD-Soil	downdrain drainage area is newly graded	2	3.40	91	13.31	6	54.44
DD-Grass	downdrain drainage area is vegetated	50	7.17	74	7.50	6	53.56

Table 19: Contribution of Flow to Downdrain from Geocomposite Outlet

Hydraulic Conductivity of Cover Soils {k_{cover}} (cm/sec) [assumed]	Hydraulic Conductivity of Cover Soils {k_{cover}} (ft/sec) [assumed]	Controlling Drainage Area {A} (ac)	Contribution of Flow from Geocomposite Outlet {Q} (cfs)
1.00E-04	3.28E-06	7.50	1.07

Table 20: Downdrain Capacity Check

Controlling Drainage Area {A} (ac)	Peak Runoff {Q} (cfs) [Ref. 4]	Contribution of Flow from Geocomposite Outlet {Q} (cfs)	Total Flow to Downdrain {Q} (cfs)	Downdrain Capacity {Q} (cfs)	Downdrain Capacity > Total Flow to Downdrain?
7.50	53.56	1.07	54.63	54.95	yes

The maximum allowable downdrain drainage area is 7.5 acres.

6.0 Drop inlets and flared end sections

Drop inlets will be installed to convey flow from top deck channels and tack-on benches to downdrains. The drop inlets will have a grate which may impact flow capacity. Additionally, during landfill operations, the flow from tack-on benches will discharge into downdrains through a flared end section.

Design criteria for the drop inlets was evaluated by first selecting a drop inlet grate and then comparing the drop inlet grate capacity to the flow rates previously estimated in this calculation.

Design criteria for the flared end section during operations was evaluated using HydroCAD software [Ref. 4].

6.1 Drop inlet grate capacity

During landfill operations, the flow from tack-on benches will discharge into downdrains using a drop inlet. The drop inlet will be a Nyloplast 24-inch diameter dome grate, with inlet capacity as shown in Reference 6. The capacity of the drop inlet grates was evaluated as shown in the following table:

Table 21: Drop Inlet Grate Capacity

Device Contributing Flow	Flow {Q} (cfs)	No. of Drop Inlets	Flow per Inlet {Q} (cfs)	Maximum Allowable Flow Depth (ft)	Head (ft) [Ref. 6]	Freeboard (in)
tack-on bench (final cover conditions)	7.53	1	7.53	1.5	0.73	9

The Nyloplast 24-inch diameter dome grate provides freeboard for the conditions modeled for the tack-on bench during final cover conditions.

6.2 Flared end section capacity

During landfill operations, the flow from tack-on benches will discharge into downdrains using a flared end section. The capacity of the flared end section was evaluated using HydroCAD software and summarized in the following table:

Table 22: Flared End Section Capacity

Device Contributing Flow	Flow {Q} (cfs)	No. of Flared End Sections	Flow per Flared End Section {Q} (cfs)	Maximum Allowable Flow Depth (ft)	Head (ft) [Ref. 6]	Freeboard (in)
tack-on bench (landfill operations)	7.53	1	7.53	1.5	1.37	2

A flared end section provides freeboard for the conditions modeled for the tack-on bench during landfill operations.

DISCUSSION:

The proposed stormwater features have capacity for the conditions modeled.

The geocomposite transmissivity as tested in a laboratory must be greater than 6.87×10^{-4} m^2/sec to provide adequate cover system geocomposite capacity. The transmissivity testing parameters should be consistent with the proposed cover system design. Recommended cover system geocomposite transmissivity parameters are listed as follows:

- Upper material = 2 feet of site-specific cover soil compacted to 95 percent of Standard Proctor maximum dry density and within 3 percent of optimum moisture content;
- Lower material = geomembrane proposed for cover system;
- Seating time = 100 hours;
- Hydraulic gradient = 0.33; and

- Normal load = 1000 psf.

Note that these testing requirements apply to the geocomposite proposed for the cover system. Refer to the "Liner System Geocomposite Calculation" package for transmissivity testing requirements for geocomposite proposed for the liner system.

REFERENCES:

1. Bachus, Robert et. al. "The GSE Drainage Design Manual", second edition, June 2007.
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6. Nyloplast manufacturers product information, copyright June 2012.
7. United States Department of Agriculture, "Urban Hydrology for Small Watersheds", Technical Release 55, June 1986.

REFERENCE 1

Bachus, Robert et. al. “The GSE Drainage Design Manual”, second edition, June 2007.

4.2.1 Final Cover Drainage Layer

The final cover geocomposite is relatively close to the surface of the landfill, and is therefore directly affected by short-term inputs from precipitation. The geocomposite is typically overlain by approximately 2-ft (0.6 m) of protective and vegetative soil. The properties of this soil layer can significantly influence how much precipitation impinges on the drainage layer.

Thiel and Stewart [1993] describe a relatively simple and conservative method of estimating the amount of liquid that may percolate into the drainage layer. Their approach has since been labeled the "unit gradient" method. The basis for this method is that for the critical condition it can be assumed that the cover soil is saturated, and water from continued rains will percolate vertically through the cover soil. Since the head on top of the cover soil is practically zero (due to runoff), the gradient through the cover soil is unity. Therefore Darcy's law gives the inflow percolation as (see also Figure 4.1):

$$Q_{in} = k_{cover} \times i_{in} \times A \tag{4.1}$$

where Q_{in} = inflow percolation rate (m^3/sec); i_{in} = inflow gradient = 1; and A = area (m^2).

If we examine a unit width of the cover slope, the area would be equal to the slope length (or distance between drainage outlets), L, times the unit width. Therefore,

$$Q_{in} = k_{cover} \times L \tag{4.2}$$

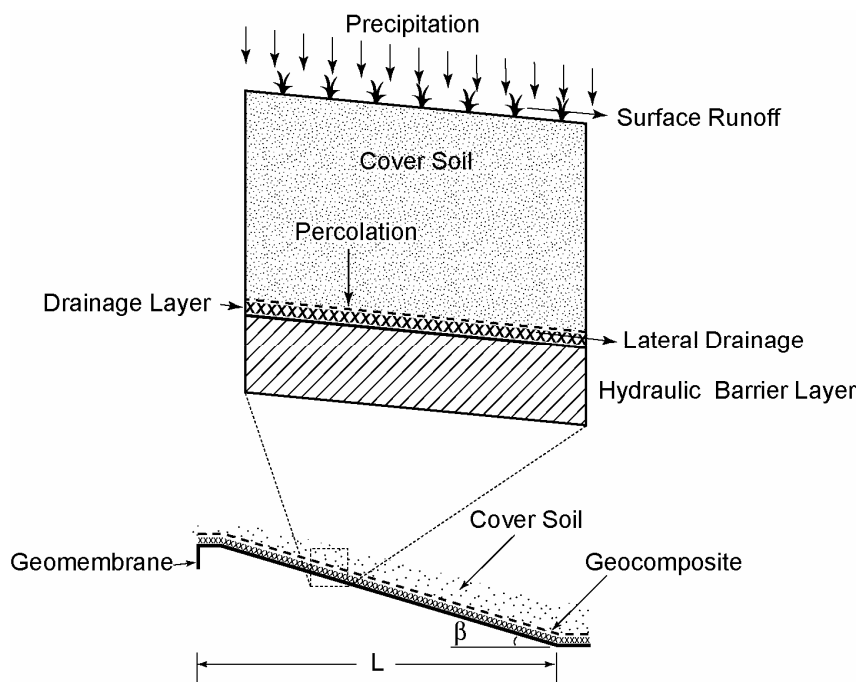


Figure 4.1. Disposition of precipitation in a typical final cover system.

If we desire that all flow that infiltrates down to the drainage geocomposite is carried entirely by the geocomposite (i.e., head above the geomembrane is less than or equal to thickness of the geocomposite), then the limiting flow condition at the downstream end of the geocomposite (per unit width) would be:

$$Q_{out} = \theta_{req} \times i_{out} \tag{4.3}$$

where Q_{out} = the flow rate coming out of the drainage geocomposite (m^3/sec-m); θ_{req} is the transmissivity of the geocomposite (m^3/sec-m); and i_{out} = the gradient of the flow within geocomposite = $\sin\beta$, where β = the slope angle.

By establishing that $Q_{in} = Q_{out}$, an equation can be written solving for the required transmissivity of the geocomposite, as follows:

$$\theta_{req} = \frac{k_{cover} . L}{\sin \beta} \tag{4.4}$$

Note that Equation 4.4 assumes infiltration rate equal to the permeability of the cover soil. In certain dry climates this assumption may be considered overly conservative. In such cases an alternative approach is provided by Soong and Koerner [1997], who describe a method for the calculation of percolation rate - q_i - by estimating rainfall runoff from the cover system. They suggest that an estimate of the percolation rate into the cover drainage layer can be obtained according to:

$$q_i = P(1-RC) \tag{4.5}$$

where q_i = infiltration or percolation rate (m/hr); P = probable maximum precipitation (m/hr); and RC = runoff coefficient (dimensionless, see Table 4.1).

Table 4.1. Typical run-off coefficients for various surface conditions [Daniel, 1993].

Description of the Grass-covered Soil	Slope of Ground Surface	Runoff Coefficient
Sandy soil	Flat (<2%)	0.05 – 0.10
	Mild (2 – 7%)	0.10 – 0.15
	Steep (>7%)	0.15 – 0.20
Clayey soil	Flat (<2%)	0.13 – 0.17
	Mild (2 – 7%)	0.18 – 0.22
	Steep (>7%)	0.25 – 0.35

Required transmissivity (θ_{req}) can then be calculated by substituting k_{cover} in Equation 4.4 with q_i, as follows:

$$\theta_{req} = \frac{q_i . L}{\sin \beta} \tag{4.6}$$

However, Thiel and Stewart [1993] suggest that percolation rate into the drainage layer (q_i) is essentially equal to permeability of cover soil (k_{cover}) when $P(1-RC)>k_{cover}$, i.e.,

factors for each component. The magnitude of each reduction factor (which should be equal to or greater than 1) should reflect a correction that provides a best estimate of the anticipated reduction. It should not be inflated to a larger value to account for uncertainty, since this has already been accounted for in the factor of safety (FS_D). The allowable transmissivity is shown in Equation 4.24 below (see also GRI procedure GC8):

$$\theta_{\text{allow}} = \theta_{\text{req}} \cdot FS_D \cdot RF_{CR} \cdot RF_{CC} \cdot RF_{BC} \tag{4.24}$$

where:
θ_{allow} = allowable transmissivity of geocomposites or geonet (m^2/sec),
FS_D = overall factor of safety for drainage (dimensionless),
RF_{CR} = reduction factor for long-term creep (dimensionless),
RF_{CC} = reduction factor for chemical clogging (dimensionless),
RF_{BC} = reduction factor for biological clogging (dimensionless).

The allowable transmissivity (θ_{allow}) in Equation 4.24 should be compared with the 100-hour transmissivity value obtained from a test. The specified 100-hour transmissivity value should be equal to or higher than the allowable value of transmissivity. Typical 100-hour transmissivity data for some products is presented in Appendix A. The designer should contact manufacturers for the most up-to-date information on their products.

In addition to the reduction factors in Equation 4.24, a review of the chemical compatibility of the resin used in the geonet to the fluid that the geonet will be exposed to, should be performed. Most geonets are made of HDPE, which is very resistant in most environments where they are used; therefore, this is seldom an issue. Ultimately, the engineer's review should result in a "go no-go" determination, in which the designer decides that the material is acceptable for use or not. If it is deemed acceptable, no reduction in the required transmissivity is applied due to the chemical degradation associated with chemical compatibility issues.

The allowable transmissivity discussed here should not be confused with the index transmissivity used for purposes of quality control or conformance testing. The latter is typically performed between steel plates for 15 minutes at a pressure of 10,000 or 15,000 psf and is completely unsuitable for the purpose of design. Project specifications can include both performance and index transmissivity requirements, provided that a clear distinction is made between them.

4.3.1 Drainage Factor of Safety, FS_D

The overall drainage factor of safety should be applied to take into account possible uncertainties in the selection and determination of the design parameters. When selecting an appropriate factor of safety for drainage, the designer should evaluate the criticality of the project, considering such factors as: (i) the cost of repair; (ii) the potential for loss of life; (iii) the certainty of the design parameters; and (iv) the probability of failure. Recommended values of FS_D are typically between 2.0 to 3.0 [Giroud, et al., 2000a], with a larger value resulting in a larger required geocomposite transmissivity, and therefore, higher cost. The authors of this design manual believe that lower-end values (i.e., 2.0) are acceptable for most projects, since the performance

of geosynthetic materials is fairly well established. Narejo & Richardson [2002] propose a value of 2.0 as an overall factor of safety for drainage.

4.3.2 Chemical Clogging Reduction Factor, RF_{CC}

The chemical clogging reduction factor is intended to account for the clogging of the geocomposite due to precipitates deposited from high alkalinity soils (typically calcium and magnesium). The designer should evaluate the soils and waste he/she anticipates being placed on the drainage system. GRI-GC8 recommends using values in the range of 1.0 to 1.2 for chemical clogging in the final cover system (see Table 4.4). If the designer finds that high alkalinity soils or other precipitants are not present, use of the lower value (i.e., 1.0) should be acceptable.

The authors believe that the risk for chemical clogging in the landfill gas collection layer should be similar to that in the leak detection systems. Water vapor within the landfill gas that is collected by the landfill gas collection layer will often condense, resulting in liquid which is referred to as condensate. This condensate often has similar characteristics to landfill leachate; therefore, the authors recommend using a range similar to the LDS (Leakage Detection System) range of 1.1 to 1.5, since the layer will have a level of exposure to leachate similar to that of the LDS. In the absence of available information, the designer is urged to choose a conservative value (i.e., 1.5).

Table 4.4. Chemical clogging and biological clogging reduction factors [GRI GC8].

Application	**Reduction Factor for Chemical Clogging (RF_{CC})**	**Reduction Factor for Biological Clogging (RF_{BC})**
Cover Drainage Layer	1.0 to 1.2	1.2 to 3.5
Leachate Collection and Removal Layer	1.5 to 2.0	1.1 to 1.3
Leakage Detection Layer	1.1 to 1.5	1.1 to 1.3

The designer should evaluate the soils he/she anticipates using in the protective layer of the liner system and the materials anticipated in the overlying waste, in order to estimate the risk of chemical clogging of the primary leachate collection layer. GRI-GC8 recommends using values in the range of 1.5 to 2.0 for chemical clogging in the leachate collection system (see Table 4.4). Values at the lower end of the range should be used for municipal solid waste.

GRI-GC8 recommends using values in the range of 1.1 to 1.5 for chemical clogging in the leakage detection layer (see Table 4.4). The designer should evaluate the soils he/she anticipates using in the protective layer of the liner system and the typical materials anticipated in the waste stream, in order to evaluate the risk of chemical clogging.

4.3.3 Biological Clogging Reduction Factor, RF_{BC}

The biological clogging reduction factor accounts for the reduction of flow in the geonet due to the growth of biological organisms such as fungi or algae, or root penetration through the overlying soil. GRI-GC8 recommends using values in the range of 1.2 to 3.5 for biological

clogging in the final cover system (see Table 4.4). The authors consider the upper end of this range to constitute a condition whereby improper design of the cover allows root penetration to occur. Coordination is required with a plant biologist and the cover system designer to understand how prolific and how deep roots may develop. The reduction factor for biological clogging should then represent anticipated design conditions.

GRI-GC8 does not provide explicit recommendations for selecting a biological clogging reduction factor for a landfill gas collection layer. A comparison to the other functions described in GRI-GC8 can nonetheless be made. The authors believe that the risk for biological clogging in the landfill gas collection layer should be similar to the leakage detection layer. The authors recommend using a range similar to that in the leakage detection layer range of 1.1 to 1.3, since the layer's level of exposure to leachate will be similar to that of the LDS. In the absence of available information, the designer is urged to choose a conservative value (i.e., 1.3).

GRI-GC8 recommends using values in the range of 1.1 to 1.3 for biological clogging in the leachate collection system (see Table 4.4). The designer should evaluate the conditions anticipated in the landfill to select an appropriate value for the biological clogging reduction factor. In the absence of available information, the designer is urged to choose a conservative value (i.e., 1.3).

GRI-GC8 recommends using values in the range of 1.1 to 1.3 for biological clogging in the leakage detection system (see Table 4.4). The designer should evaluate the conditions anticipated in the landfill to select an appropriate value for the biological clogging reduction factor. In the absence of available information, the designer is urged to choose a conservative value (i.e., 1.3).

4.3.4 Creep Reduction Factors, RF_{CR}

Performance transmissivity tests are typically conducted for up to 100 hours, as required by GRI test procedure GC8. The decrease in transmissivity with time levels off within 100 hours (and usually much sooner than that), indicating that much of the initial compression and intrusion has already taken place (see Figure 2.10). Reduction factor for creep, RF_{CR}, accounts for the decrease in transmissivity beyond the first 100 hours covered by the performance transmissivity test. The quality of the geonet core, including its structure, thickness, mass and density can have a significant influence on creep reduction factors. Appendix B presents creep reduction factors for geonets manufactured by GSE Lining Technology, Inc. Products from other manufacturers can have creep factors different from those given here.

Regardless of the type of product, creep increases with increasing overburden stress. For this reason, creep reduction factors for cover applications (i.e., cover drainage and gas removal layers) are significantly smaller than those for liner system applications (i.e., LCRS and LDS). As shown in Appendix B, a creep reduction factor of 1.1 is adequate for most cover projects. Creep reduction factors should be selected on the basis of normal stress for LCRS and LDS.

4.4 Design Compression Strength of Geonets and Geocomposites

4.4.1 Introduction

REFERENCE 2

North Carolina Department of Environment and Natural Resources, “Erosion and Sediment Control Planning and Design Manual”, Revised May 2013.

Table 8.03e Runoff curve numbers of urban areas[1]

Cover Description: Cover type and hydrologic condition	Average percent impervious area[2]	Curve number for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [4]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1. Average runoff condition, and Ia = 0.2S.
2. The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using Figure 8.03c or 8.03d.
3. CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4. Composite CN's to use for the design of temporary measures during grading and construction should be computed using Figure 8.03c or 8.03d based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

The permissible velocity procedure is recommended for the design of vegetative channels because of common usage and the availability of reliable design tables. The tractive force approach is recommended for design of channels with temporary synthetic liners or riprap liners. The tractive force procedure is described in full in the U.S. Department of Transportation, Federal Highway Administration Bulletin, *Design of Roadside Channels with Flexible Linings*.

Permissible Velocity Procedure

The permissible velocity procedure uses two equations to calculate flow:

Manning's equation,

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

where:

V	=	average velocity in the channel in ft/sec.
n	=	Manning's roughness coefficient, based upon the lining of the channel
R	=	hydraulic radius, wetted cross-sectional area/wetted perimeter in ft
S	=	slope of the channel in ft/ft

and the continuity equation,

$$Q = AV$$

where:

Q	=	flow in the channel in cfs
A	=	cross-sectional area of flow within the channel in ft^2
V	=	average velocity in the channel in ft/sec.

Manning's equation and the continuity equation are used together to determine channel capacity and flow velocity. A nomograph for solving Manning's equation is given in Figure 8.05a.

Selecting Permanent Channel Lining

Channel lining materials include such flexible materials as grass, riprap and gabions, as well as rigid materials such as paving blocks, flag stone, gunite, asphalt, and concrete. The design of concrete and similar rigid linings is generally not restricted by flow velocities. However, flexible channel linings do have maximum permissible flow velocities beyond which they are susceptible to erosion. The designer should select the type of liner that best fits site conditions.

Table 8.05a lists maximum permissible velocities for established grass linings and soil conditions. Before grass is established, permissible velocity is determined by the choice of temporary liner. Permissible velocities for riprap linings are higher than for grass and depend on the stone size selected.

Table 8.05a
Maximum Allowable Design Velocities[1]
for Vegetated Channels

Typical Channel Slope Application	Soil Characteristics[2]	Grass Lining	Permissible Velocity[3] for Established Grass Lining (ft/sec)
0-5%	Easily Erodible Non-plastic (Sands & Silts)	Bermudagrass	5.0
		Tall fescue	4.5
		Bahiagrass	4.5
		Kentucky bluegrass	4.5
		Grass-legume mixture	3.5
	Erosion Resistant Plastic (Clay mixes)	Bermudagrass	6.0
		Tall fescue	5.5
		Bahiagrass	5.5
		Kentucky bluegrass	5.5
		Grass-legume mixture	4.5
5-10%	Easily Erodible Non-plastic (Sands & Silts)	Bermudagrass	4.5
		Tall fescue	4.0
		Bahiagrass	4.0
		Kentucky bluegrass	4.0
		Grass-legume mixture	3.0
	Erosion Resistant Plastic (Clay mixes)	Bermudagrass	5.5
		Tall fescue	5.0
		Bahiagrass	5.0
		Kentucky bluegrass	5.0
		Grass-legume mixture	3.5
>10%	Easily Erodible Non-plastic (Sands & Silts)	Bermudagrass	3.5
		Tall fescue	2.5
		Bahiagrass	2.5
		Kentucky bluegrass	2.5
	Erosion Resistant Plastic (Clay mixes)	Bermudagrass	4.5
		Tall fescue	3.5
		Bahiagrass	3.5
		Kentucky bluegrass	3.5

Source: USDA-SCS Modified

NOTE: [1]Permissible Velocity based on 10-year storm peak runoff
[2]Soil erodibility based on resistance to soil movement from concentrated flowing water.
[3]Before grass is established, permissible velocity is determined by the type of temporary liner used.

Selecting Channel Cross-Section Geometry

To calculate the required size of an open channel, assume the design flow is uniform and does not vary with time. Since actual flow conditions change throughout the length of a channel, subdivide the channel into design reaches, and design each reach to carry the appropriate capacity.

The three most commonly used channel cross-sections are “V”-shaped, parabolic, and trapezoidal. Figure 8.05b gives mathematical formulas for the area, hydraulic radius and top width of each of these shapes.

Design Procedure-Permissible Velocity

The following is a step-by-step procedure for designing a runoff conveyance channel using Manning's equation and the continuity equation:

Step 1. Determine the required flow capacity, Q, by estimating peak runoff rate for the design storm (*Appendix 8.03*).

Step 2. Determine the slope and select channel geometry and lining.

Step 3. Determine the permissible velocity for the lining selected, or the desired velocity, if paved. (see Table 8.05a, page 8.05.4)

Step 4. Make an initial estimate of channel size—divide the required Q by the permissible velocity to reach a "first try" estimate of channel flow area. Then select a geometry, depth, and top width to fit site conditions.

Step 5. Calculate the hydraulic radius, R, from channel geometry (Figure 8.05b, page 8.05.5).

Step 6. Determine roughness coefficient *n*.

Structural Linings—see Table 8.05b, page 8.05.6.

Grass Lining:

a. Determine retardance class for vegetation from Table 8.05c, page 8.05.8. To meet stability requirement, use retardance for newly mowed condition (generally C or D). To determine channel capacity, use at least one retardance class higher.

b. Determine *n* from Figure 8.05c, page 8.05.7.

Step 7. Calculate the actual channel velocity, V, using Manning's equation (Figure 8.05a, pg. 8.05.3), and calculate channel capacity, Q, using the continuity equation.

Step 8. Check results against permissible velocity and required design capacity to determine if design is acceptable.

Step 9. If design is not acceptable, alter channel dimensions as appropriate. For trapezoidal channels, this adjustment is usually made by changing the bottom width.

Table 8.05b
Manning's *n* for Structural Channel Linings

Channel Lining	Recommended *n* values
Asphaltic concrete, machine placed	0.014
Asphalt, exposed prefabricated	0.015
Concrete	0.015
Metal, corrugated	0.024
Plastic	0.013
Shotcrete	0.017
Gabion	0.030
Earth	0.020

Source: American Society of Civil Engineers (modified)

Step 10. For grass-lined channels once the appropriate channel dimensions have been selected for low retardance conditions, repeat steps 6 through 8 using a higher retardance class, corresponding to tall grass. Adjust capacity of the channel by varying depth where site conditions permit.

NOTE 1: If design velocity is greater than 2.0 ft/sec., a temporary lining may be required to stabilize the channel until vegetation is established. The temporary liner may be designed for peak flow from the 2-year storm. If a channel requires a temporary lining, the designer should analyze shear stresses in the channel to select the liner that provides protection and promotes establishment of vegetation. For the design of temporary liners, use tractive force procedure.

NOTE 2: Design Tables—Vegetated Channels and Diversions at the end of this section may be used to design grass-lined channels with parabolic cross-sections.

Step 11. Check outlet for carrying capacity and stability. If discharge velocities exceed allowable velocities for the receiving stream, an outlet protection structure will be required (Table 8.05d, page 8.05.9).

Sample Problem 8.05a illustrates the design of a grass-lined channel.

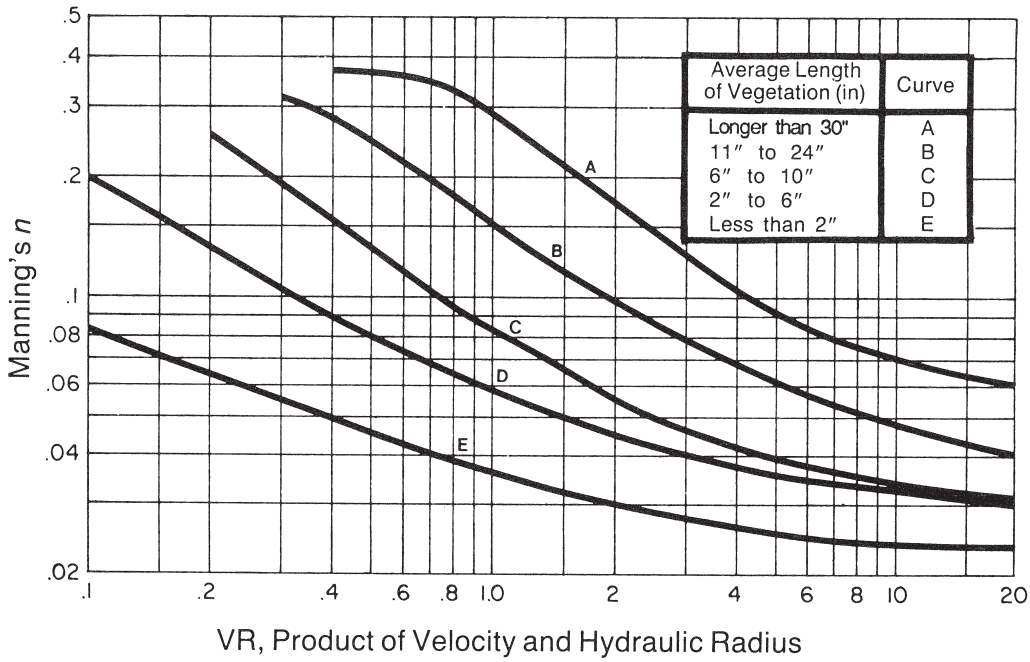


Figure 8.05c Manning's *n* related to velocity, hydraulic radius, and vegetal retardance.
Note: From Sample Problem 8.05a multiply Vp x Hydralulic Radius (4.5x0.54=2.43), then enter the product of VR and extend a straight line up to Retardance class "D", next project a straight line to the left to determine a trial manning's *n*.

Table 8.05d Maximum Permissible Velocities for Unprotected Soils in Existing Channels.

Materials	Maximum Permissible Velocities (fps)
Fine Sand (noncolloidal)	2.5
Sand Loam (noncolloidal)	2.5
Silt Loam (noncolloidal)	3.0
Ordinary Firm Loam	3.5
Fine Gravel	5.0
Stiff Clay (very colloidal)	5.0
Graded, Loam to Cobbles (noncolloidal)	5.0
Graded, Silt to Cobbles (colloidal)	5.5
Alluvial Silts (noncolloidal)	3.5
Alluvial Silts (colloidal)	5.0
Coarse Gravel (noncolloidal)	6.0
Cobbles and Shingles	5.5

Sample Problem 8.05a Design of a Grass-lined Channel.

Given:

Design Q_{10} = 16.6 cfs

Proposed channel grade = 2%
Proposed vegetation: Tall fescue
Soil: Creedmoor (easily erodible)
Permissible velocity, V_p = 4.5 ft/s (Table 8.05a)
Retardance class: "B" uncut, "D" cut (Table 8.05c).
Trapezoidal channel dimensions:
designing for low retardance condition (retardance class D)
design to meet V_p.

Find:

Channel dimensions

Solution:

Make an initial estimate of channel size

A = Q/V, 16.6 cfs/4.5 ft/sec = 3.69 ft^2
Try bottom width = 3.0 ft w/side slopes of 3:1

Z = 3
$A = bd + Zd^2$
$P = b + 2d\sqrt{Z^2 + 1}$
R = AP

An iterative solution using Figure 8.05a to relate flow depth to Manning's *n* proceeds as follows: Manning's equation is used to check velocities.
*From Fig. 8.05c, pg. 8.05.7, Retardance Class d (VR=4.5x0.54=2.43)

d (ft)	A (ft^2)	R (ft)	*n	Vt (fps)	Q (cfs)	Comments
0.8	4.32	0.54	0.043	3.25	14.0	$V<V_p$ OK, $Q<Q_{10}$
						(too small, try deeper channel)
0.9	5.13	0.59	0.042	3.53	18.10	$V<V_p$, OK, $Q>Q_{10}$, OK

Now design for high retardance (class B):

For the ease of construction and maintenance assume and try d = 1.5 ft and trial velocity V_t = 3.0 ft/sec

d (ft)	A (ft^2)	R (ft)	V_t (fps)	n	V (fps)	Q (cfs)	Comments
1.5	11.25	0.90	3.0	0.08	2.5	28	reduce V_t
			2.0	0.11	1.8	20	reduce V_t
			1.6	0.12	1.6	18	
			**1.5	0.13	1.5	17	$Q>Q_{10}$ OK

** These assumptions = actual V (fps.) (chart continued on next page)

(continued) Sample Problem 8.05a Design of a Grass-lined Channel.

Channel summary:
Trapezoidal shape, Z = 3, b = 3 ft, d = 1.5 ft, grade = 2%

Note: In Sample Problem 8.05a the "n-value" is first chosen based on a permissible velocity and not a design velocity criteria. Therefore, the use of Table 8.05c may not be as accurate as individual retardance class charts when a design velocity is the determining factor.

Tractive Force Procedure

The design of riprap-lined channels and temporary channel linings is based on analysis of tractive force.

NOTE: This procedure is for uniform flow in channels and is *not* to be used for design of deenergizing devices and may not be valid for larger channels.

To calculate the required size of an open channel, assume the design flow is uniform and does not vary with time. Since actual flow conditions change through the length of a channel, subdivide the channel into design reaches as appropriate.

PERMISSIBLE SHEAR STRESS
The permissible shear stress, T_d, is the force required to initiate movement of the lining material. Permissible shear stress for the liner is not related to the erodibility of the underlying soil. However, if the lining is eroded or broken, the bed material will be exposed to the erosive force of the flow.

COMPUTING NORMAL DEPTH
The first step in selecting an appropriate lining is to compute the design flow depth (the normal depth) and determine the shear stress.

Normal depths can be calculated by Manning's equation as shown for trapezoidal channels in Figure 8.05d. Values of the Manning's roughness coefficient for different ranges of depth are provided in Table 8.05e for temporary linings and Table 8.05f for riprap. The coefficient of roughness generally decreases with increasing flow depth.

Table 8.05e Manning's Roughness Coefficients for Temporary Lining Materials

	n* value for Depth Ranges		
Lining Type	**0-0.5 ft**	**0.5-2.0 ft**	**>2.0 ft**
Woven Paper Net	0.016	0.015	0.015
Jute Net	0.028	0.022	0.019
Fiberglass Roving	0.028	0.021	0.019
Straw with Net	0.065	0.033	0.025
Curled Wood Mat	0.066	0.035	0.028
Synthetic Mat	0.036	0.025	0.021

* Adapted from: FHWA-HEC 15, Pg. 37 - April 1988

Table 8.05f Manning's Roughness Coefficient

Lining Category	Lining Type	*n* - value: *n* value for Depth Ranges 0-0.5 ft (0-15 cm)	0.5-2.0 ft (15-60 cm)	2.0 ft (>60 cm)
Rigid	Concrete	0.015	0.013	0.013
	Grouted Riprap	0.040	0.030	0.028
	Stone Masonry	0.042	0.032	0.030
	Soil Cement	0.025	0.022	0.020
	Asphalt	0.018	0.016	0.016
Unlined	Bare Soil	0.023	0.020	0.020
	Rock Cut	0.045	0.035	0.025
Gravel Riprap	1-inch (2.5-cm) D_{50}	0.044	0.033	0.030
	2-inch (5-cm) D_{50}	0.066	0.041	0.034
Rock Riprap	6-inch (15-cm) D_{50}	0.104	0.069	0.035
	12-inch (30-cm) D_{50}	--	0.078	0.040

Note: Values listed are representative values for the respective depth ranges. Manning's roughness coefficients, *n*, vary with the flow depth.

DETERMINING SHEAR STRESS

Shear stress, T, at normal depth is computed for the lining by the following equation:

$$T = yds$$

$$T_d = \text{Permissible shear stress}$$

where:

T = shear stress in lb/ft^2
y = unit weight of water, 62.4 lb/ft^3
d = flow depth in ft
s = channel gradient in ft/ft

If the permissible shear stress, T_d, given in Table 8.05g is greater than the computed shear stress, the riprap or temporary lining is considered acceptable. If a lining is unacceptable, select a lining with a higher permissible shear stress and repeat the calculations for normal depth and shear stress. In some cases it may be necessary to alter channel dimensions to reduce the shear stress.

Computing tractive force around a channel bend requires special considerations because the change in flow direction imposes higher shear stress on the channel bottom and banks. The maximum shear stress in a bend, T_b, is given by the following equation:

$$T_b = K_b T$$

where:

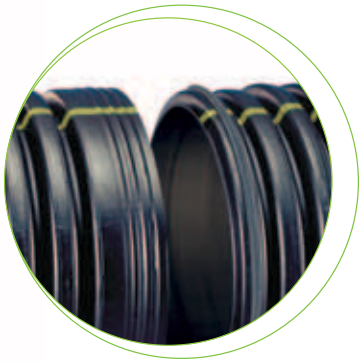
T_b = bend shear stress in lb/ft^2
k_b = bend factor
T = computed stress for straight channel in lb/ft^2

The value of k_b is related to the radius of curvature of the channel at its center line, R_c, and the bottom width of the channel, B, Figure 8.05e. The length of channel requiring protection downstream from a bend, L_p, is a function of the roughness of the lining material and the hydraulic radius as shown in Figure 8.05f.

REFERENCE 3

ADS N-12 ST IB Pipe manufacturers product information, copyright 2010.

N-12® ST IB PIPE (PER AASHTO)



N-12 corrugated dual-wall pipe was introduced in 1987. Today's N-12 pipe offers significant performance advantages, plus the best soil-tight joint in the industry. Available in diameters from 4" to 60" (100 to 1500 mm), N-12 pipe is replacing reinforced concrete pipe as a preferred product for storm water applications.

ADS N-12 pipe contains a superior built-in bell-and-spigot joint. The joints are sealed by high-quality, factory-installed rubber gaskets that meet all the requirements of ASTM F477. A polyethylene bell minimizes joint distortion. The chipping and cracking that is common to concrete bells is eliminated.

APPLICATIONS:

Storm Sewers	Slopes/Edge Drains
Retention/Detention	Mining/Forestry/Industrial
Golf, Turf & Recreation	Foundation Drains
Culverts/Cross Drains	Downspouts/Roof Drainage
Grain Aeration	Land Reclamation
Waterways	Terracing
Ditch Enclosures	

FEATURES:

- 4" – 60" (100 to 1500 mm) diameters available
- Nominal 20 ft. (6 m) and 13 ft. (4 m) lengths available
- Bell-and-spigot joint design
- In-line bell design
- Exceptional joint strength
- Excellent abrasion and corrosion resistance
- Light weight
- Fast installation times
- Structural strength that will support H-25 live loads with 1' (0.3 m) minimum cover; 54" and 60" (1250 and 1500 mm) pipe requires 2' (0.6 m) cover for H-25 loads

BENEFITS:

- Variety of diameters and lengths fit any project
- Joint only requires lube for fitting - ends are pushed together for easy field installation
- Unlike pipes from other manufacturers, there are no additional gasket materials, grout or sealing bands to transport and apply
- Installation cost savings from lower shipping costs, fewer people, and less heavy equipment required
- Hydraulic efficiency from smooth interior
- Long-term durability of HDPE

ADS Service: ADS representatives are committed to providing you with the answers to all your questions, including specifications, and installation and more.

ADS N-12® ST IB PIPE (PER AASHTO) SPECIFICATION

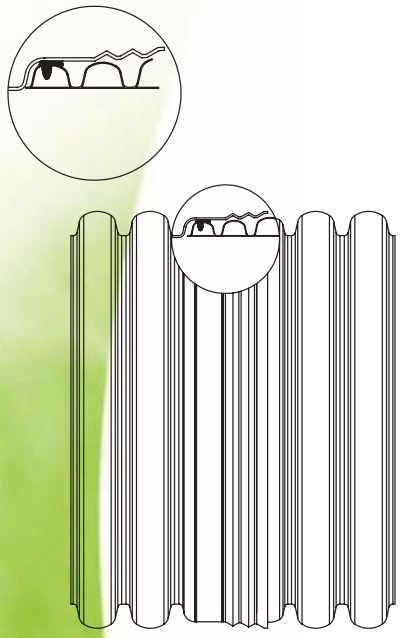
SCOPE

This specification describes 4- through 60-inch (100 to 1500 mm) ADS N-12 ST IB pipe (per AASHTO) for use in gravity flow drainage applications.

PIPE REQUIREMENTS

N-12 ST IB pipe (per AASHTO) shall have a smooth interior and annular exterior corrugations.

- 4- through 10-inch (100 to 250 mm) shall meet AASHTO M252, Type S
- 12- through 60-inch (300 to 1500 mm) shall meet AASHTO M294, Type S or ASTM F2306
- Manning's "n" value for use in design shall be 0.012



JOINT PERFORMANCE

Pipe shall be joined using a bell-and-spigot joint meeting AASHTO M252, AASHTO M294, or ASTM F2306. The joint shall be soil-tight and gaskets, when applicable, shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.

FITTINGS

Fittings shall conform to AASHTO M252, AASHTO M294 or ASTM F2306.. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle gasket meeting the soil-tight joint performance requirements of AASHTO M252, AASHTO M294 or ASTM F2306.

MATERIAL PROPERTIES

Virgin material for pipe and fitting production shall be high-density polyethylene conforming with the minimum requirements of cell classification 424420C for 4- through 10-inch (100 to 250 mm) diameters, or 435400C for 12- through 60-inch (300 to 1500 mm) diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%. The 12- through 60-inch (300 to 1500 mm) virgin pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294 and ASTM F2306, respectfully.

INSTALLATION

Installation shall be in accordance with ASTM D2321 and ADS published installation guidelines, with the exception that minimum cover in trafficked areas for 4- through 48-inch (100 to 1200 mm) diameters shall be one foot (0.3 m) and for 54- and 60-inch (1350-1500 mm) diameters, the minimum cover shall be 2 foot (0.6 m) in single run applications. Backfill for minimum cover situations shall consist of Class 1, Class 2 (minimum 90% SPD) or Class 3 (minimum 90% SPD) material. Maximum fill heights depend on embedment material and compaction level; please refer to Technical Note 2.01. Contact your local ADS representative or visit our website at www.ads-pipe.com for a copy of the latest installation guidelines.

PIPE DIMENSIONS

Nominal Pipe I.D.* in. (mm)	4 (100)	6 (150)	8 (200)	10 (250)	12 (300)	15 (375)	18 (450)	24 (600)	30 (750)	36 (900)	42 (1050)	48 (1200)	54 (1350)	60 (1500)
Nominal Pipe O.D.** in. (mm)	4.8 (122)	6.9 (175)	9.1 (231)	11.4 (290)	14.5 (368)	18 (457)	22 (559)	28 (711)	36 (914)	42 (1050)	48 (1200)	54 (1350)	61 (1549)	67 (1702)
Perforations	All diameters available with or without perforations.													

*Check with sales representative for availability by region.
**Pipe O.D. values are provided for reference purposes only, values stated for 12- through 60-inch are ±1 inch. Contact a sales representative for exact values.

ADS "Terms and Conditions of Sale" are available on the ADS website, www.ads-pipe.com
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1-800-821-6710 www.ads-pipe.com

REFERENCE 4

HydroCAD 10.00 (build 9), HydroCAD Software Solutions LLC, 2013.

Summary for Subcatchment 17S: TDC-Soil

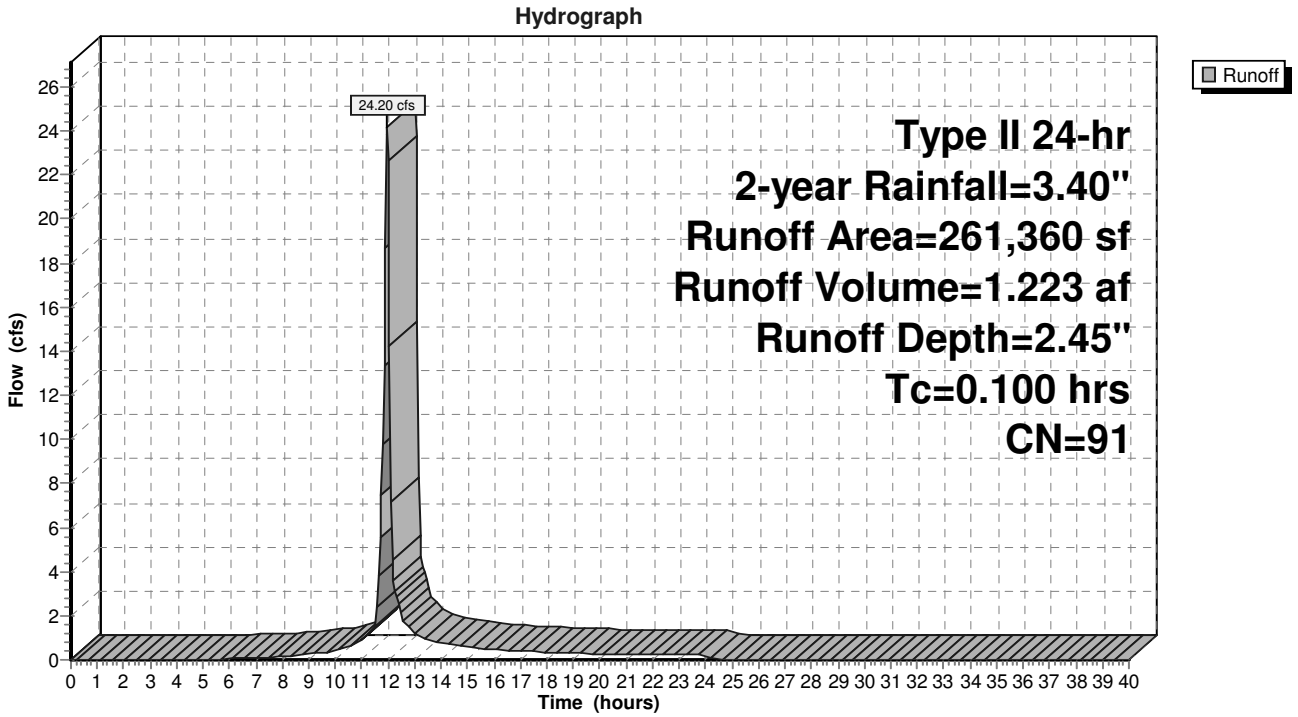
Runoff = 24.20 cfs @ 11.97 hrs, Volume= 1.223 af, Depth= 2.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-year Rainfall=3.40"

Area (sf)	CN	Description
261,360	91	Newly graded area, HSG C

Tc (hours)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.100					**Direct Entry, minimum Tc**

Subcatchment 17S: TDC-Soil



Summary for Subcatchment 18S: TDC-Grass

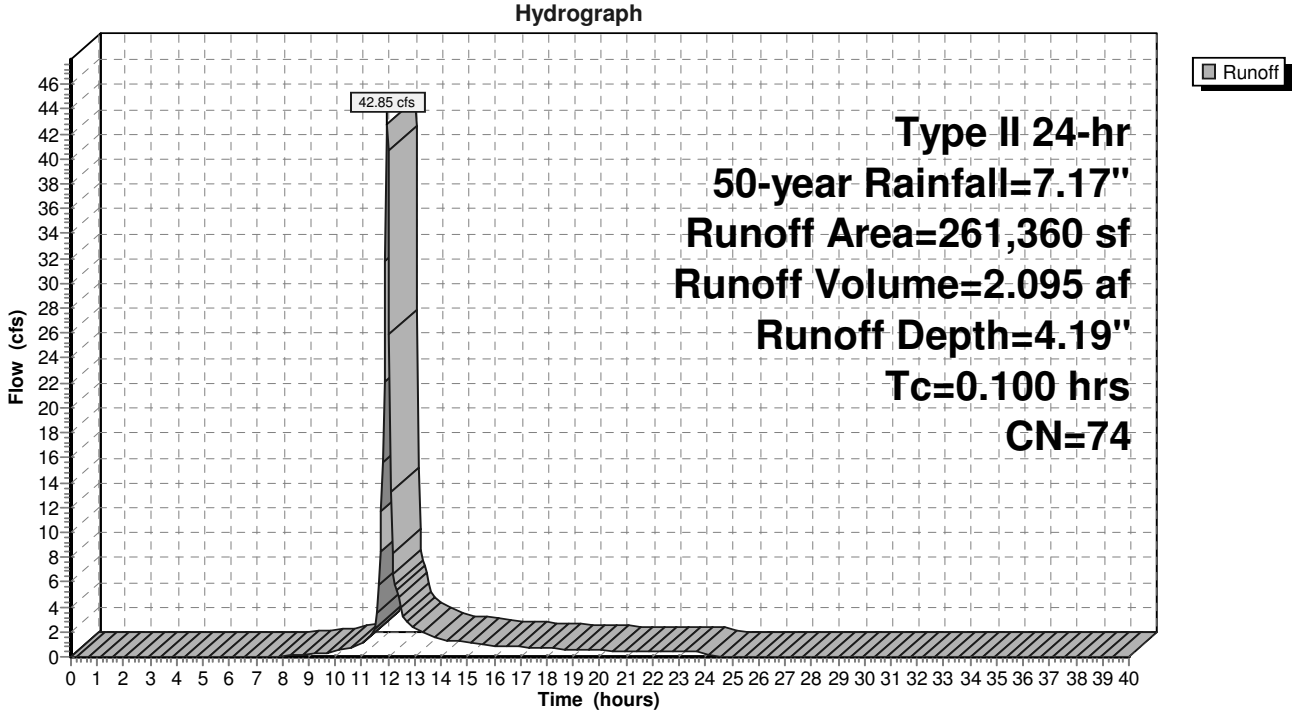
Runoff = 42.85 cfs @ 11.97 hrs, Volume= 2.095 af, Depth= 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sf)	CN	Description
261,360	74	>75% Grass cover, Good, HSG C

Tc (hours)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.100					**Direct Entry, minimum Tc**

Subcatchment 18S: TDC-Grass



Summary for Subcatchment 19S: TOB-Soil

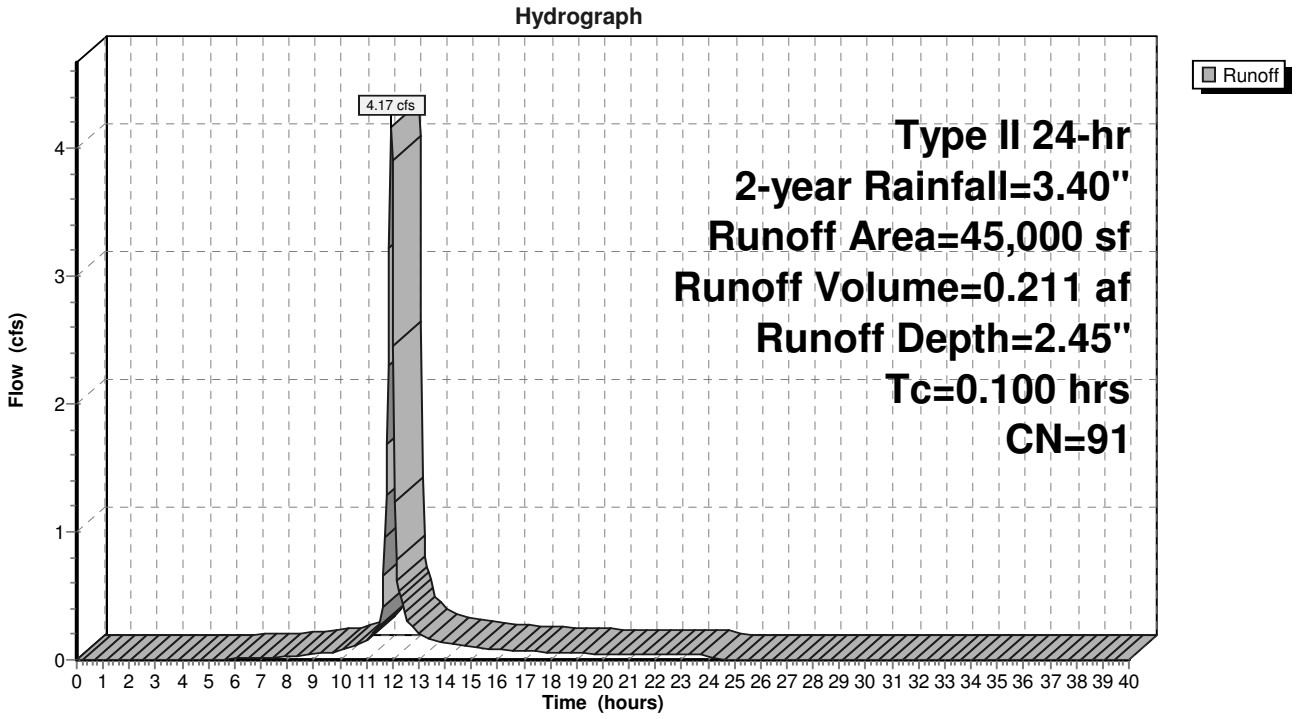
Runoff = 4.17 cfs @ 11.97 hrs, Volume= 0.211 af, Depth= 2.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-year Rainfall=3.40"

Area (sf)	CN	Description
45,000	91	Newly graded area, HSG C

Tc (hours)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.100					**Direct Entry, minimum Tc**

Subcatchment 19S: TOB-Soil



Summary for Subcatchment 20S: TOB-Grass

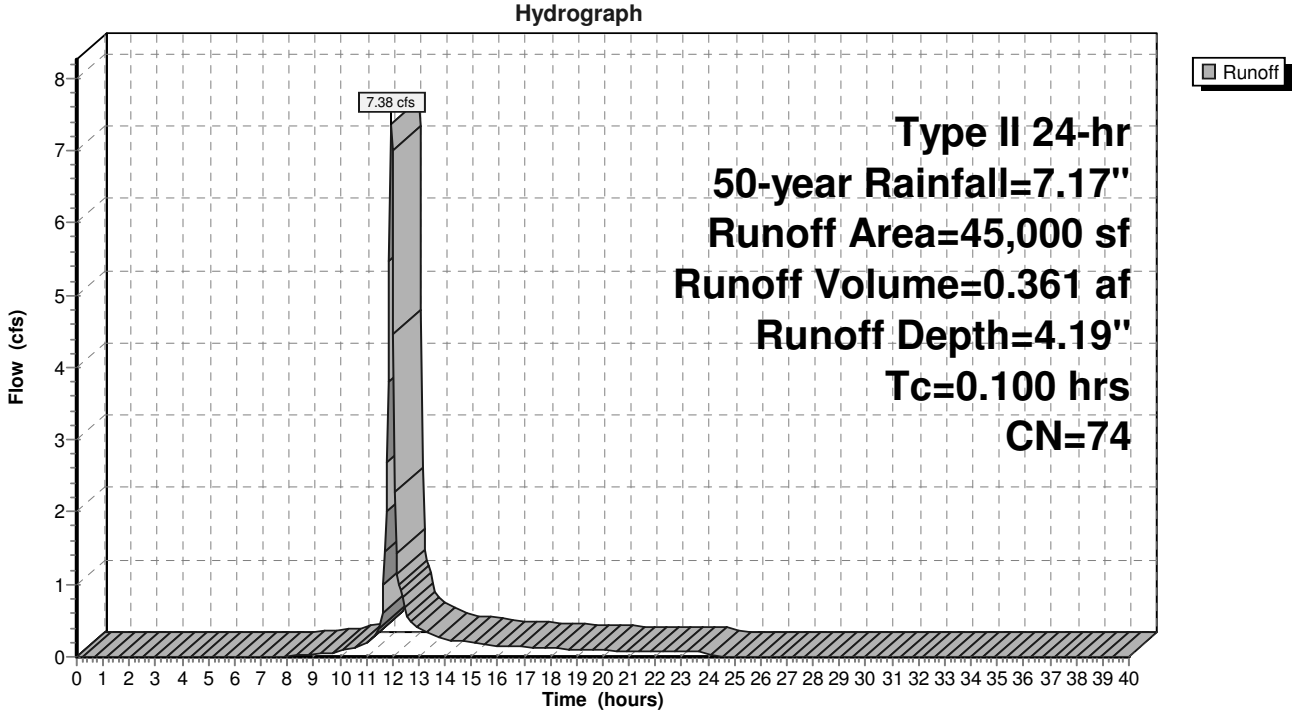
Runoff = 7.38 cfs @ 11.97 hrs, Volume= 0.361 af, Depth= 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sf)	CN	Description
45,000	74	>75% Grass cover, Good, HSG C

Tc (hours)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.100					**Direct Entry, minimum Tc**

Subcatchment 20S: TOB-Grass



Summary for Subcatchment 21S: DD-Soil

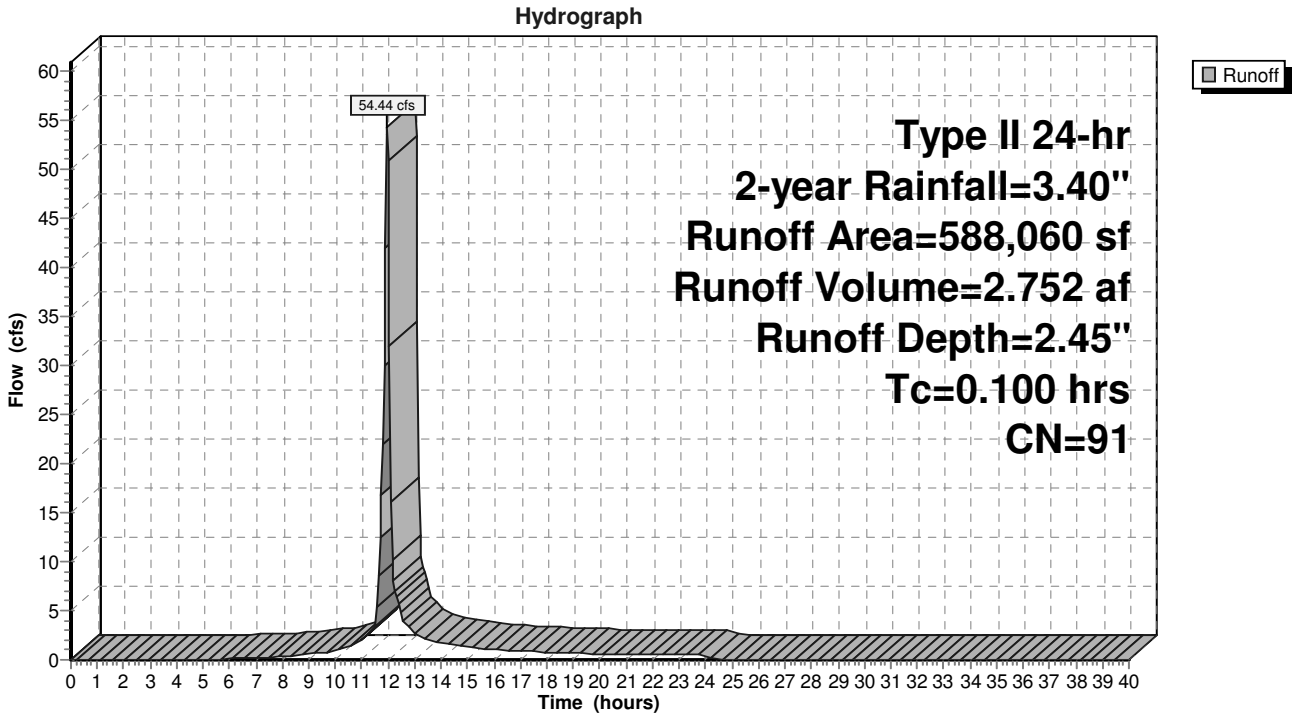
Runoff = 54.44 cfs @ 11.97 hrs, Volume= 2.752 af, Depth= 2.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-year Rainfall=3.40"

Area (sf)	CN	Description
588,060	91	Newly graded area, HSG C

Tc (hours)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.100					**Direct Entry, minimum Tc**

Subcatchment 21S: DD-Soil



Summary for Subcatchment 22S: DD-Grass

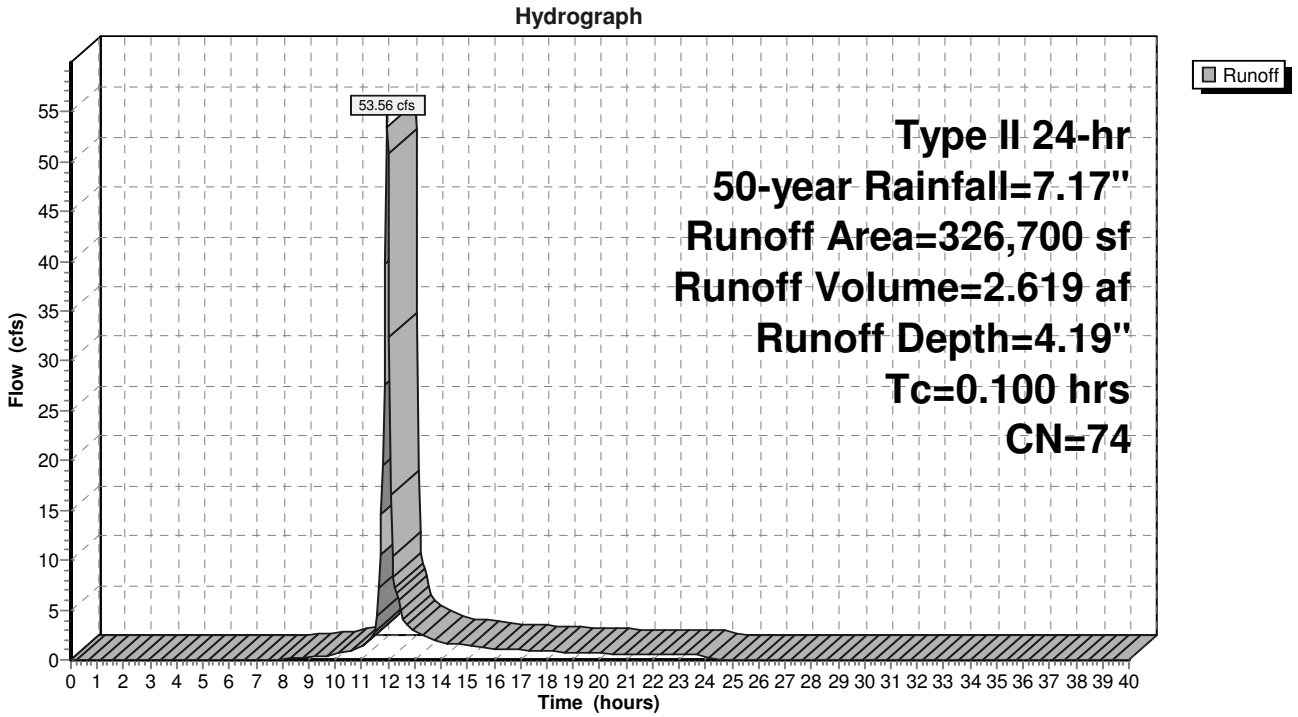
Runoff = 53.56 cfs @ 11.97 hrs, Volume= 2.619 af, Depth= 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sf)	CN	Description
326,700	74	>75% Grass cover, Good, HSG C

Tc (hours)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.100					**Direct Entry, minimum Tc**

Subcatchment 22S: DD-Grass



Summary for Pond 25P: TOB-FES

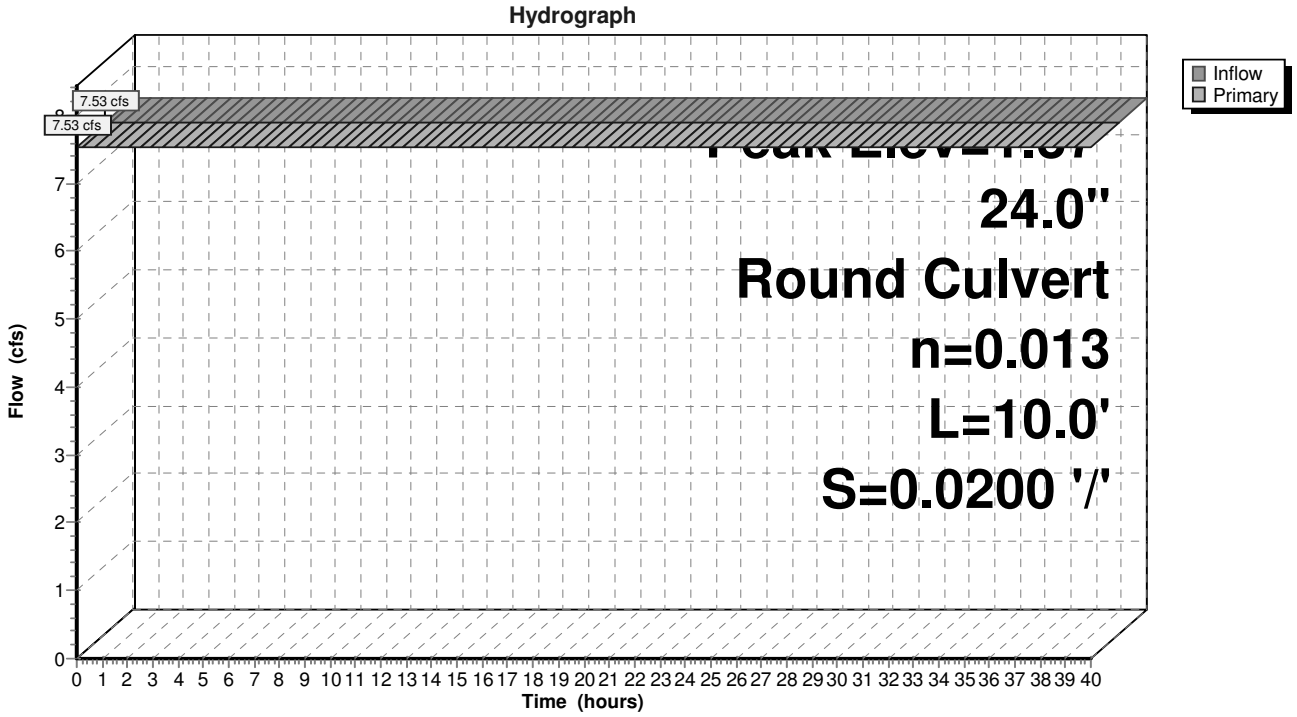
Inflow	=	7.53 cfs @	0.00 hrs, Volume=	24.924 af,	Incl. 7.53 cfs Base Flow
Outflow	=	7.53 cfs @	0.00 hrs, Volume=	24.924 af,	Atten= 0%, Lag= 0.0 min
Primary	=	7.53 cfs @	0.00 hrs, Volume=	24.924 af	

Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Peak Elev= 1.37' @ 0.00 hrs
Flood Elev= 1.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**24.0" Round Culvert** L= 10.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 0.00' / -0.20' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=7.53 cfs @ 0.00 hrs HW=1.37' (Free Discharge)
└─**1=Culvert** (Barrel Controls 7.53 cfs @ 4.64 fps)

Pond 25P: TOB-FES



REFERENCE 5

Bonnin, G.M. et. al., “NOAA Atlas 14, Volume 2, Version 3, Point Precipitation Frequency Estimates”, NOAA National Weather Service, obtained September 15, 2014.

NOAA Atlas 14, Volume 2, Version 3
Location name: Eden, North Carolina, US*
Latitude: 36.4999°, Longitude: -79.7013°
Elevation: 582 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.363 (0.331-0.397)	0.433 (0.396-0.473)	0.512 (0.467-0.560)	0.567 (0.518-0.619)	0.633 (0.575-0.688)	0.676 (0.612-0.735)	0.717 (0.646-0.781)	0.754 (0.676-0.822)	0.796 (0.708-0.869)	0.826 (0.729-0.902)
10-min	0.579 (0.529-0.634)	0.692 (0.633-0.757)	0.820 (0.749-0.898)	0.908 (0.829-0.991)	1.01 (0.917-1.10)	1.08 (0.974-1.17)	1.14 (1.03-1.24)	1.20 (1.07-1.30)	1.26 (1.12-1.38)	1.30 (1.15-1.42)
15-min	0.724 (0.661-0.792)	0.870 (0.796-0.951)	1.04 (0.947-1.14)	1.15 (1.05-1.25)	1.28 (1.16-1.39)	1.36 (1.23-1.48)	1.44 (1.30-1.57)	1.51 (1.35-1.64)	1.59 (1.41-1.73)	1.63 (1.44-1.78)
30-min	0.993 (0.906-1.09)	1.20 (1.10-1.31)	1.47 (1.35-1.61)	1.66 (1.52-1.82)	1.89 (1.72-2.06)	2.05 (1.86-2.23)	2.21 (1.99-2.40)	2.35 (2.11-2.56)	2.52 (2.24-2.75)	2.64 (2.33-2.89)
60-min	1.24 (1.13-1.35)	1.51 (1.38-1.65)	1.89 (1.73-2.07)	2.17 (1.98-2.36)	2.52 (2.29-2.74)	2.78 (2.52-3.03)	3.04 (2.74-3.31)	3.29 (2.95-3.59)	3.62 (3.22-3.95)	3.86 (3.41-4.22)
2-hr	1.47 (1.35-1.61)	1.79 (1.63-1.96)	2.25 (2.06-2.46)	2.61 (2.38-2.85)	3.08 (2.80-3.36)	3.45 (3.12-3.75)	3.83 (3.44-4.16)	4.20 (3.75-4.57)	4.71 (4.15-5.12)	5.10 (4.45-5.56)
3-hr	1.59 (1.46-1.73)	1.93 (1.78-2.11)	2.44 (2.24-2.66)	2.82 (2.58-3.07)	3.33 (3.03-3.62)	3.73 (3.38-4.04)	4.13 (3.72-4.48)	4.54 (4.06-4.92)	5.08 (4.49-5.52)	5.50 (4.81-5.98)
6-hr	1.96 (1.80-2.15)	2.37 (2.18-2.61)	2.99 (2.74-3.27)	3.48 (3.17-3.80)	4.15 (3.76-4.53)	4.70 (4.22-5.12)	5.28 (4.70-5.73)	5.87 (5.18-6.37)	6.71 (5.82-7.29)	7.38 (6.31-8.02)
12-hr	2.36 (2.17-2.59)	2.87 (2.63-3.14)	3.63 (3.32-3.96)	4.26 (3.88-4.62)	5.15 (4.65-5.57)	5.89 (5.28-6.37)	6.70 (5.94-7.21)	7.56 (6.62-8.12)	8.81 (7.57-9.48)	9.84 (8.31-10.6)
24-hr	2.81 (2.61-3.04)	3.40 (3.16-3.68)	4.33 (4.02-4.67)	5.10 (4.72-5.48)	6.22 (5.72-6.68)	7.17 (6.55-7.69)	8.20 (7.44-8.79)	9.32 (8.39-10.0)	11.0 (9.74-11.8)	12.4 (10.9-13.3)
2-day	3.30 (3.08-3.55)	3.99 (3.72-4.30)	5.04 (4.70-5.42)	5.90 (5.48-6.33)	7.12 (6.59-7.63)	8.13 (7.48-8.71)	9.21 (8.42-9.88)	10.4 (9.40-11.1)	12.0 (10.8-13.0)	13.4 (11.9-14.5)
3-day	3.49 (3.26-3.76)	4.22 (3.93-4.55)	5.33 (4.96-5.73)	6.23 (5.79-6.69)	7.52 (6.95-8.07)	8.59 (7.89-9.21)	9.72 (8.88-10.4)	10.9 (9.92-11.8)	12.7 (11.4-13.7)	14.2 (12.6-15.3)
4-day	3.68 (3.43-3.97)	4.45 (4.15-4.80)	5.61 (5.23-6.05)	6.56 (6.10-7.06)	7.92 (7.32-8.51)	9.04 (8.31-9.71)	10.2 (9.35-11.0)	11.5 (10.4-12.4)	13.4 (12.0-14.4)	14.9 (13.2-16.1)
7-day	4.22 (3.96-4.51)	5.07 (4.75-5.42)	6.29 (5.89-6.72)	7.29 (6.81-7.78)	8.71 (8.11-9.28)	9.88 (9.14-10.5)	11.1 (10.2-11.9)	12.4 (11.4-13.3)	14.3 (12.9-15.3)	15.9 (14.2-17.0)
10-day	4.77 (4.48-5.10)	5.71 (5.37-6.10)	7.01 (6.58-7.48)	8.06 (7.55-8.60)	9.53 (8.89-10.2)	10.7 (9.96-11.4)	12.0 (11.1-12.8)	13.3 (12.2-14.2)	15.1 (13.8-16.2)	16.6 (15.0-17.8)
20-day	6.43 (6.05-6.85)	7.65 (7.21-8.16)	9.20 (8.66-9.81)	10.4 (9.79-11.1)	12.1 (11.3-12.9)	13.4 (12.5-14.3)	14.7 (13.7-15.7)	16.1 (14.9-17.2)	17.9 (16.4-19.2)	19.3 (17.6-20.8)
30-day	7.95 (7.53-8.41)	9.40 (8.91-9.94)	11.1 (10.5-11.7)	12.3 (11.7-13.0)	14.0 (13.2-14.8)	15.3 (14.4-16.2)	16.5 (15.5-17.5)	17.7 (16.6-18.8)	19.3 (18.0-20.5)	20.5 (19.0-21.9)
45-day	10.0 (9.48-10.6)	11.8 (11.2-12.5)	13.7 (13.0-14.5)	15.2 (14.4-16.0)	17.1 (16.1-18.0)	18.5 (17.4-19.5)	19.8 (18.6-21.0)	21.1 (19.8-22.4)	22.8 (21.3-24.2)	24.0 (22.3-25.6)
60-day	12.0 (11.4-12.6)	14.0 (13.4-14.8)	16.1 (15.3-17.0)	17.7 (16.8-18.6)	19.7 (18.7-20.7)	21.2 (20.0-22.3)	22.6 (21.3-23.8)	23.9 (22.5-25.2)	25.6 (24.0-27.1)	26.8 (25.1-28.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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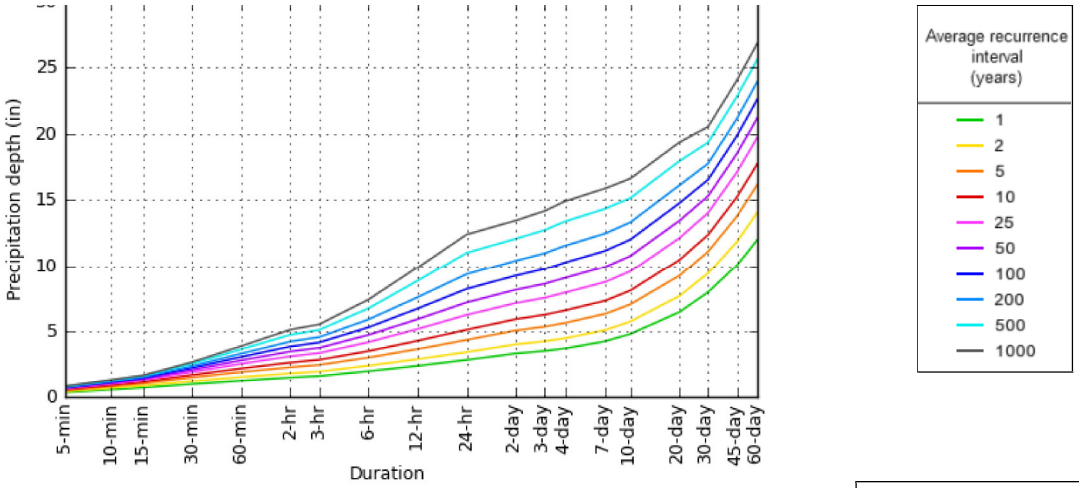
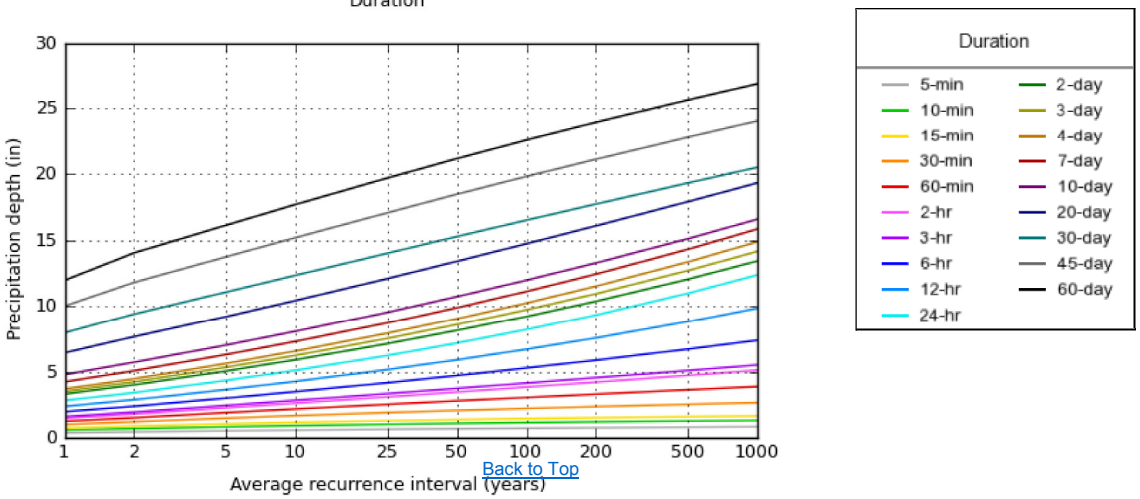
PF graphical





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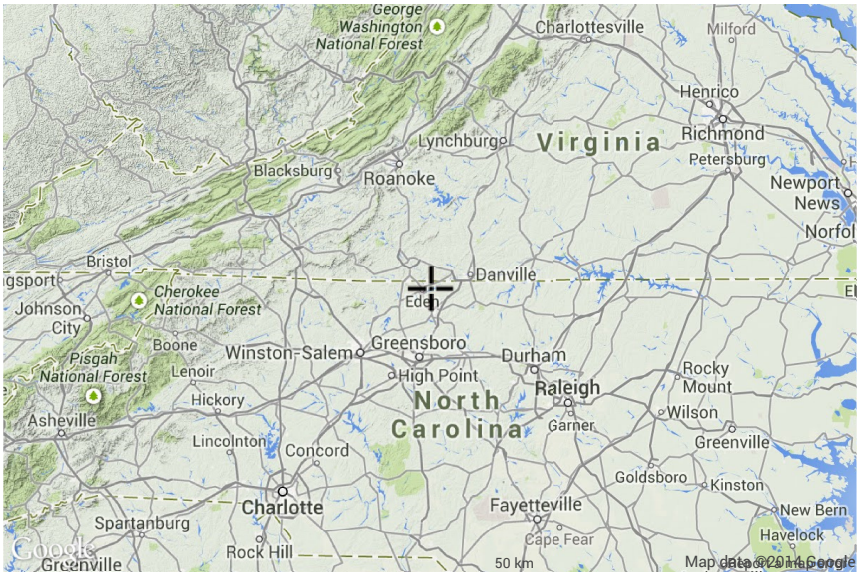
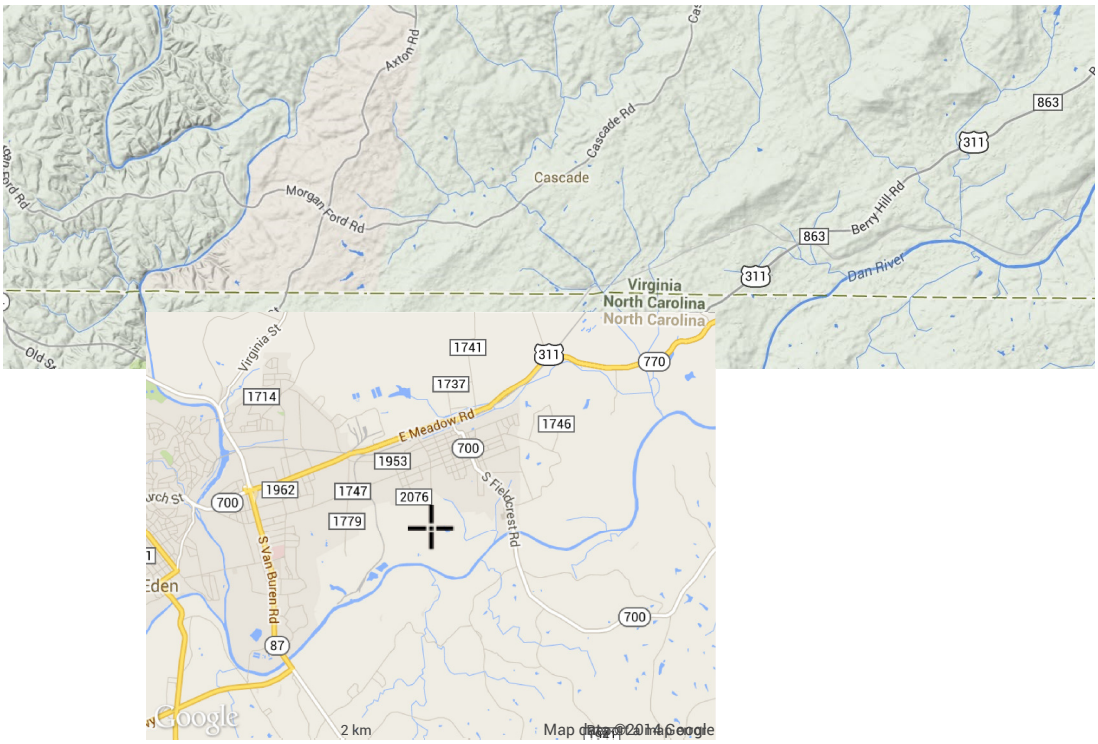
Maps & aerials

NOAA Atlas 14, Volume 2, Version 3 Created (GMT): Mon Sep 15 14:27:08 2014

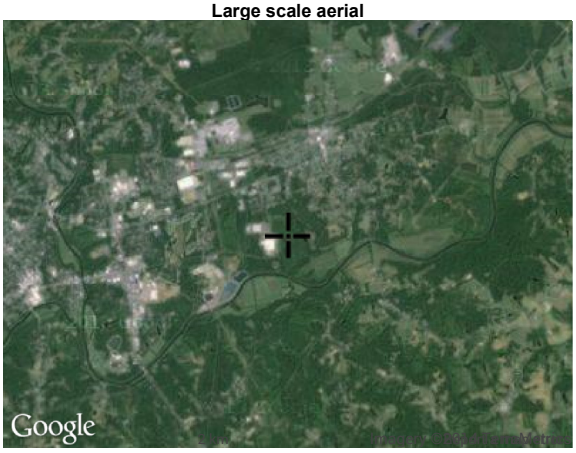
Small scale terrain



Large scale terrain



Large scale aerial



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Office of Hydrologic Development
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Silver Spring, MD 20910
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REFERENCE 6

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Nyloplast Grate Inlet Capacity Charts

These charts are based on equations from the USDOT/FAA Advisory Circular pertaining to Surface Drainage Design, AC No: AC150/5320-5C and the USDOT/FHWA Urban Drainage Design Manual, Hydraulic Engineering Circular No. 22, Third Edition, Publication No. FHWA-NHI-10-009. Certain assumptions have been made, and no two installations will necessarily perform the same way. Safety factors should change with site conditions and is left to the discretion of the design engineer.

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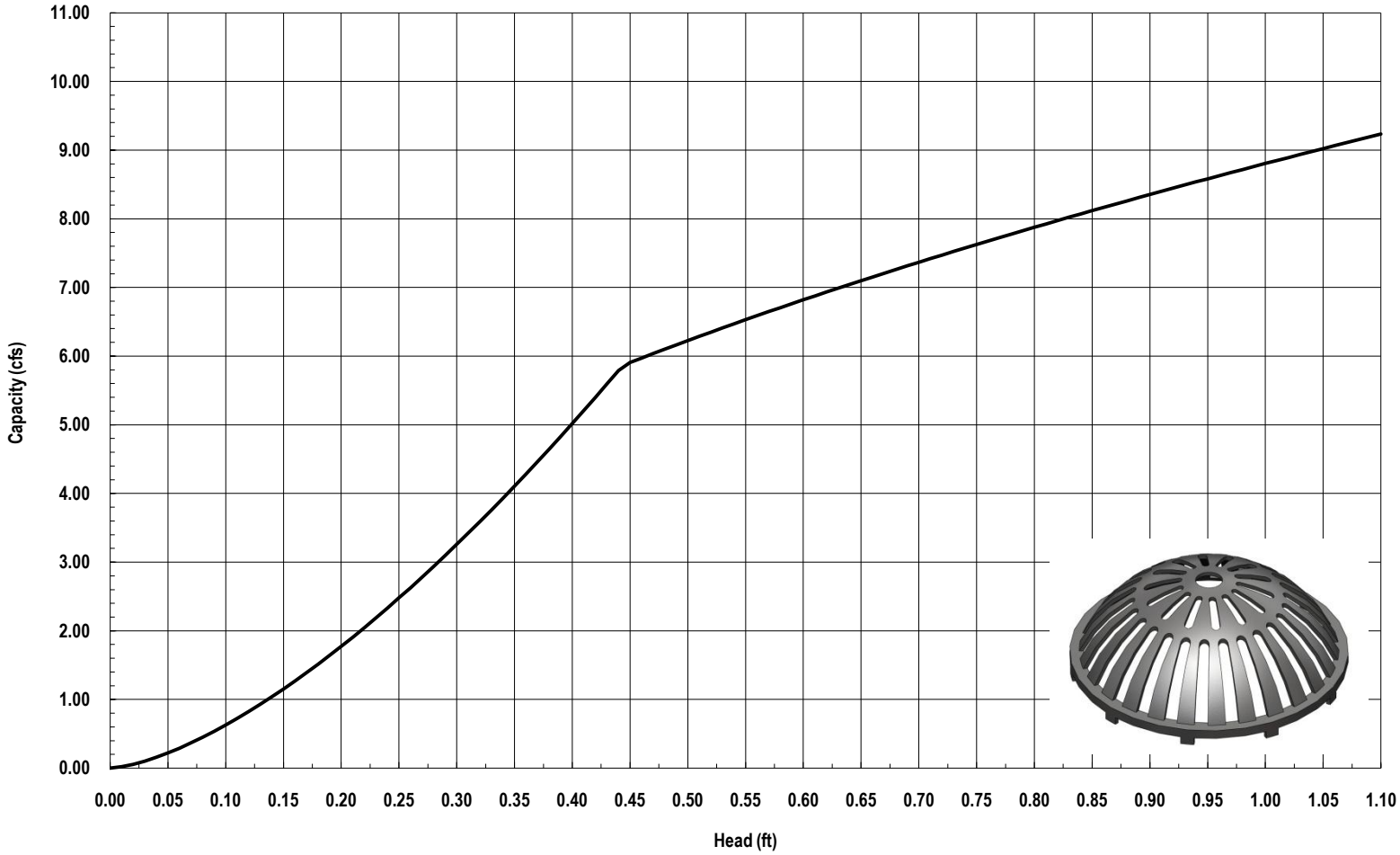
June 2012

Nyloplast 24" Dome Grate Inlet Capacity Chart



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REFERENCE 7

United States Department of Agriculture, “Urban Hydrology for Small Watersheds”, Technical Release 44, June 1986.

Manning's equation is:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad \text{[eq. 3-4]}$$

where:

V = average velocity (ft/s)
r = hydraulic radius (ft) and is equal to a/p_w
a = cross sectional flow area (ft^2)
p_w = wetted perimeter (ft)
s = slope of the hydraulic grade line (channel slope, ft/ft)
n = Manning's roughness coefficient for open channel flow.

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1959) or Linsley et al. (1982). After average velocity is computed using equation 3-4, T_t for the channel segment can be estimated using equation 3-1.

Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

Limitations

- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 3-3 was developed for use with the four standard rainfall intensity-duration relationships.

- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T_c. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.

- The minimum T_c used in TR-55 is 0.1 hour.

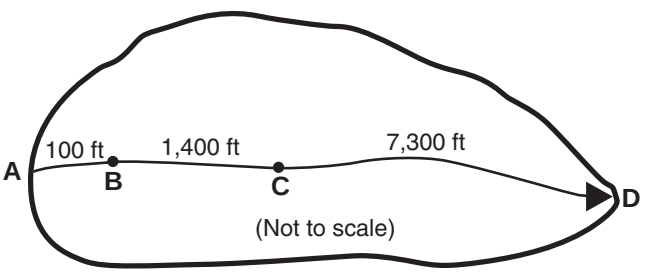
- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

Example 3-1

The sketch below shows a watershed in Dyer County, northwestern Tennessee. The problem is to compute T_c at the outlet of the watershed (point D). The 2-year 24-hour rainfall depth is 3.6 inches. All three types of flow occur from the hydraulically most distant point (A) to the point of interest (D). To compute T_c, first determine T_t for each segment from the following information:

Segment AB: Sheet flow; dense grass; slope (s) = 0.01 ft/ft; and length (L) = 100 ft. Segment BC: Shallow concentrated flow; unpaved; s = 0.01 ft/ft; and L = 1,400 ft. Segment CD: Channel flow; Manning's n = .05; flow area (a) = 27 ft^2; wetted perimeter (p_w) = 28.2 ft; s = 0.005 ft/ft; and L = 7,300 ft.

See figure 3-2 for the computations made on worksheet 3.



APPENDIX VI-2

Landfill Perimeter Stormwater Calculation

Calculation Title:
Landfill Perimeter Stormwater Calculation

Summary:
The perimeter channels, slope access road channels, and outlet structure for the proposed Dan River landfill were conservatively designed for stability and hydraulic capacity for a Type II 50-year, 24-hour design storm event of 7.17 inches while maintaining channel lining stability.

Designs for flow volume, if any, may be developed based on the 25-year, 24-hour storm event.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal		Jessica Ketchum	Cedric H Ruhl
		Tryambak Kaushik	**Jessica Ketchum**	**Cedric Ruhl**

OBJECTIVE:

The objective of this calculation is to design the perimeter and slope access road channels, drop-inlets and culverts for the proposed Dan River Landfill.

METHOD:

The stormwater features were evaluated using the SCS method and Manning's equation for the 50-year, 24-hour design storm.

DEFINITION OF VARIABLES:

A = drainage area;
A_C = cross-section area of flow through channel;
b = bottom width of flow through channel;
d = flow depth of flow through channel;
CN = curve number;
D = channel depth;
i = rainfall depth;
n = Manning's roughness co-efficient for flow through channel;
P = wetted perimeter of flow through channel;
Q = discharge flow;
R = hydraulic radius of flow through channel;
S = longitudinal slope of the channel flow;
T = top width of flow through channel;
V = velocity of flow through channel; and
Z = channel side slope.

CALCULATIONS:

1.0 Perimeter Stormwater Channels

Two stormwater perimeter channels will be located around the perimeter of the proposed Dan River Landfill. The eastern perimeter channel will begin at the high point towards the northern end of the landfill and convey stormwater in a clockwise direction to the low point towards the southern end of the landfill, the western perimeter channel will convey flow in a counter-clockwise direction. The stormwater channels were divided into reaches as shown on Figure 1.

Design criteria for the channels was evaluated by first estimating the peak flow to the channels using the SCS method, and then evaluating the channel capacity using Manning's equation [Ref. 3]. The channels were designed for capacity for the 50-year design storm.

1.1 Channel peak flow rates

The landfill perimeter road and the landfill side slopes were both assumed to contribute flow to the channel reaches. The land use properties of the landfill perimeter road were assumed to consist of aggregate and the landfill side slopes were assumed to have grass vegetative surface cover for the long-term conditions. The time of concentration for the storm water runoff was

assumed to be 6 minutes [Ref. 5]. Peak flow rates to the channels were estimated using HydroCAD software [Ref. 2] and are summarized in the following table:

Table 1: Channel Peak Flow Rates

Channel Reach	Rainfall		Contribution of Flow from Road				Contribution of Flow from Landfill				Design Flow {Q_{50}} (cfs)
	Design Storm Event (years)	Rainfall for 24-Hour Storm {i} (in) [Ref. 1]	Land Use	Curve Number {CN} [Ref. 3]	Drainage Area {A} (ac)	Peak Runoff {Q_{50}} (cfs) [Ref. 2]	Land Use	Curve Number {CN} [Ref. 3]	Drainage Area {A} (ac)	Peak Runoff {Q_{50}} (cfs) [Ref. 2]	
ER-1	50	7.17	Gravel Roads, HSG C	89	0.44	4.09	>75% Grass cover, Good, HSG C	74	5.91	42.20	46.29
ER-2	50	7.17			0.50	4.65			2.07	14.78	65.72
ER-3	50	7.17			0.54	5.02			2.21	15.78	86.52
ER-4	50	7.17			0.31	2.88			4.66	33.28	122.68
ER-5	50	7.17			0.17	1.58			1.08	7.71	131.97
WR-1	50	7.17			0.54	5.02			0.64	4.57	9.59
WR-2	50	7.17			0.46	4.28			2.65	18.92	32.79
WR-3	50	7.17			0.54	5.02			4.55	32.49	70.30

1.2 Channel capacity

The stormwater perimeter channels were assumed to consist of trapezoidal channels with dimensions as presented in the following table:

Table 2: Channel Dimensions

Channel ID	Bottom Width {b} (ft)	Depth {D} (ft)	Left Side Slope {Z_1H:V}	Right Side Slope {Z_2H:V}	Top Width {T} (ft)	Minimum Longitudinal Slope {S} (ft/ft)	Maximum Longitudinal Slope {S} (ft/ft)
ER-1	2	2	2	2	10	0.0355	0.0604
ER-2	2	2	2	2	10	0.0137	0.0200
ER-3	2	2	2	2	10	0.0141	0.0211
ER-4	2	2	2	2	10	0.0155	0.0537
ER-5	2	2	2	2	10	0.0122	0.0163
WR-1	2	2	2	2	10	0.0332	0.0389
WR-2	2	2	2	2	10	0.0397	0.0448
WR-3	2	2	2	2	10	0.0154	0.0500

The capacity of storm water channel was evaluated using Manning's equation [Ref. 3] as presented in the following equation:

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

where, n is manning's coefficient, R is hydraulic radius and S is longitudinal slope of storm water flow.

Hence, the total discharge from the channel was given by

$$Q = A_C V$$

The flow cross-section area "A_C" and wetted perimeter "P" were calculated based on the geometry of a trapezoidal channel with a flow depth "d", bottom width "b", left side slope "Z_1", and right side slope "Z_2", using the following relationships:

$$A_C = bd + 0.5Z_1d^2 + 0.5Z_2d^2$$
$$P = b + \sqrt{[(Z_1d)^2 + d^2]} + \sqrt{[(Z_2d)^2 + d^2]}$$

The channel was assumed to have concrete lining and was evaluated in flow capacity for the minimum and maximum slope conditions subject to the 50-year, 24-hour design storm event. The trial flow depth and Manning's n were iteratively modified until the channel capacity exceeded the predicted peak runoff for the conditions modeled. Channel capacity estimated for the minimum channel grade is shown in the following table:

Table 3: Channel Capacity - Minimum Channel Slope

Channel ID	Storm Recurrence Interval (years)	Channel Lining	Manning's n {n} [Ref. 3]	Trial Flow Depth {d} (ft)	Flow Area {A_C} (ft^2)	Wetted Perimeter {P} (ft)	Hydraulic Radius {R} (ft)	Velocity {V} (ft/s)	Channel Capacity {Q} (cfs)	Peak Runoff {Q} (cfs)	Channel Capacity > Peak Runoff?	Freeboard (in)
ER-1	50	Concrete	0.013	0.87	3.3	5.9	0.6	14.5	47	46	yes	14
ER-2	50	Concrete	0.013	1.30	6.0	7.8	0.8	11.2	67	66	yes	8
ER-3	50	Concrete	0.013	1.46	7.2	8.5	0.8	12.1	87	87	yes	6
ER-4	50	Concrete	0.013	1.68	9.0	9.5	0.9	13.8	124	123	yes	4
ER-5	50	Concrete	0.013	1.83	10.4	10.2	1.0	12.8	133	132	yes	2
WR-1	50	Concrete	0.013	0.39	1.1	3.7	0.3	9.1	10	10	yes	19
WR-2	50	Concrete	0.013	0.71	2.4	5.2	0.5	13.8	33	33	yes	15
WR-3	50	Concrete	0.013	1.30	6.0	7.8	0.8	11.9	71	70	yes	8

Similarly, channel lining stability capacity was estimated for the maximum channel slope conditions as shown in the following table:

Table 4: Channel Lining Stability - Maximum Channel Slope

Channel ID	Storm Recurrence Interval (years)	Channel Lining	Manning's n {n} [Ref. 2]	Trial Flow Depth {d} (ft)	Flow Area {A_C} (ft^2)	Wetted Perimeter {P} (ft)	Hydraulic Radius {R} (ft)	Velocity {V} (ft/s)	Channel Capacity {Q} (cfs)	Peak Runoff {Q} (cfs)	Channel Capacity > Peak Runoff?	Freeboard (in)
ER-1	50	Concrete	0.013	0.76	2.7	5.4	0.5	17.6	47	46	yes	15
ER-2	50	Concrete	0.013	1.18	5.1	7.3	0.7	12.9	66	66	yes	10
ER-3	50	Concrete	0.013	1.33	6.2	7.9	0.8	14.1	87	87	yes	8
ER-4	50	Concrete	0.013	1.26	5.7	7.6	0.7	21.8	124	123	yes	9
ER-5	50	Concrete	0.013	1.72	9.4	9.7	1.0	14.3	134	132	yes	3
WR-1	50	Concrete	0.013	0.38	1.0	3.7	0.3	9.8	10	10	yes	19
WR-2	50	Concrete	0.013	0.69	2.3	5.1	0.5	14.4	34	33	yes	16
WR-3	50	Concrete	0.013	0.98	3.9	6.4	0.6	18.4	71	70	yes	12

The concrete lining of the channels is anticipated to provide channel lining stability. The hydraulic analyses indicate that the perimeter channels have capacity to pass the 50-year, 24-hour design storm.

2.0 Outlet structure

The perimeter stormwater channels will convey stormwater around the perimeter of the landfill to an outlet structure at the southern end of the landfill. The outlet storm water structure for the proposed Dan River landfill is designed to consist of a grated drop-inlet and culverts. HydroCAD software [Ref. 2] was used for design of the outlet structure.

The storm water from perimeter channels was routed to 5 grates [Ref. 4] at the top of a 10 ft deep drop-inlet. The drop inlet will discharge through two 36-inch diameter corrugated dual-wall HDPE outlet culverts with a length of 145 ft and a longitudinal slope of 6.3%. HydroCAD predicted a peak elevation head of 557.55 ft which was less than the design flood elevation depth of 558 ft, indicating that the proposed outlet structure has capacity to pass the 50-year, 24-hour design storm.

3.0 Slope access road channel

Following closure, a slope access road (SAR) will provide access from the landfill perimeter to the top of the landfill. A channel will be located adjacent to the slope access road to drain storm water from the landfill. The channel will discharge into downdrains at intermittent intervals along the length of the channel. The channel was divided in four different parts and assumed to convey storm water from four different drainage areas (Figure 2).

3.1 Slope access road channel peak flow rates

The drainage area of SAR channels generally consisted of gravel paved surface and landfill vegetative side slope surface. The tributary drainage area was assumed to consist of 50 percent gravel paved surface and 50 percent landfill vegetative surface. The time of concentration for storm water runoff to SAR channels was assumed to be 6 minutes [Ref. 5]. SAR channel peak flow rates estimated using HydroCAD software [Ref. 2] are summarized in the following table:

Table 5: Slope Access Road Channel Peak Flow Rates

Channel Reach	Rainfall		Contribution of Flow from Road			Contribution of Flow from Landfill			
	Design Storm Event (years)	Rainfall for 24-Hour Storm {i} (in) [Ref. 1]	Land Use	Curve Number {CN} [Ref. 1]	Drainage Area {A} (ac)	Land Use	Curve Number {CN} [Ref. 1]	Drainage Area {A} (ac)	Peak Runoff {Q_{50}} (cfs) [Ref. 2]
SAR-1	50	7.17	Gravel Roads, HSG C	89	0.27	>75% Grass cover, Good, HSG C	74	0.27	4.5
SAR-2	50	7.17			0.34			0.34	5.7
SAR-3	50	7.17			0.35			0.35	5.8
SAR-4	50	7.17			0.39			0.39	6.5

3.2 Slope access road channel capacity

SAR channels' capacity were evaluated based on Manning's formulations as previously presented. The following table presents SAR channel dimensions for the hydraulic capacity analysis:

Table 6: Slope Access Road Channel Dimensions						
Channel ID	Bottom Width {b} (ft)	Depth {D} (ft)	Left Side Slope {Z_1H:V}	Right Side Slope {Z_2H:V}	Top Width {T} (ft)	Longitudinal Slope {S} (ft/ft)
SAR-1	3	1	3	3	9	0.0800
SAR-2	3	1	3	3	9	0.0800
SAR-3	3	1	3	3	9	0.0800
SAR-4	3	1	3	3	9	0.0800

The SAR channels were analysed for hydraulic capacity for the 50-year, 24-hour design storm under long–term grass channel lining conditions. SAR channels' capacity analyses is presented in the following table:

Table 7: Slope Access Road Channel Capacity												
Channel ID	Storm Recurrence Interval (years)	Channel Lining	Manning's n {n} [Ref. 3]	Trial Flow Depth {d} (ft)	Flow Area {A_C} (ft^2)	Wetted Perimeter {P} (ft)	Hydraulic Radius {R} (ft)	Velocity {V} (ft/s)	Channel Capacity {Q} (cfs)	Peak Runoff {Q} (cfs)	Channel Capacity > Peak Runoff?	Freeboard (in)
SAR-1	50	Grass	0.098	0.48	2.13	6.04	0.35	2.15	4.58	4.46	yes	6
SAR-2	50	Grass	0.085	0.50	2.25	6.16	0.37	2.53	5.70	5.69	yes	6
SAR-3	50	Grass	0.085	0.51	2.31	6.23	0.37	2.56	5.92	5.84	yes	6
SAR-4	50	Grass	0.080	0.52	2.37	6.29	0.38	2.75	6.52	6.51	yes	6

The SAR channels generally had 6 inches of free board for the design peak runoff capacity. The maximum SAR channel velocity for the peak flow was 2.75 ft/s which is less than the maximum allowable velocity of 4 ft/s for grass lined open channel flow [Ref. 3]. Hence, the SAR grass lining is stable for the design storm conditions.

DISCUSSION:

The perimeter channels, slope access road channels, and outlet structure for the proposed Dan River landfill were designed for stability and capacity for a Type II 50-year, 24-hour design storm event of 7.17 inches while maintaining channel lining stability.

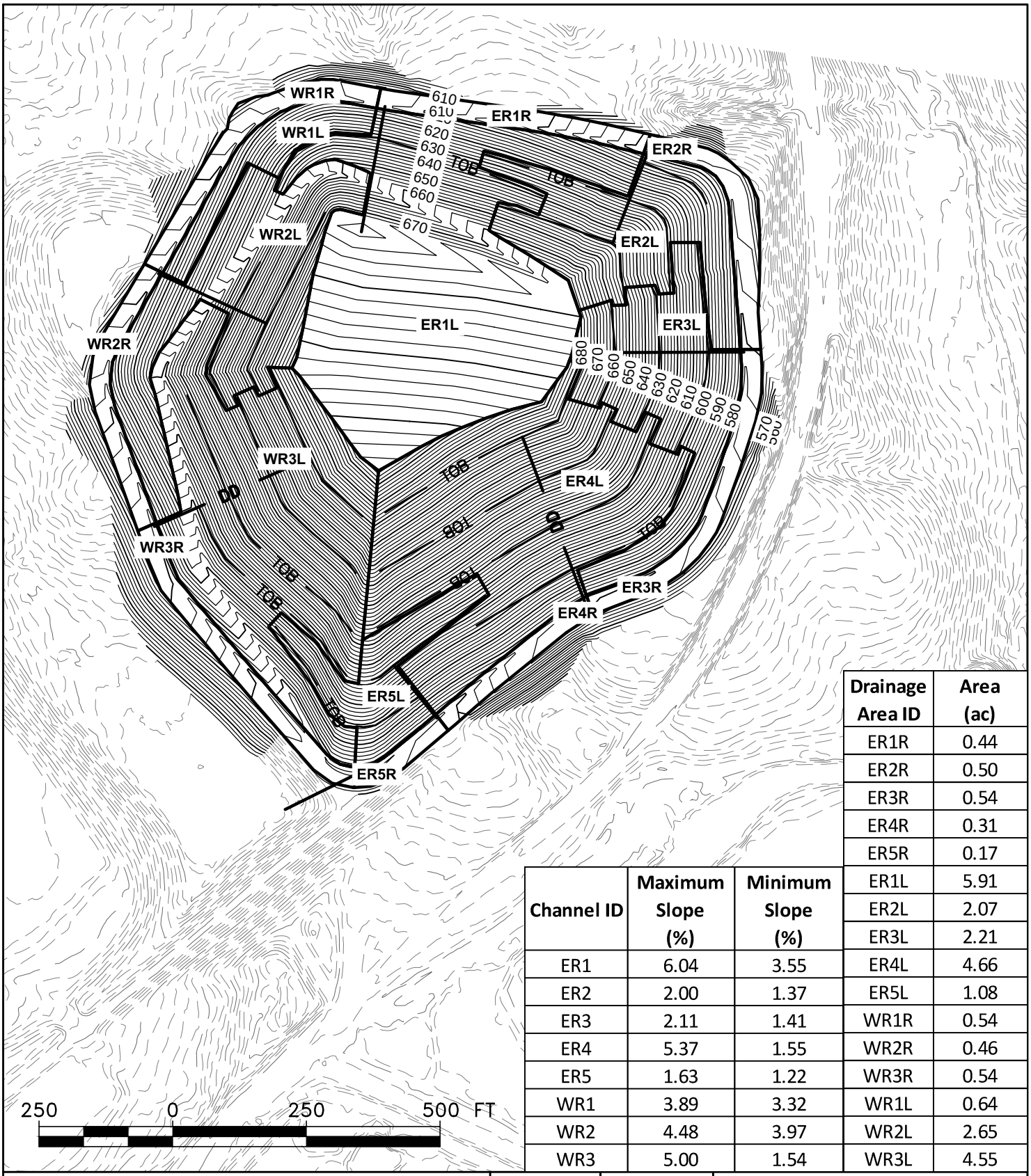
FIGURES:

1. Drainage area locations for landfill perimeter channels
2. Drainage area locations for landfill slope access road channel

REFERENCES:

1. Bonnin, G.M. et. al., "NOAA Atlas 14, Volume 2, Version 3, Point Precipitation Frequency Estimates", NOAA National Weather Service, obtained September 15, 2014.
2. HydroCAD 10.00 (build 9), HydroCAD Software Solutions LLC, 2013.
3. North Carolina Department of Environment and Natural Resources, "Erosion and Sediment Control Planning and Design Manual", Revised May 2013.
4. "Standard Specification for Roads and Structures", North Carolina Department of Transportation, Raleigh, January 2012.
5. United States Department of Agriculture, "Urban Hydrology for Small Watersheds", Technical Release 55, June 1986.

FIGURES



Drainage Area ID	Area (ac)
ER1R	0.44
ER2R	0.50
ER3R	0.54
ER4R	0.31
ER5R	0.17
ER1L	5.91
ER2L	2.07
ER3L	2.21
ER4L	4.66
ER5L	1.08
WR1R	0.54
WR2R	0.46
WR3R	0.54
WR1L	0.64
WR2L	2.65
WR3L	4.55

Channel ID	Maximum Slope (%)	Minimum Slope (%)
ER1	6.04	3.55
ER2	2.00	1.37
ER3	2.11	1.41
ER4	5.37	1.55
ER5	1.63	1.22
WR1	3.89	3.32
WR2	4.48	3.97
WR3	5.00	1.54

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CLIENT: DUKE ENERGY CAROLINAS
ROCKINGHAM COUNTY, NC

PROJECT: DAN RIVER LANDFILL

TITLE: LANDFILL PERIMETER STORMWATER CALCULATION
DRAINAGE AREA LOCATIONS
LANDFILL PERIMETER CHANNELS

DWN BY:	DATUM:	DATE:
TK	NAD99	08/26/2015
CHK'D BY:	REV. NO.:	PROJECT NO:
CHR	0	7810-14-0065
PROJECTION:	SCALE:	FIGURE No.
UTM Zone 0	AS SHOWN	1

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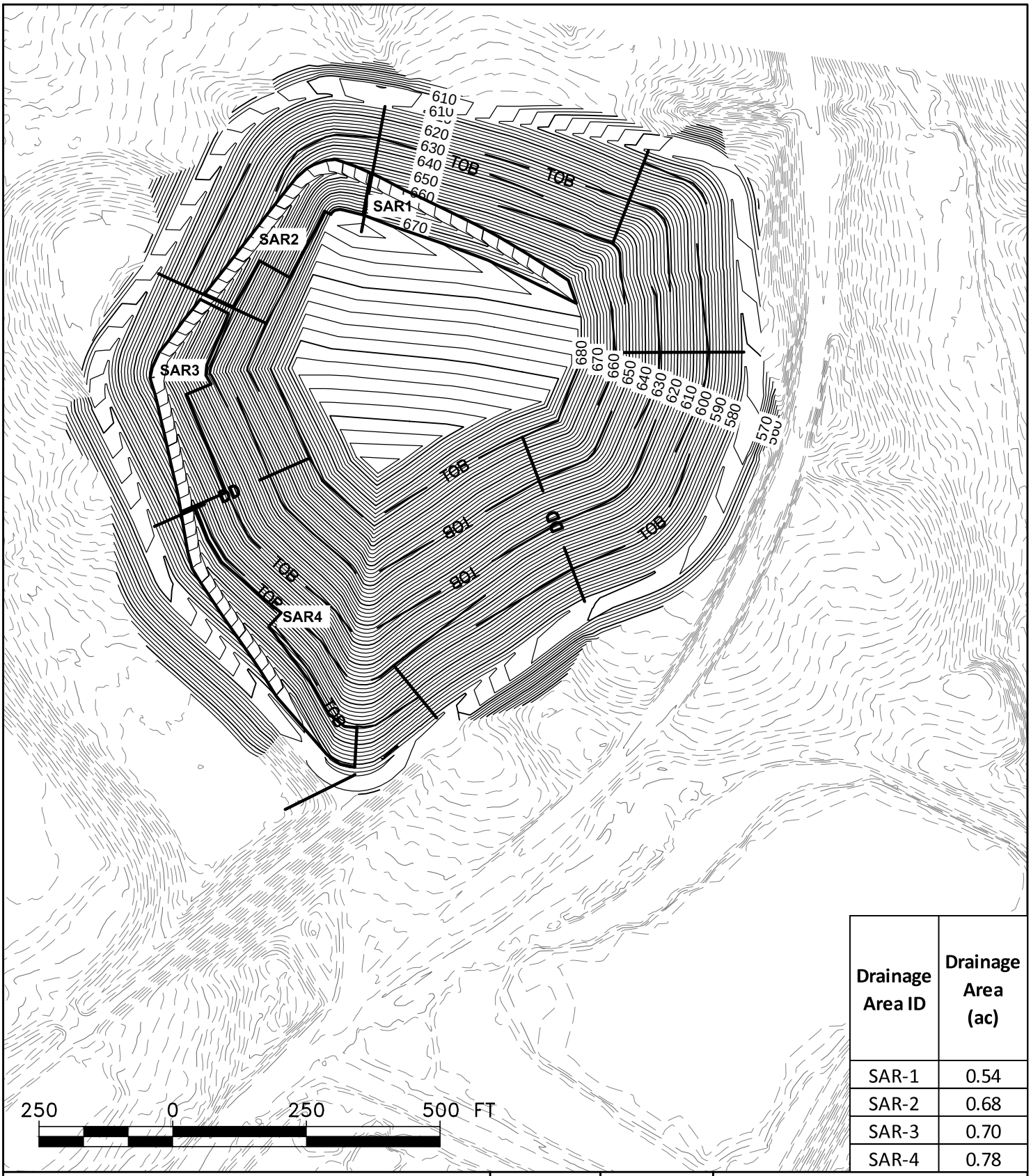

Drainage Area ID	Drainage Area (ac)
SAR-1	0.54
SAR-2	0.68
SAR-3	0.70
SAR-4	0.78

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CLIENT LOGO: DUKE ENERGY

CLIENT: DUKE ENERGY CAROLINAS
ROCKINGHAM COUNTY, NC

PROJECT: DAN RIVER LANDFILL	DWN BY: TK	DATUM: NAD99	DATE: 08/26/2015
TITLE: LANDFILL PERIMETER STORMWATER CALCULATION DRAINAGE AREA LOCATIONS LANDFILL SLOPE ACCESS ROAD CHANNEL	CHK'D BY: CHR	REV. NO.: 0	PROJECT NO: 7810-14-0065
	PROJECTION: UTM Zone 0	SCALE: AS SHOWN	FIGURE No. 2

\\Clt1-fs1\cad\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Exhibit\Landfill\2015-0813-Slope Access Road Calc Figure.dwg - 8.5x11 - Aug. 16, 2015 8:39am - cedric.ruhl

REFERENCE 1

Bonnin, G.M. et. al., “NOAA Atlas 14, Volume 2, Version 3, Point Precipitation Frequency Estimates”, NOAA National Weather Service, obtained September 15, 2014.

NOAA Atlas 14, Volume 2, Version 3
Location name: Eden, North Carolina, US*
Latitude: 36.4999°, Longitude: -79.7013°
Elevation: 582 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.363 (0.331-0.397)	0.433 (0.396-0.473)	0.512 (0.467-0.560)	0.567 (0.518-0.619)	0.633 (0.575-0.688)	0.676 (0.612-0.735)	0.717 (0.646-0.781)	0.754 (0.676-0.822)	0.796 (0.708-0.869)	0.826 (0.729-0.902)
10-min	0.579 (0.529-0.634)	0.692 (0.633-0.757)	0.820 (0.749-0.898)	0.908 (0.829-0.991)	1.01 (0.917-1.10)	1.08 (0.974-1.17)	1.14 (1.03-1.24)	1.20 (1.07-1.30)	1.26 (1.12-1.38)	1.30 (1.15-1.42)
15-min	0.724 (0.661-0.792)	0.870 (0.796-0.951)	1.04 (0.947-1.14)	1.15 (1.05-1.25)	1.28 (1.16-1.39)	1.36 (1.23-1.48)	1.44 (1.30-1.57)	1.51 (1.35-1.64)	1.59 (1.41-1.73)	1.63 (1.44-1.78)
30-min	0.993 (0.906-1.09)	1.20 (1.10-1.31)	1.47 (1.35-1.61)	1.66 (1.52-1.82)	1.89 (1.72-2.06)	2.05 (1.86-2.23)	2.21 (1.99-2.40)	2.35 (2.11-2.56)	2.52 (2.24-2.75)	2.64 (2.33-2.89)
60-min	1.24 (1.13-1.35)	1.51 (1.38-1.65)	1.89 (1.73-2.07)	2.17 (1.98-2.36)	2.52 (2.29-2.74)	2.78 (2.52-3.03)	3.04 (2.74-3.31)	3.29 (2.95-3.59)	3.62 (3.22-3.95)	3.86 (3.41-4.22)
2-hr	1.47 (1.35-1.61)	1.79 (1.63-1.96)	2.25 (2.06-2.46)	2.61 (2.38-2.85)	3.08 (2.80-3.36)	3.45 (3.12-3.75)	3.83 (3.44-4.16)	4.20 (3.75-4.57)	4.71 (4.15-5.12)	5.10 (4.45-5.56)
3-hr	1.59 (1.46-1.73)	1.93 (1.78-2.11)	2.44 (2.24-2.66)	2.82 (2.58-3.07)	3.33 (3.03-3.62)	3.73 (3.38-4.04)	4.13 (3.72-4.48)	4.54 (4.06-4.92)	5.08 (4.49-5.52)	5.50 (4.81-5.98)
6-hr	1.96 (1.80-2.15)	2.37 (2.18-2.61)	2.99 (2.74-3.27)	3.48 (3.17-3.80)	4.15 (3.76-4.53)	4.70 (4.22-5.12)	5.28 (4.70-5.73)	5.87 (5.18-6.37)	6.71 (5.82-7.29)	7.38 (6.31-8.02)
12-hr	2.36 (2.17-2.59)	2.87 (2.63-3.14)	3.63 (3.32-3.96)	4.26 (3.88-4.62)	5.15 (4.65-5.57)	5.89 (5.28-6.37)	6.70 (5.94-7.21)	7.56 (6.62-8.12)	8.81 (7.57-9.48)	9.84 (8.31-10.6)
24-hr	2.81 (2.61-3.04)	3.40 (3.16-3.68)	4.33 (4.02-4.67)	5.10 (4.72-5.48)	6.22 (5.72-6.68)	7.17 (6.55-7.69)	8.20 (7.44-8.79)	9.32 (8.39-10.0)	11.0 (9.74-11.8)	12.4 (10.9-13.3)
2-day	3.30 (3.08-3.55)	3.99 (3.72-4.30)	5.04 (4.70-5.42)	5.90 (5.48-6.33)	7.12 (6.59-7.63)	8.13 (7.48-8.71)	9.21 (8.42-9.88)	10.4 (9.40-11.1)	12.0 (10.8-13.0)	13.4 (11.9-14.5)
3-day	3.49 (3.26-3.76)	4.22 (3.93-4.55)	5.33 (4.96-5.73)	6.23 (5.79-6.69)	7.52 (6.95-8.07)	8.59 (7.89-9.21)	9.72 (8.88-10.4)	10.9 (9.92-11.8)	12.7 (11.4-13.7)	14.2 (12.6-15.3)
4-day	3.68 (3.43-3.97)	4.45 (4.15-4.80)	5.61 (5.23-6.05)	6.56 (6.10-7.06)	7.92 (7.32-8.51)	9.04 (8.31-9.71)	10.2 (9.35-11.0)	11.5 (10.4-12.4)	13.4 (12.0-14.4)	14.9 (13.2-16.1)
7-day	4.22 (3.96-4.51)	5.07 (4.75-5.42)	6.29 (5.89-6.72)	7.29 (6.81-7.78)	8.71 (8.11-9.28)	9.88 (9.14-10.5)	11.1 (10.2-11.9)	12.4 (11.4-13.3)	14.3 (12.9-15.3)	15.9 (14.2-17.0)
10-day	4.77 (4.48-5.10)	5.71 (5.37-6.10)	7.01 (6.58-7.48)	8.06 (7.55-8.60)	9.53 (8.89-10.2)	10.7 (9.96-11.4)	12.0 (11.1-12.8)	13.3 (12.2-14.2)	15.1 (13.8-16.2)	16.6 (15.0-17.8)
20-day	6.43 (6.05-6.85)	7.65 (7.21-8.16)	9.20 (8.66-9.81)	10.4 (9.79-11.1)	12.1 (11.3-12.9)	13.4 (12.5-14.3)	14.7 (13.7-15.7)	16.1 (14.9-17.2)	17.9 (16.4-19.2)	19.3 (17.6-20.8)
30-day	7.95 (7.53-8.41)	9.40 (8.91-9.94)	11.1 (10.5-11.7)	12.3 (11.7-13.0)	14.0 (13.2-14.8)	15.3 (14.4-16.2)	16.5 (15.5-17.5)	17.7 (16.6-18.8)	19.3 (18.0-20.5)	20.5 (19.0-21.9)
45-day	10.0 (9.48-10.6)	11.8 (11.2-12.5)	13.7 (13.0-14.5)	15.2 (14.4-16.0)	17.1 (16.1-18.0)	18.5 (17.4-19.5)	19.8 (18.6-21.0)	21.1 (19.8-22.4)	22.8 (21.3-24.2)	24.0 (22.3-25.6)
60-day	12.0 (11.4-12.6)	14.0 (13.4-14.8)	16.1 (15.3-17.0)	17.7 (16.8-18.6)	19.7 (18.7-20.7)	21.2 (20.0-22.3)	22.6 (21.3-23.8)	23.9 (22.5-25.2)	25.6 (24.0-27.1)	26.8 (25.1-28.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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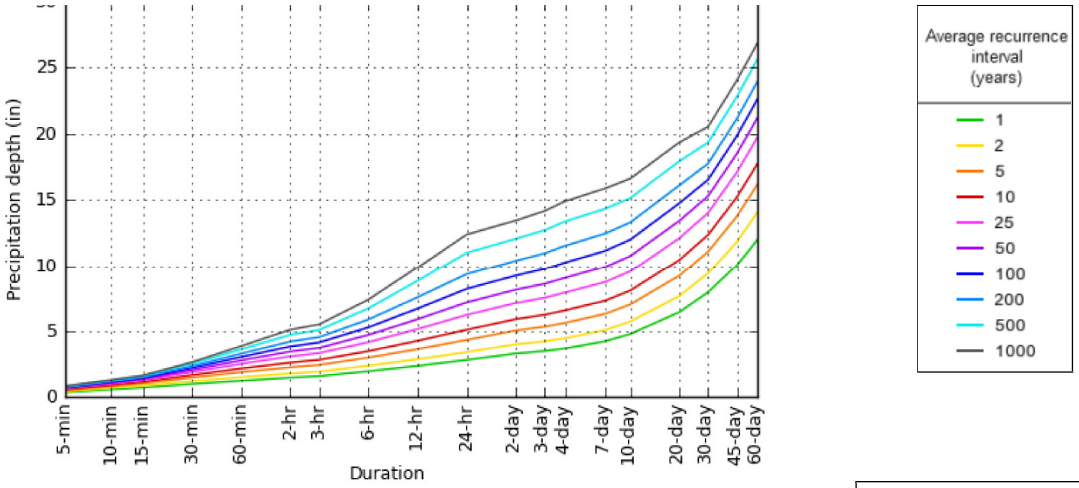
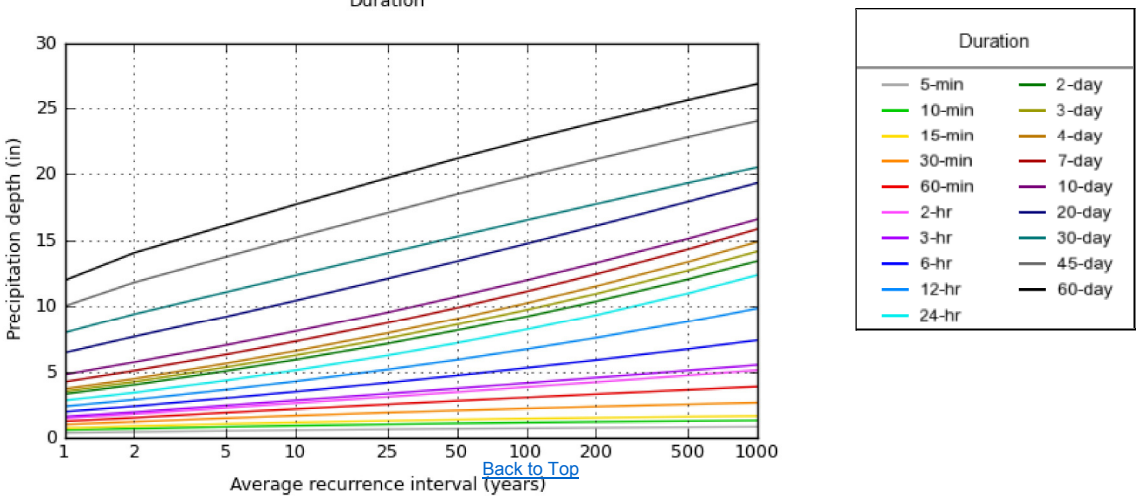
PF graphical





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Maps & aerials

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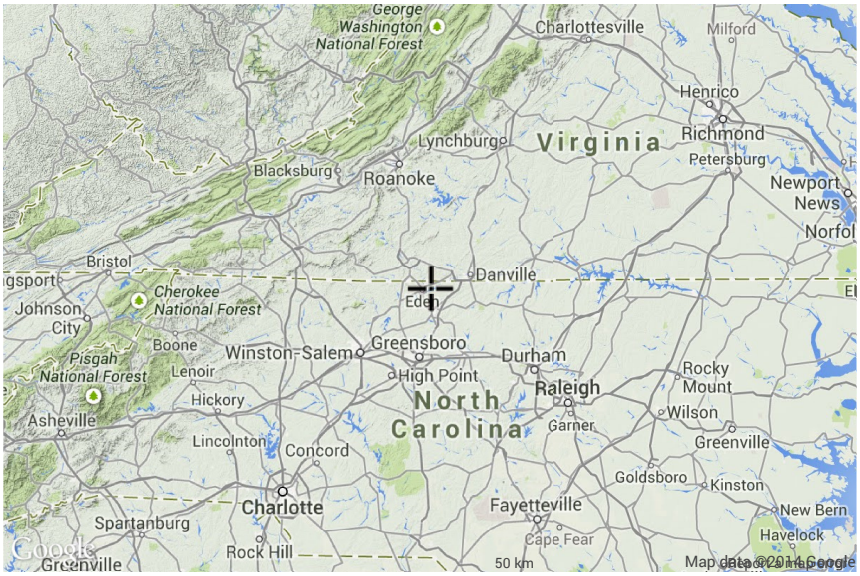
Small scale terrain



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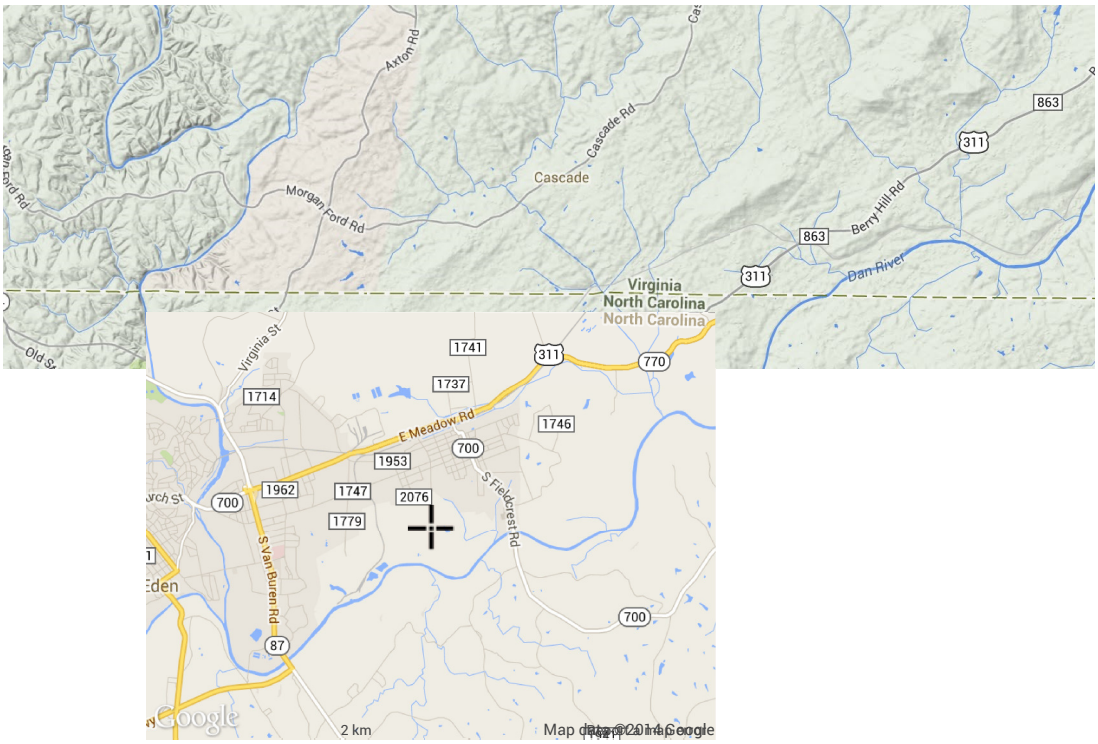

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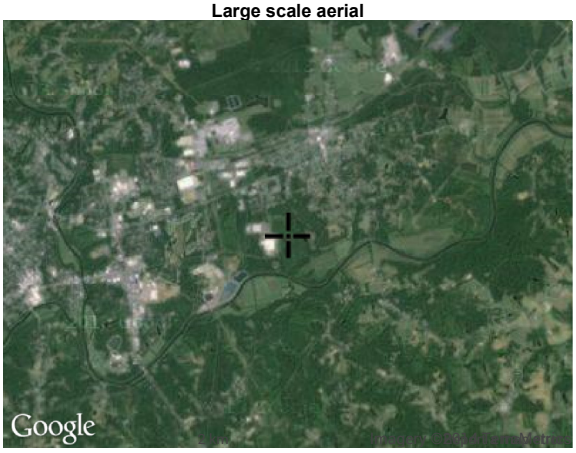

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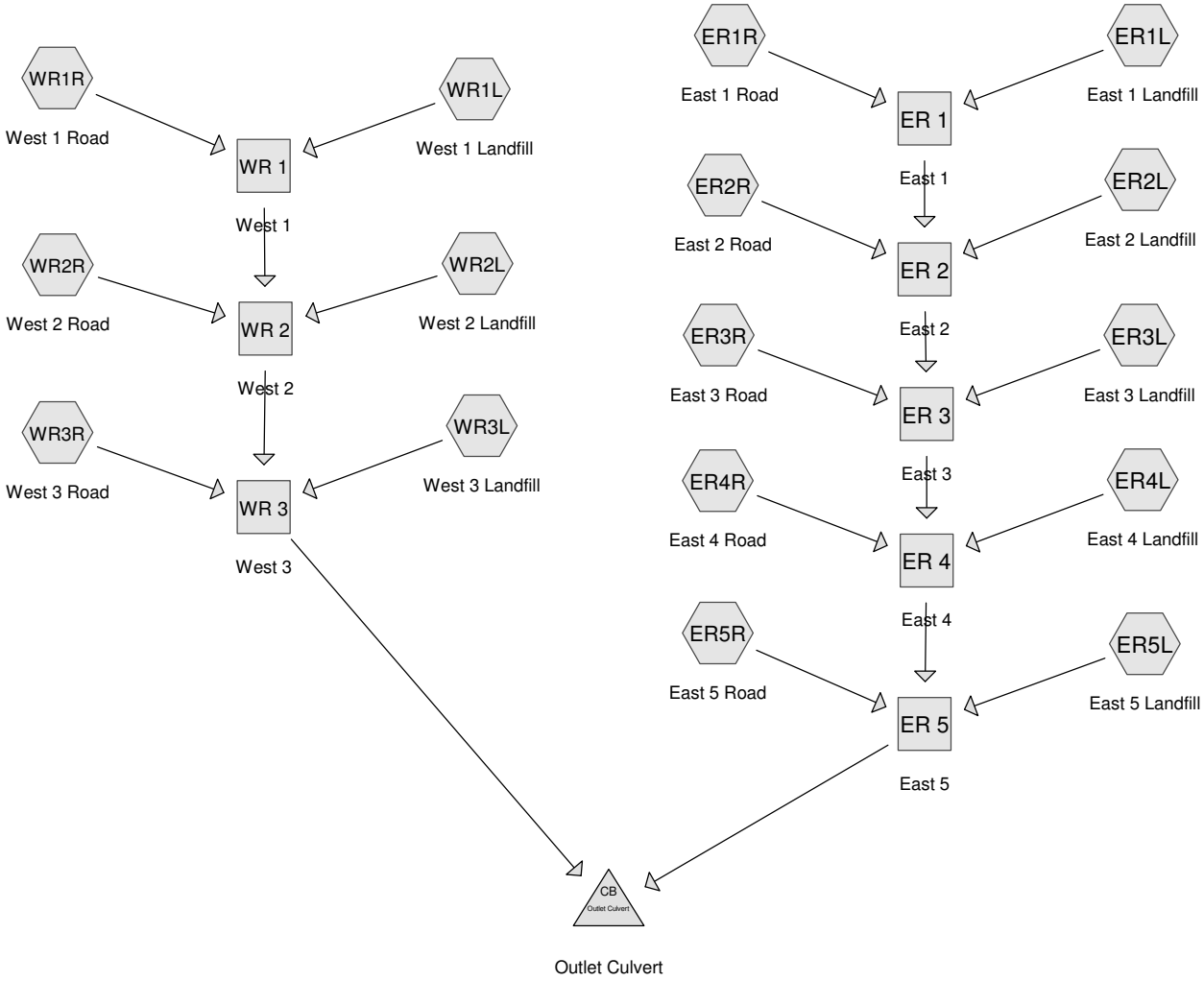
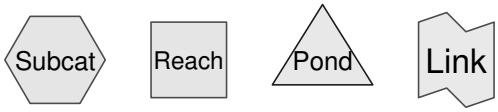
REFERENCE 2

HydroCAD 10.00 (build 9), HydroCAD Software Solutions LLC, 2013.





Routing Diagram for HydroCAD_Perm Cond_Perm Chan_WideGrate
Prepared by AMEC, Printed 8/14/2015
HydroCAD® 10.00 s/n 08086 © 2013 HydroCAD Software Solutions LLC

Summary for Subcatchment ER1L: East 1 Landfill

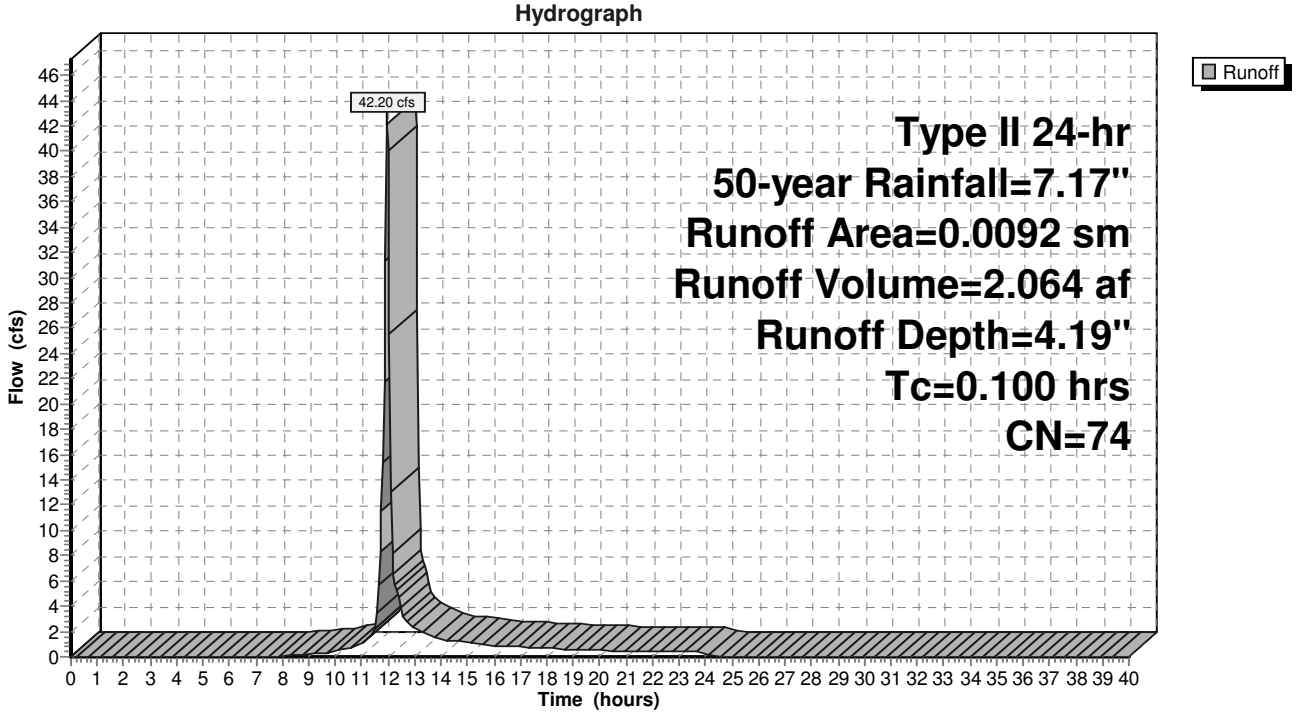
Runoff = 42.20 cfs @ 11.97 hrs, Volume= 2.064 af, Depth= 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0092	74	>75% Grass cover, Good, HSG C

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

Subcatchment ER1L: East 1 Landfill



Summary for Subcatchment ER1R: East 1 Road

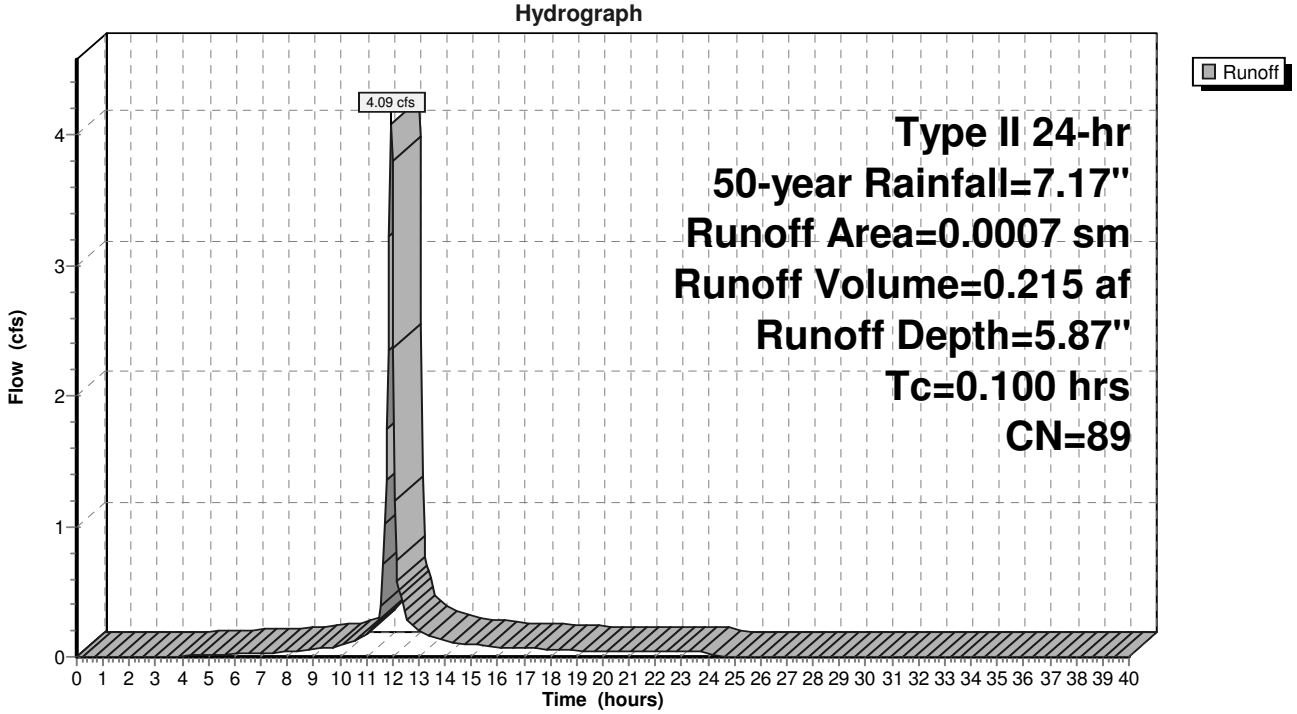
Runoff = 4.09 cfs @ 11.96 hrs, Volume= 0.215 af, Depth= 5.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0007	89	Gravel roads, HSG C

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

Subcatchment ER1R: East 1 Road



Summary for Subcatchment ER2L: East 2 Landfill

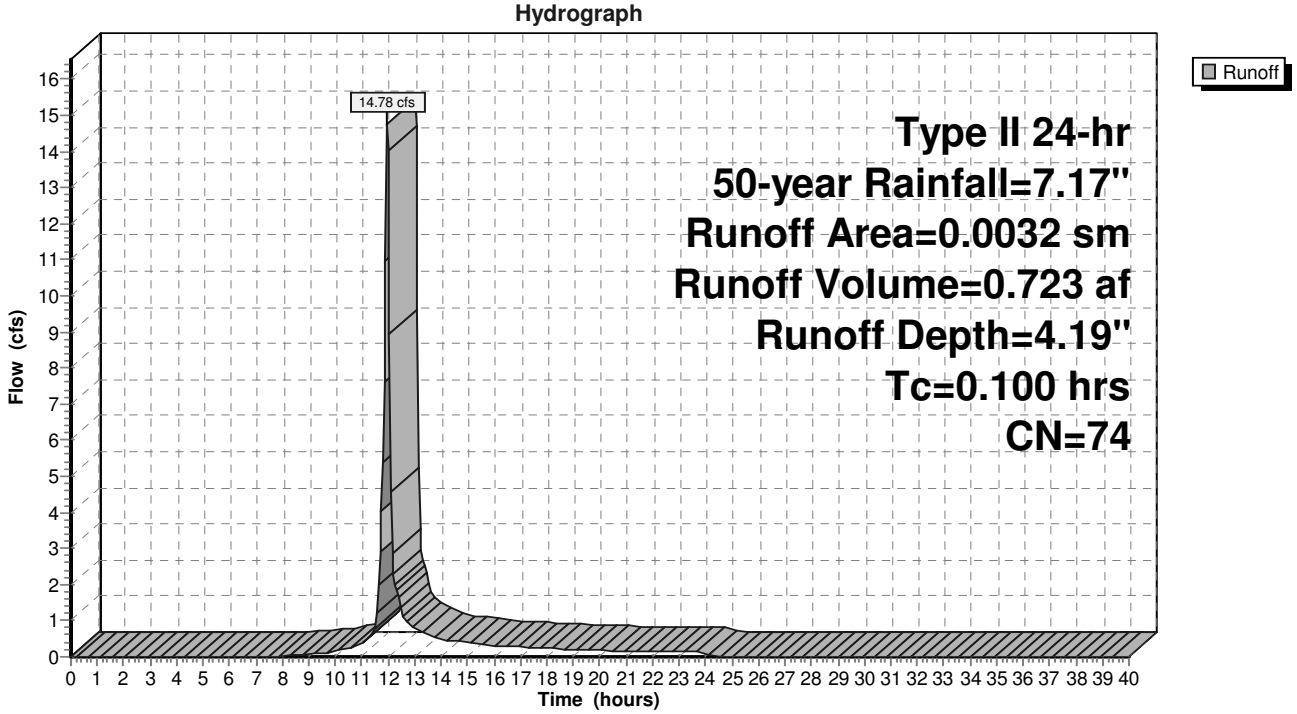
Runoff = 14.78 cfs @ 11.97 hrs, Volume= 0.723 af, Depth= 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0032	74	>75% Grass cover, Good, HSG C

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

Subcatchment ER2L: East 2 Landfill



Summary for Subcatchment ER2R: East 2 Road

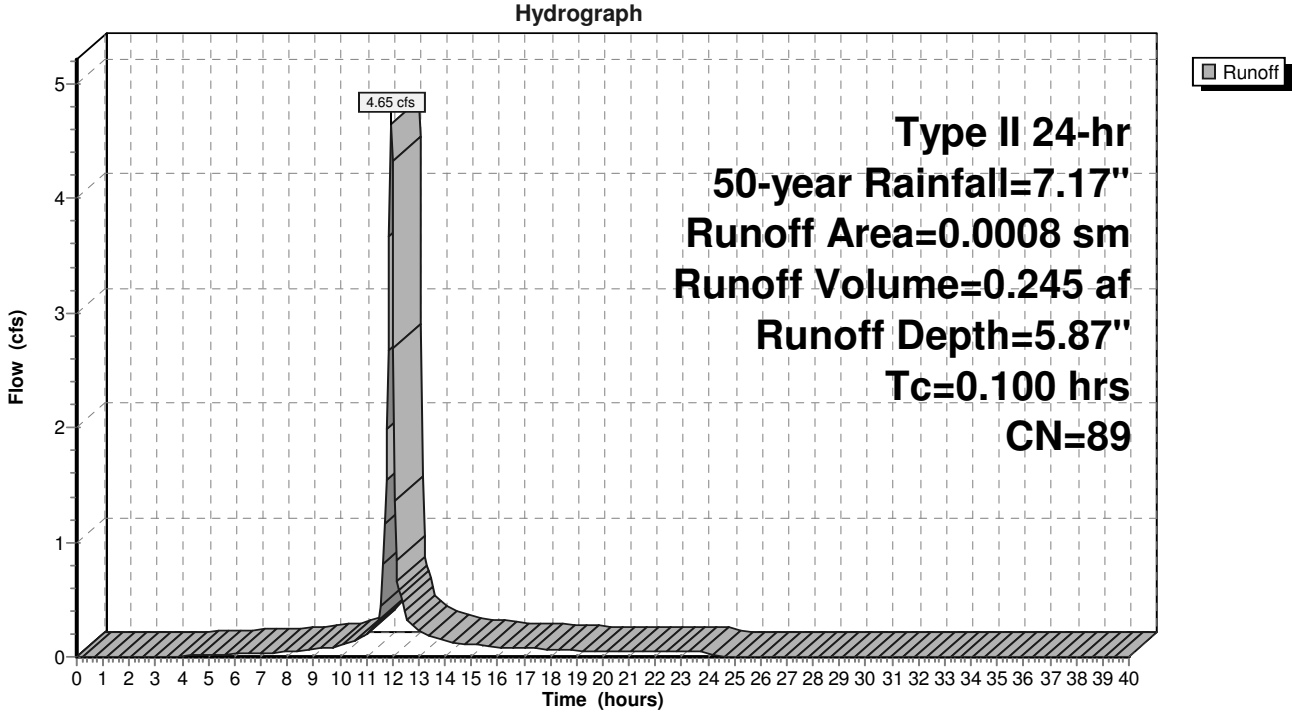
Runoff = 4.65 cfs @ 11.96 hrs, Volume= 0.245 af, Depth= 5.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0008	89	Gravel roads, HSG C

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

Subcatchment ER2R: East 2 Road



Summary for Subcatchment ER3L: East 3 Landfill

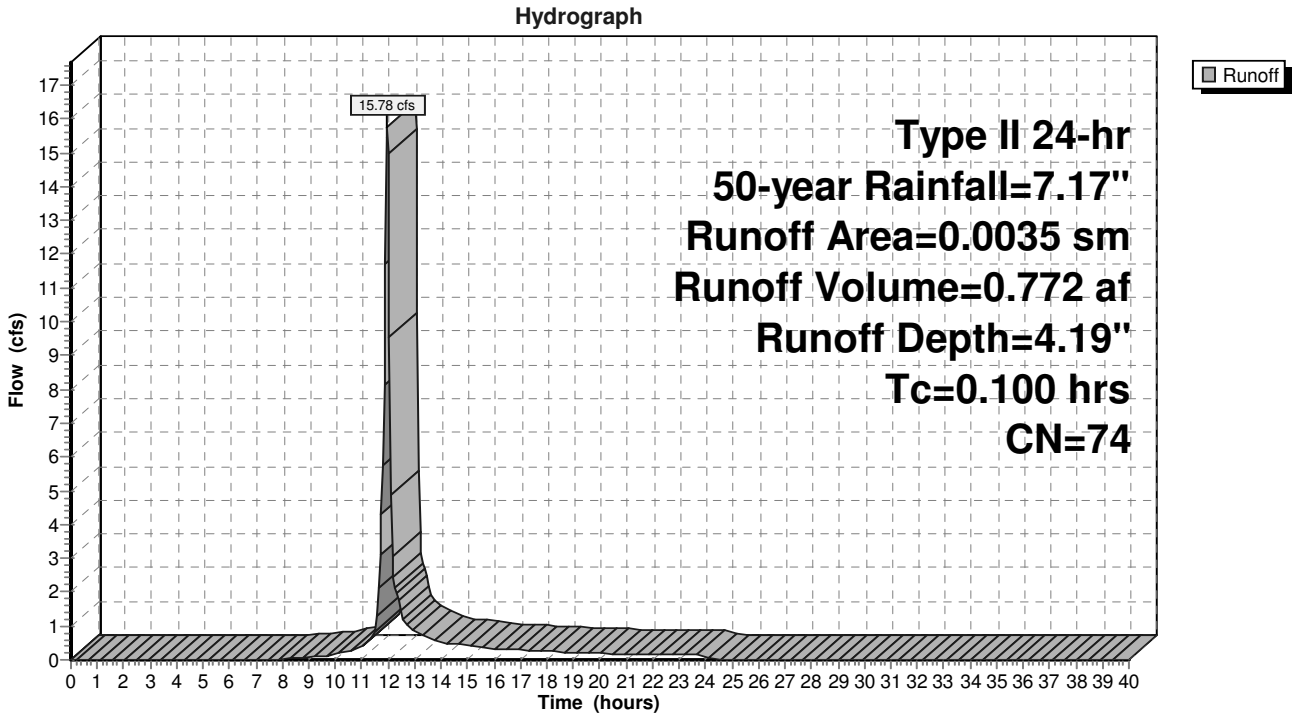
Runoff = 15.78 cfs @ 11.97 hrs, Volume= 0.772 af, Depth= 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0035	74	>75% Grass cover, Good, HSG C

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

Subcatchment ER3L: East 3 Landfill



Summary for Subcatchment ER3R: East 3 Road

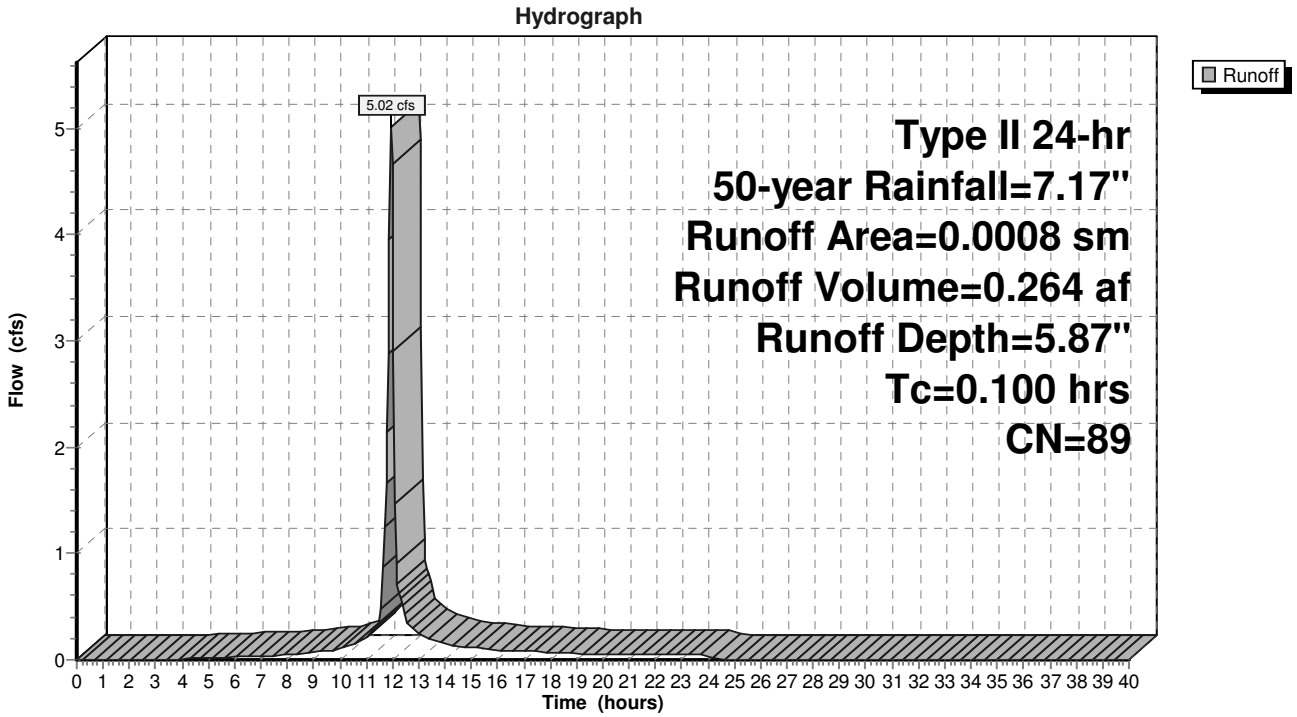
Runoff = 5.02 cfs @ 11.96 hrs, Volume= 0.264 af, Depth= 5.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0008	89	Gravel roads, HSG C

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

Subcatchment ER3R: East 3 Road



Summary for Subcatchment ER4L: East 4 Landfill

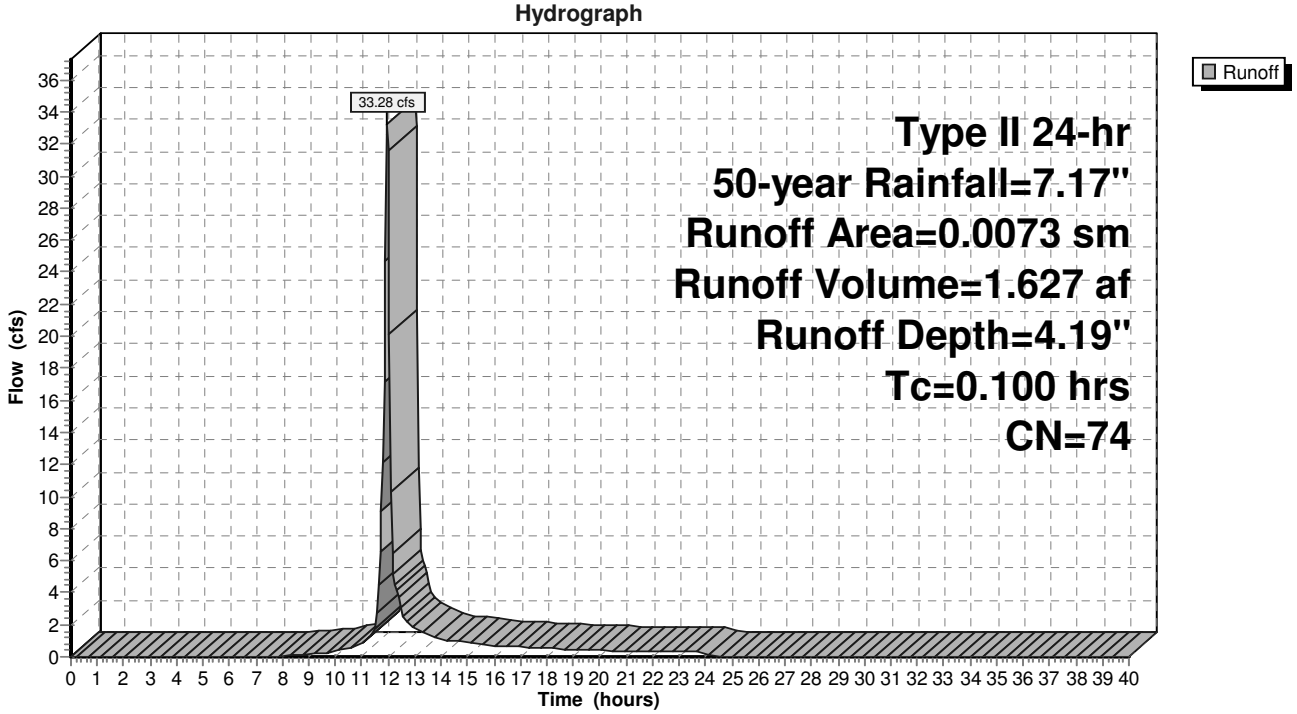
Runoff = 33.28 cfs @ 11.97 hrs, Volume= 1.627 af, Depth= 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0073	74	>75% Grass cover, Good, HSG C

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

Subcatchment ER4L: East 4 Landfill



Summary for Subcatchment ER4R: East 4 Road

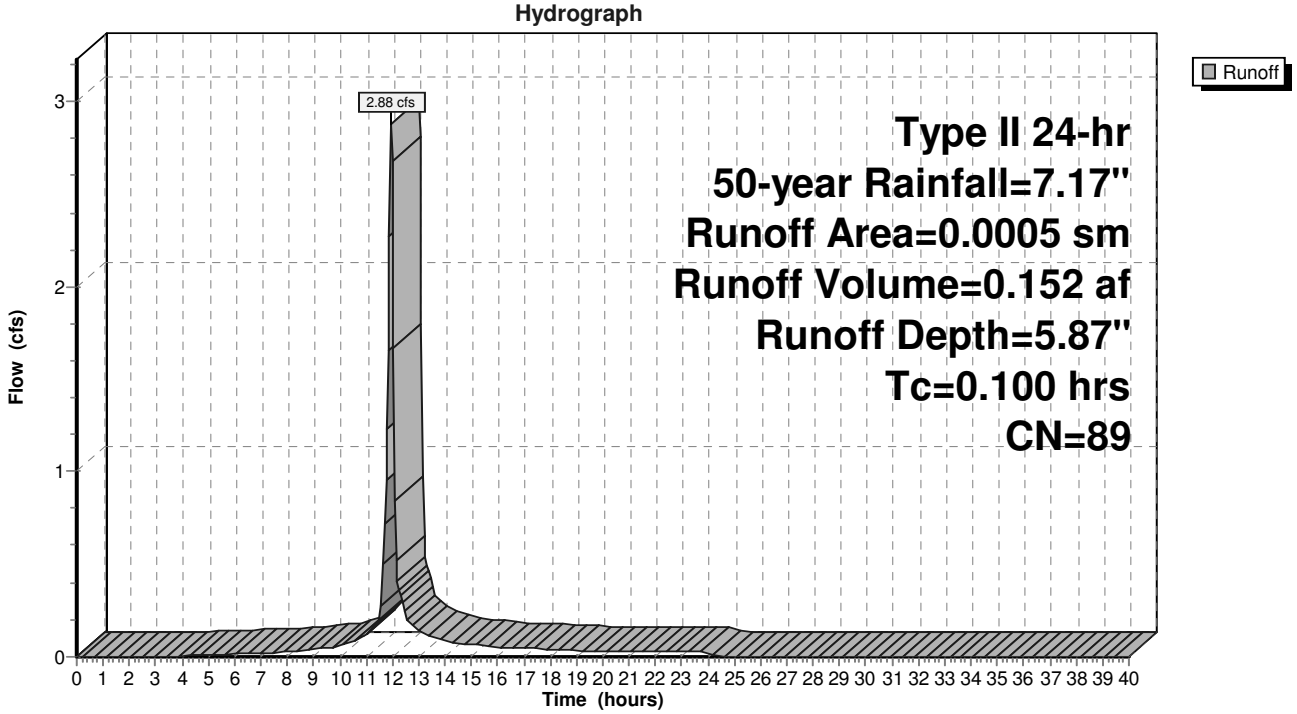
Runoff = 2.88 cfs @ 11.96 hrs, Volume= 0.152 af, Depth= 5.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0005	89	Gravel roads, HSG C

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

Subcatchment ER4R: East 4 Road



Summary for Subcatchment ER5L: East 5 Landfill

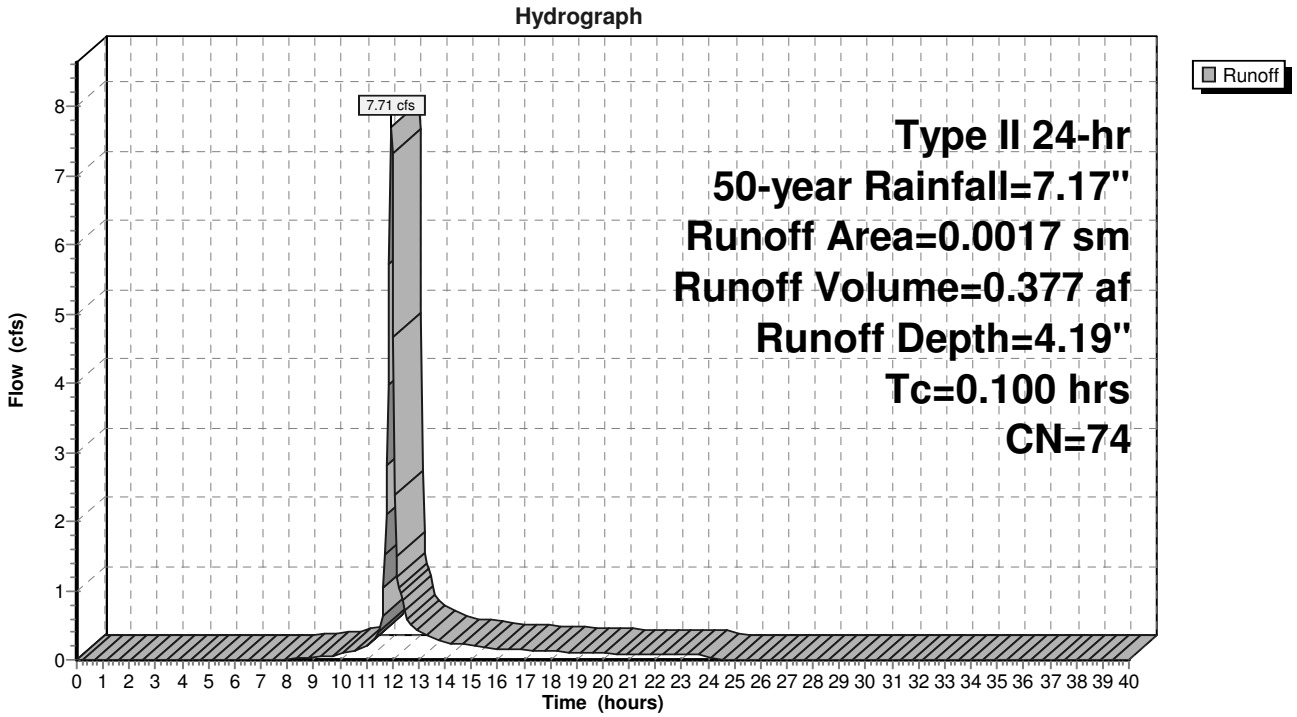
Runoff = 7.71 cfs @ 11.97 hrs, Volume= 0.377 af, Depth= 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0017	74	>75% Grass cover, Good, HSG C

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

Subcatchment ER5L: East 5 Landfill



Summary for Subcatchment ER5R: East 5 Road

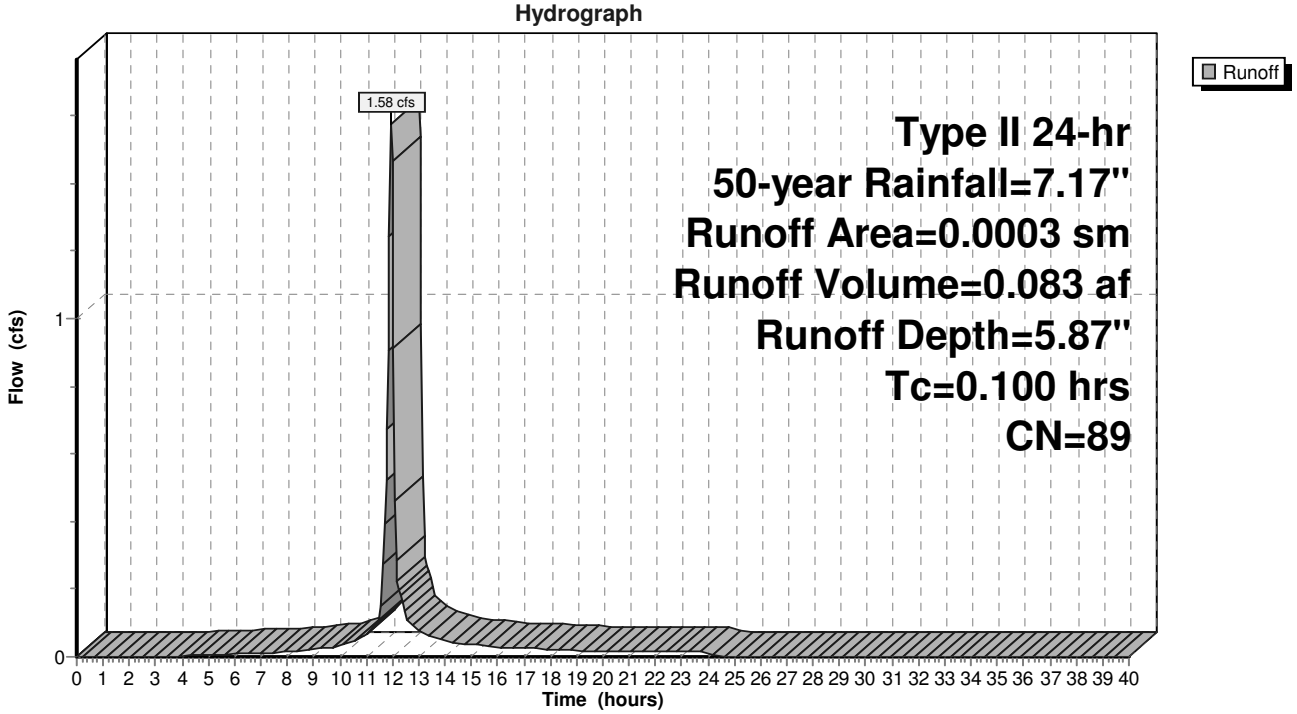
Runoff = 1.58 cfs @ 11.96 hrs, Volume= 0.083 af, Depth= 5.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0003	89	Gravel roads, HSG C

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

Subcatchment ER5R: East 5 Road



Summary for Subcatchment WR1L: West 1 Landfill

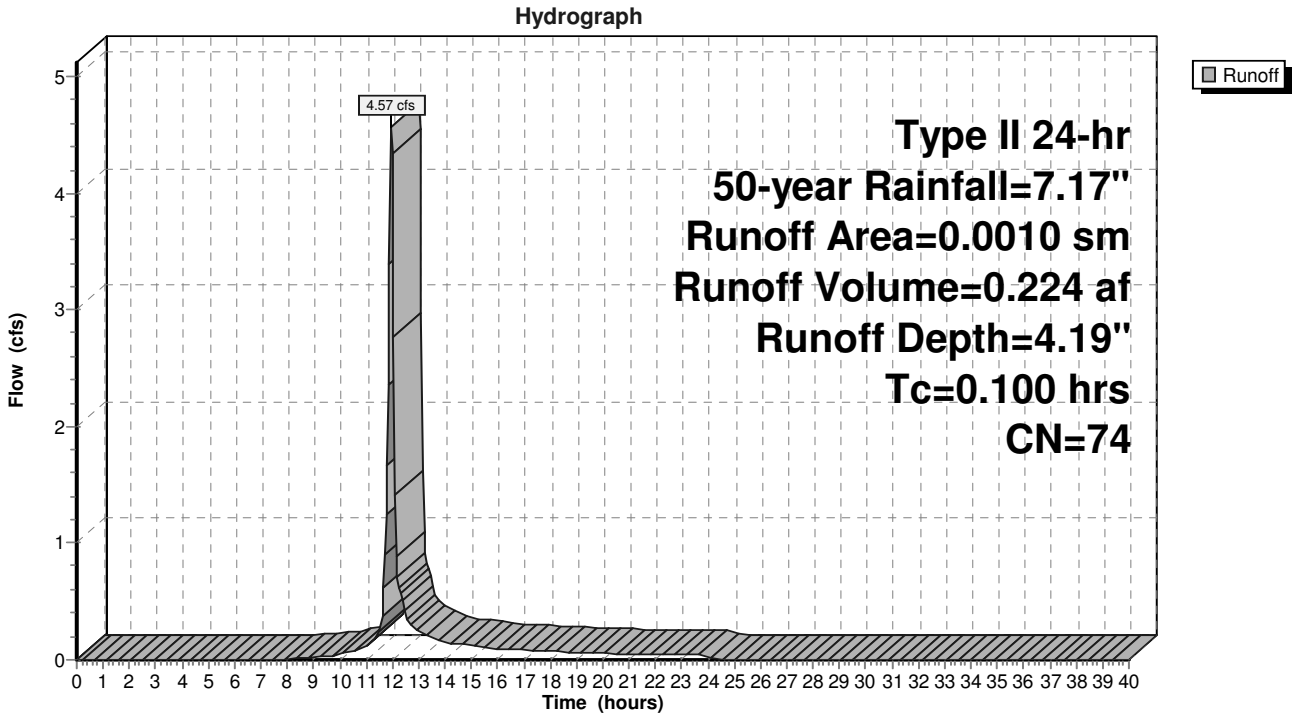
Runoff = 4.57 cfs @ 11.97 hrs, Volume= 0.224 af, Depth= 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0010	74	>75% Grass cover, Good, HSG C

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

Subcatchment WR1L: West 1 Landfill



Summary for Subcatchment WR1R: West 1 Road

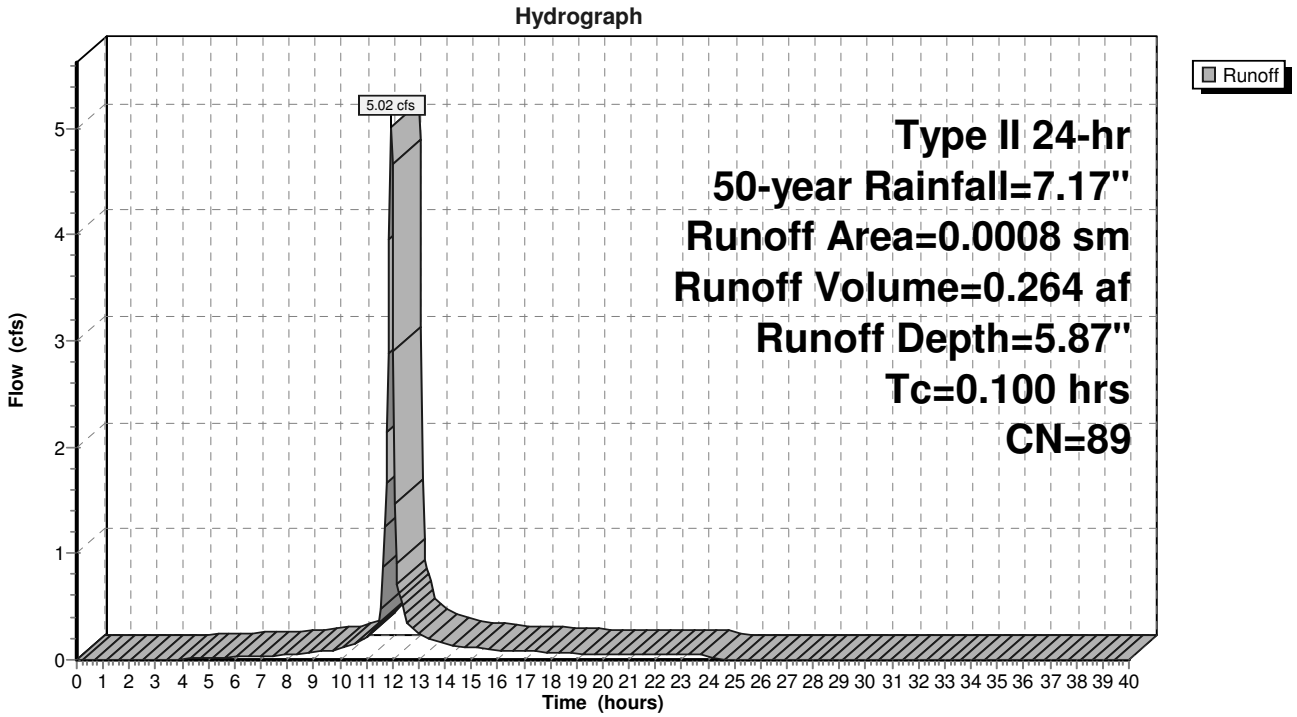
Runoff = 5.02 cfs @ 11.96 hrs, Volume= 0.264 af, Depth= 5.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0008	89	Gravel roads, HSG C

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

Subcatchment WR1R: West 1 Road



Summary for Subcatchment WR2L: West 2 Landfill

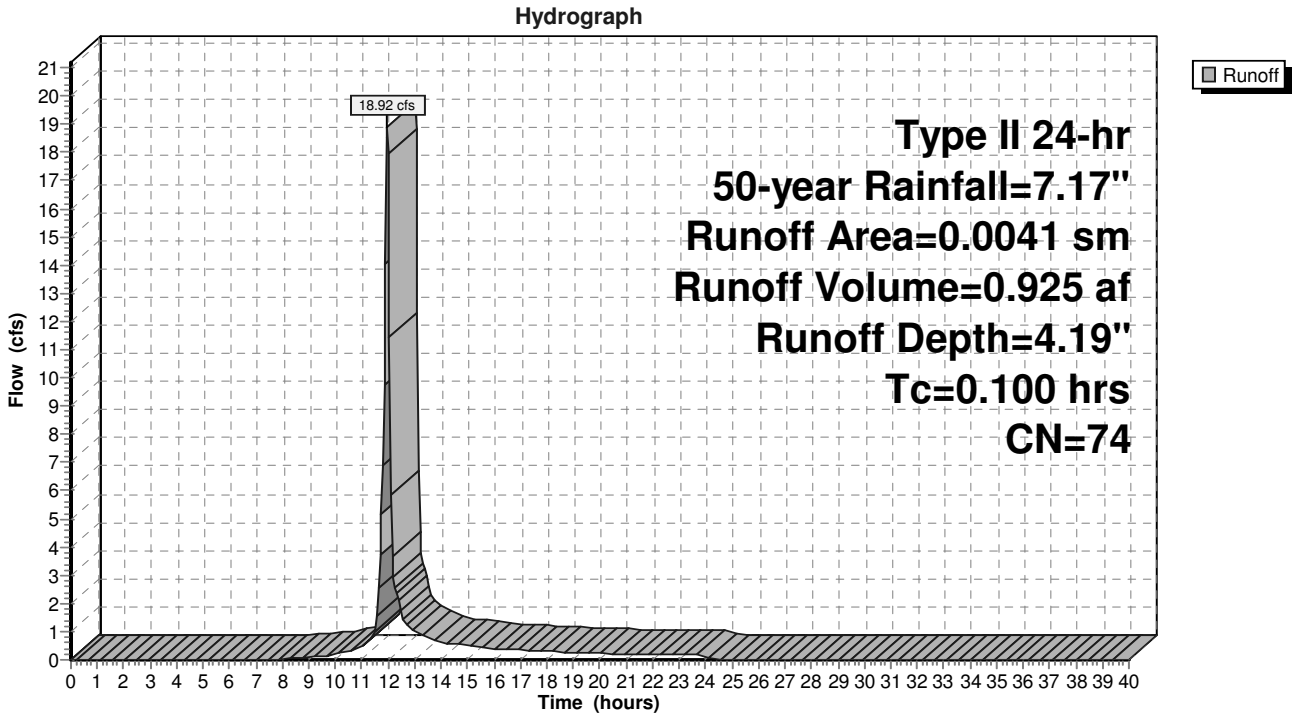
Runoff = 18.92 cfs @ 11.97 hrs, Volume= 0.925 af, Depth= 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0041	74	>75% Grass cover, Good, HSG C

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

Subcatchment WR2L: West 2 Landfill



Summary for Subcatchment WR2R: West 2 Road

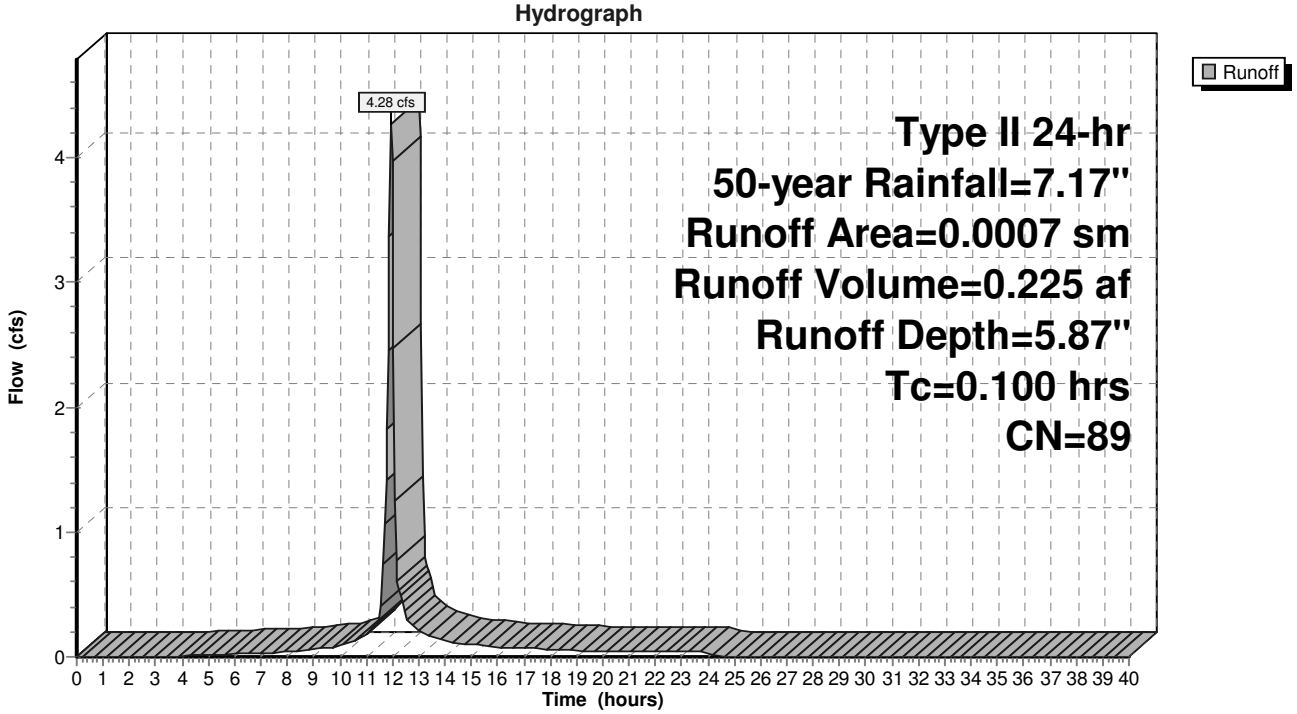
Runoff = 4.28 cfs @ 11.96 hrs, Volume= 0.225 af, Depth= 5.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0007	89	Gravel roads, HSG C

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

Subcatchment WR2R: West 2 Road



Summary for Subcatchment WR3L: West 3 Landfill

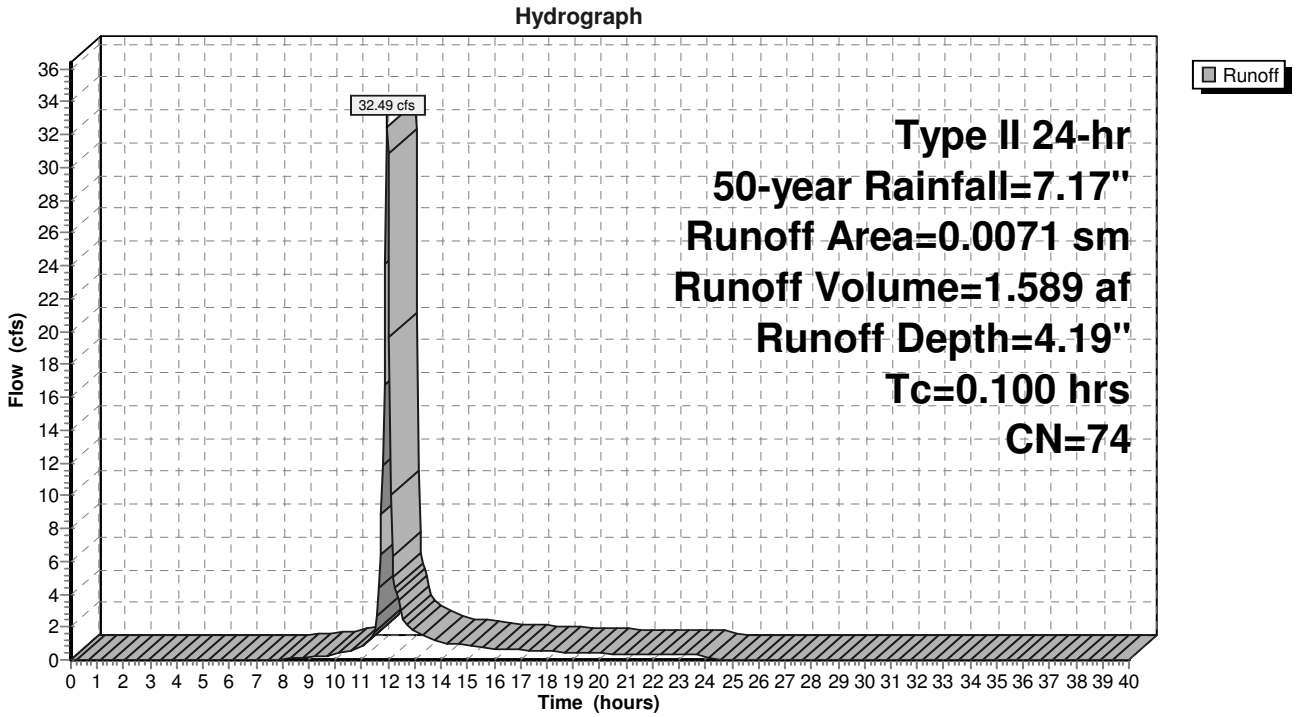
Runoff = 32.49 cfs @ 11.97 hrs, Volume= 1.589 af, Depth= 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0071	74	>75% Grass cover, Good, HSG C

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

Subcatchment WR3L: West 3 Landfill



Summary for Subcatchment WR3R: West 3 Road

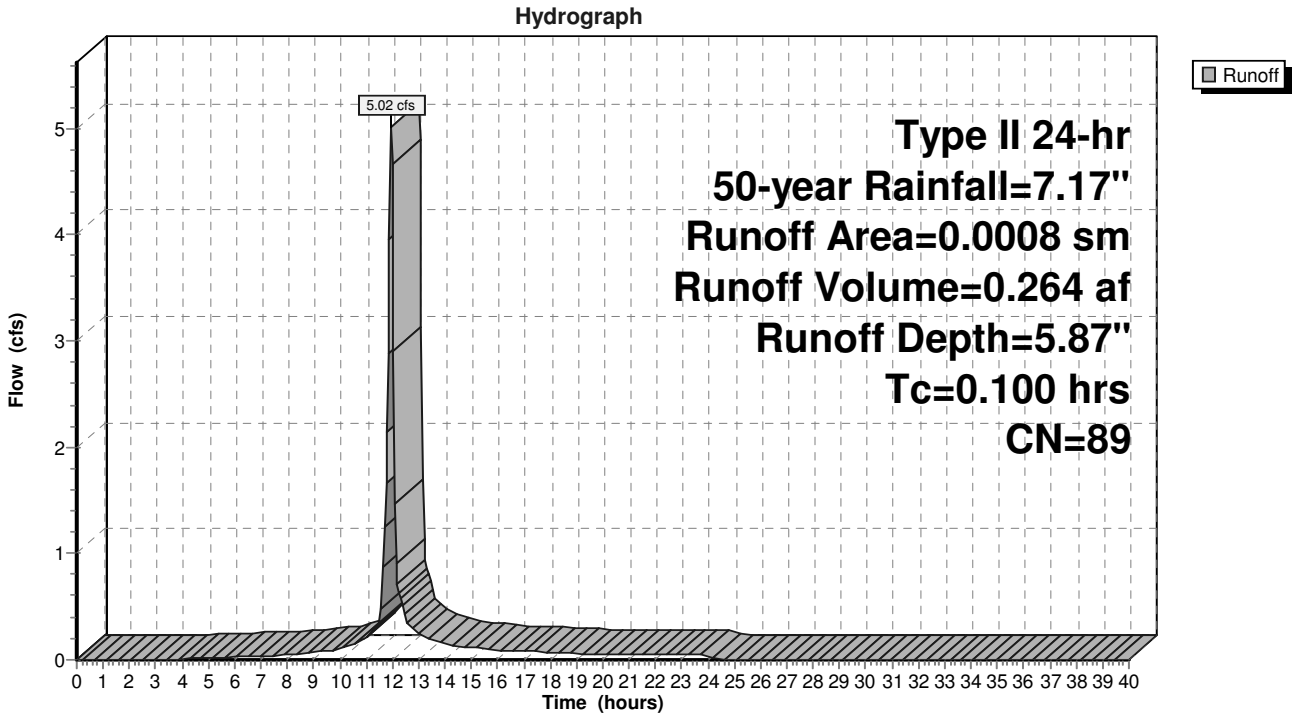
Runoff = 5.02 cfs @ 11.96 hrs, Volume= 0.264 af, Depth= 5.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sm)	CN	Description
0.0008	89	Gravel roads, HSG C

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

Subcatchment WR3R: West 3 Road

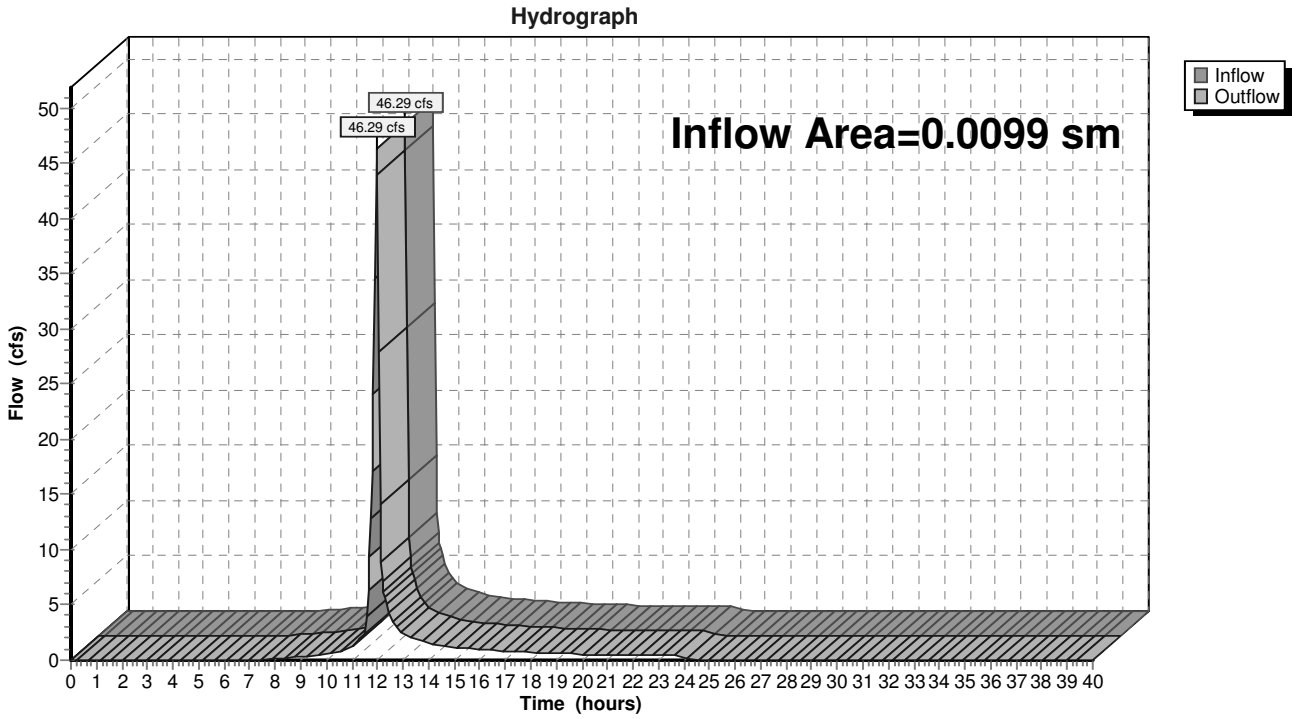


Summary for Reach ER 1: East 1

Inflow Area = 0.0099 sm, Inflow Depth = 4.31" for 50-year event
Inflow = 46.29 cfs @ 11.97 hrs, Volume= 2.279 af
Outflow = 46.29 cfs @ 11.97 hrs, Volume= 2.279 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Reach ER 1: East 1

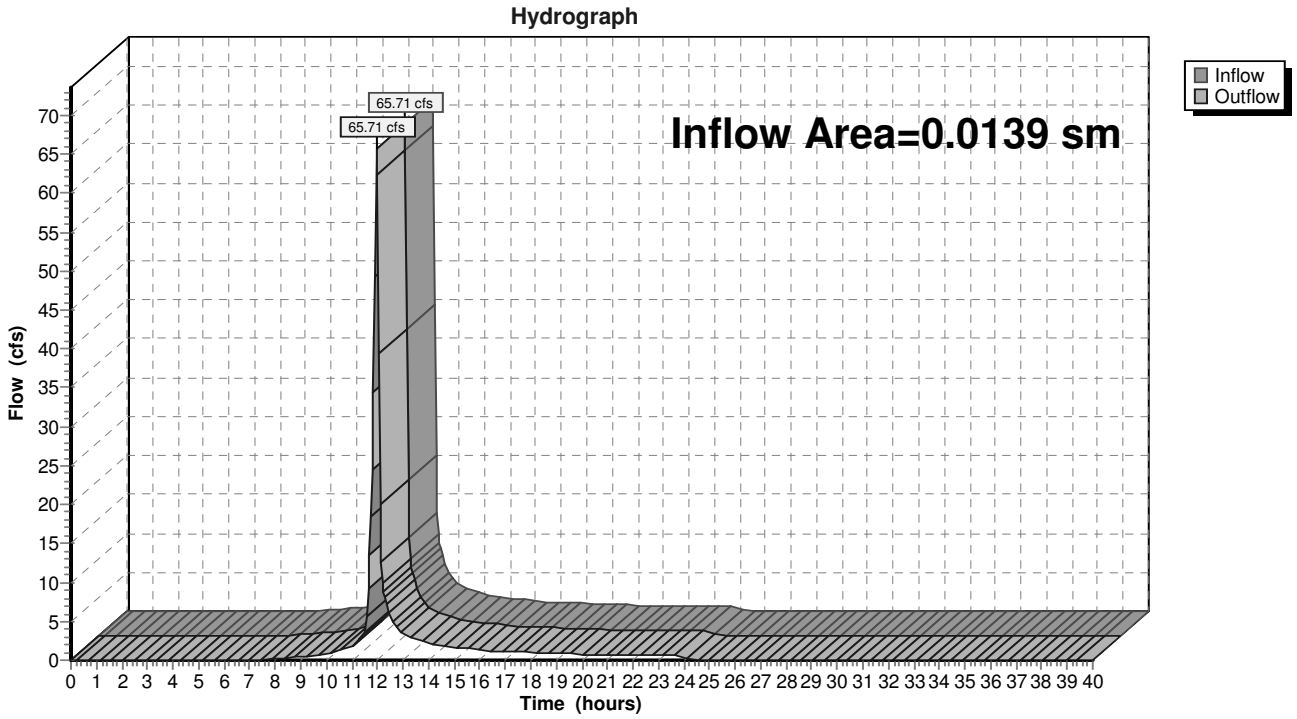


Summary for Reach ER 2: East 2

Inflow Area = 0.0139 sm, Inflow Depth = 4.37" for 50-year event
Inflow = 65.71 cfs @ 11.97 hrs, Volume= 3.247 af
Outflow = 65.71 cfs @ 11.97 hrs, Volume= 3.247 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Reach ER 2: East 2

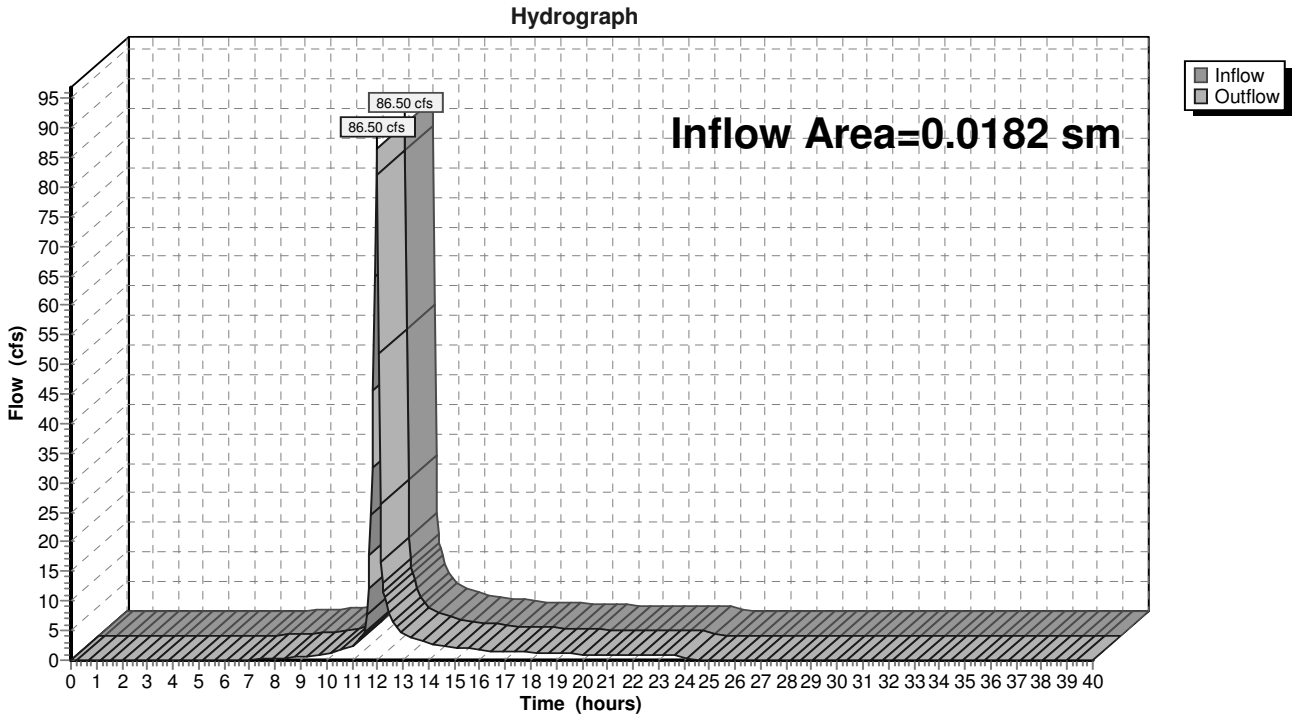


Summary for Reach ER 3: East 3

Inflow Area = 0.0182 sm, Inflow Depth = 4.40" for 50-year event
Inflow = 86.50 cfs @ 11.97 hrs, Volume= 4.283 af
Outflow = 86.50 cfs @ 11.97 hrs, Volume= 4.283 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Reach ER 3: East 3

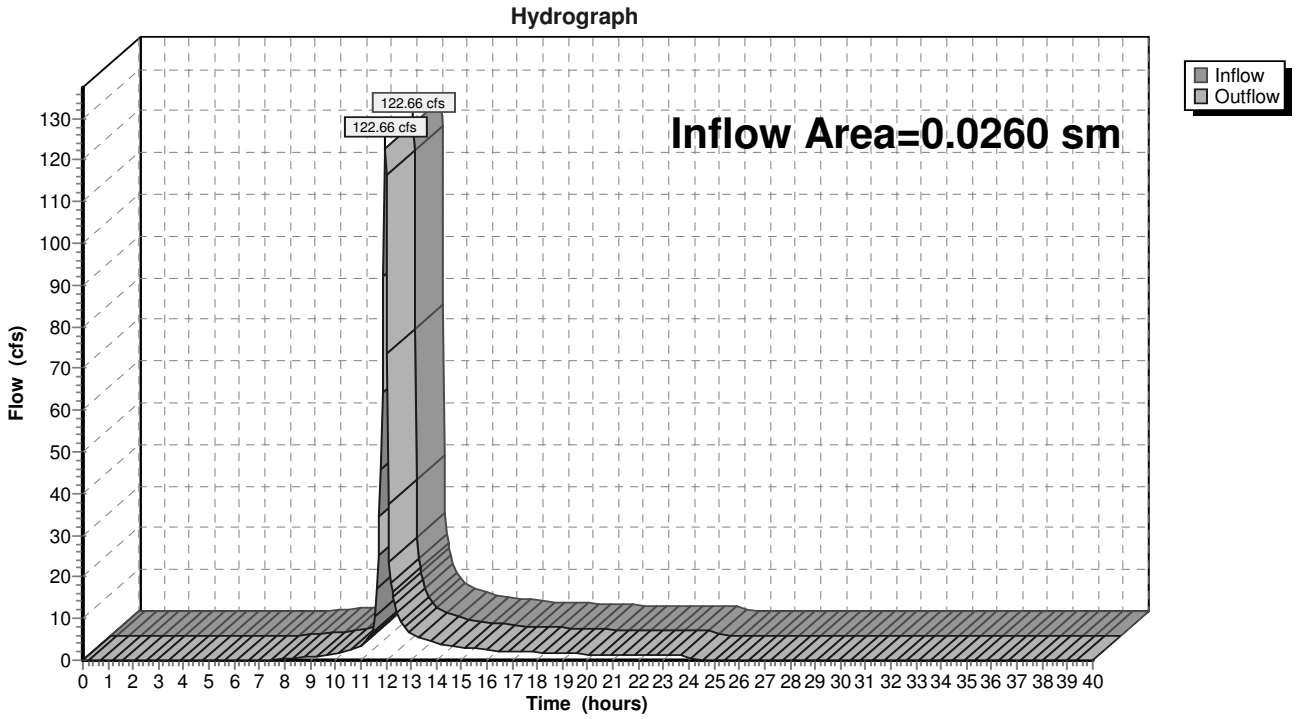


Summary for Reach ER 4: East 4

Inflow Area = 0.0260 sm, Inflow Depth = 4.37" for 50-year event
Inflow = 122.66 cfs @ 11.97 hrs, Volume= 6.062 af
Outflow = 122.66 cfs @ 11.97 hrs, Volume= 6.062 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Reach ER 4: East 4

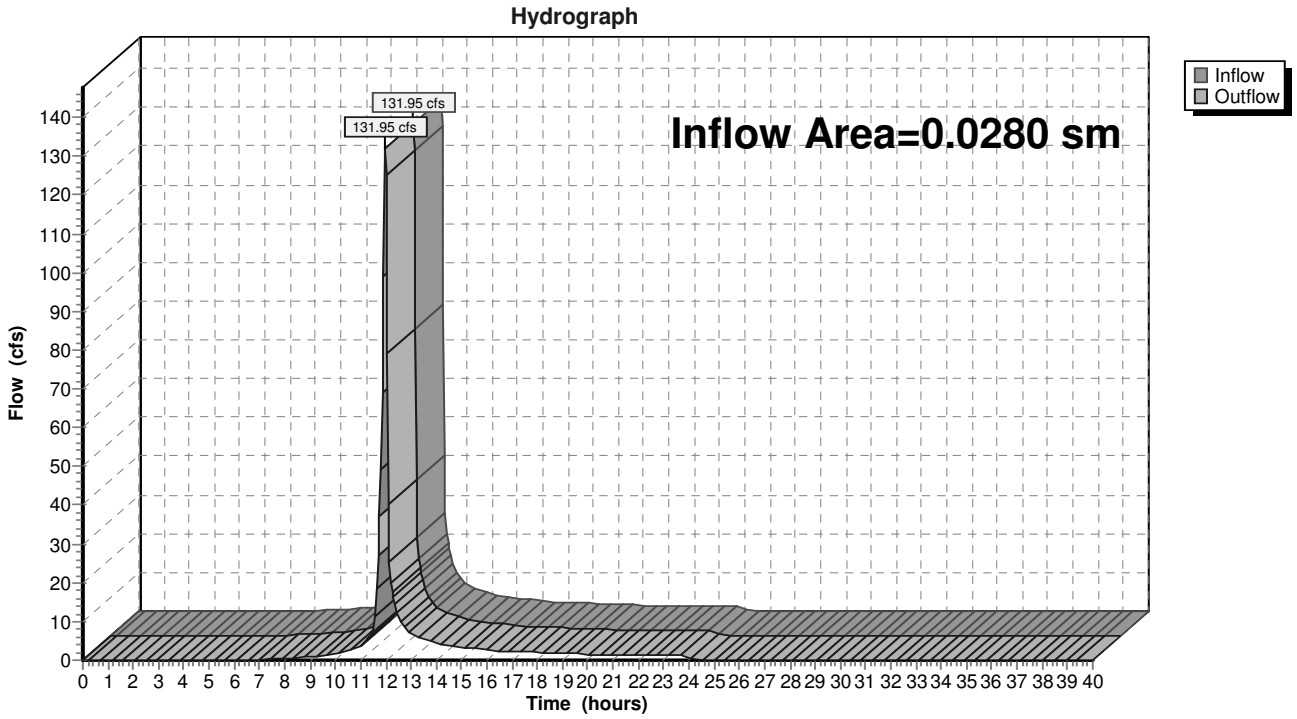


Summary for Reach ER 5: East 5

Inflow Area = 0.0280 sm, Inflow Depth = 4.38" for 50-year event
Inflow = 131.95 cfs @ 11.97 hrs, Volume= 6.523 af
Outflow = 131.95 cfs @ 11.97 hrs, Volume= 6.523 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Reach ER 5: East 5

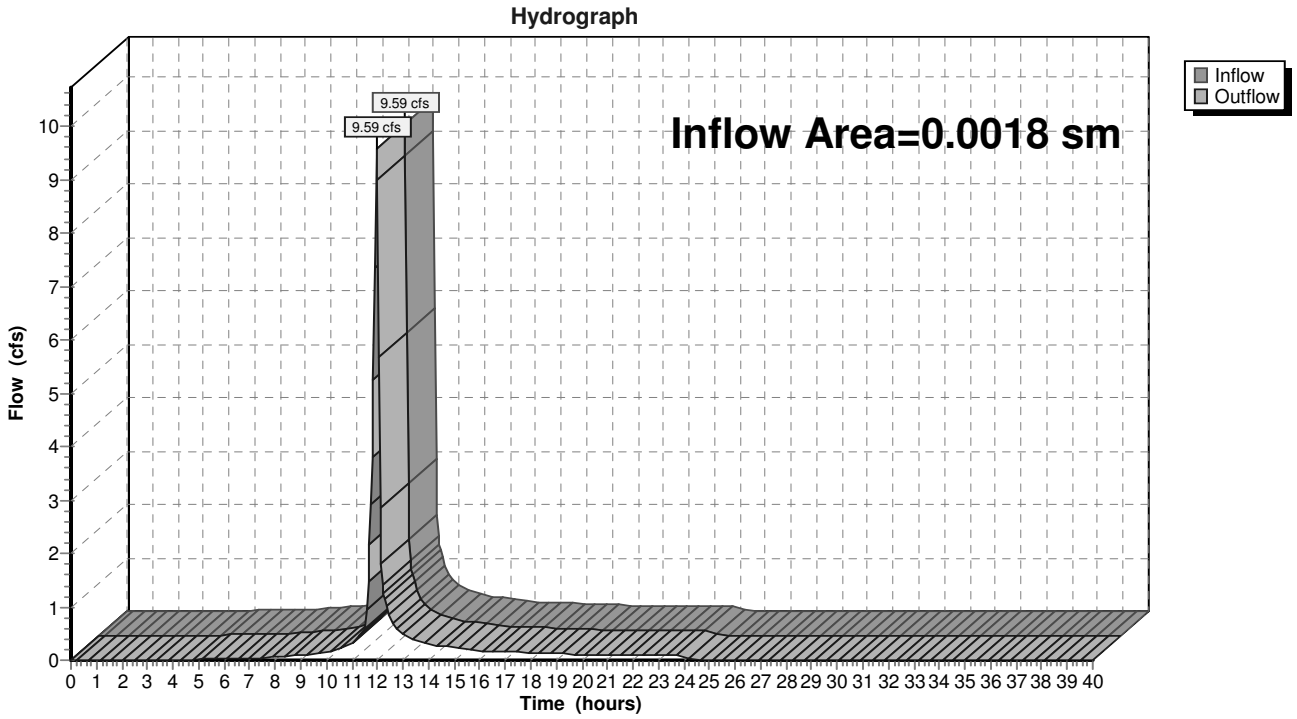


Summary for Reach WR 1: West 1

Inflow Area = 0.0018 sm, Inflow Depth = 4.96" for 50-year event
Inflow = 9.59 cfs @ 11.97 hrs, Volume= 0.488 af
Outflow = 9.59 cfs @ 11.97 hrs, Volume= 0.488 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Reach WR 1: West 1

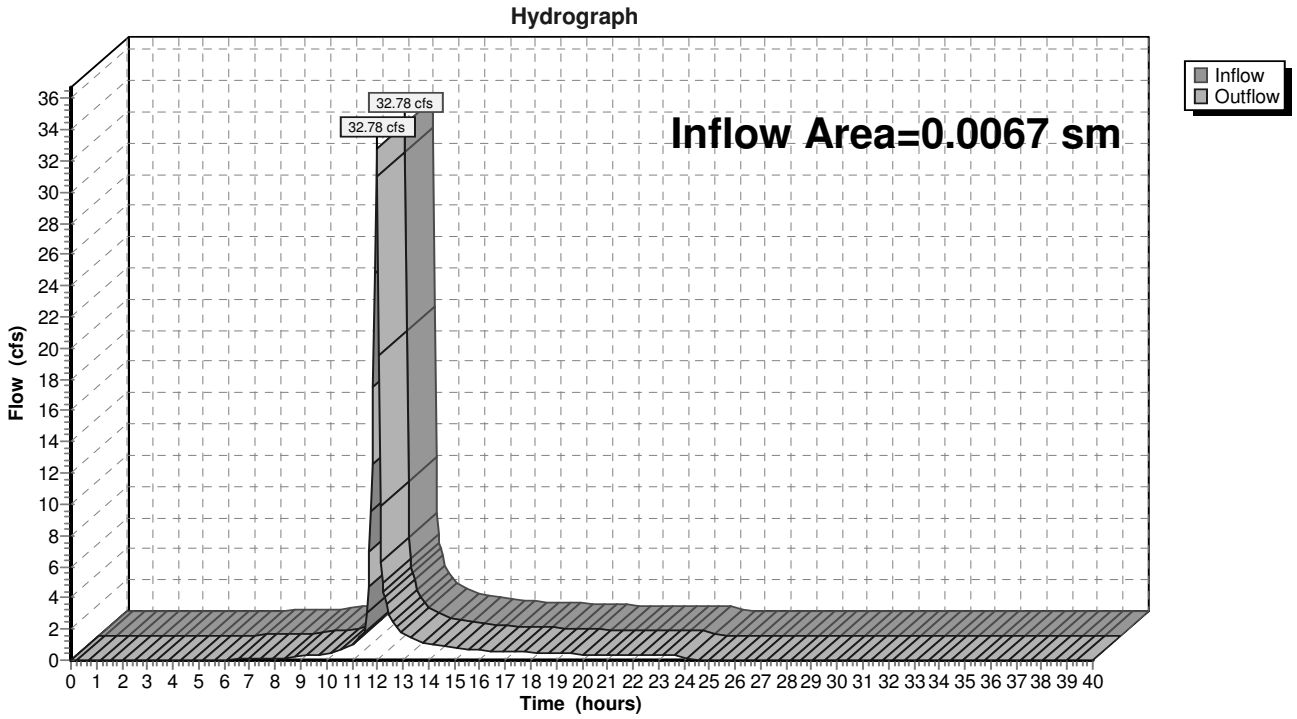


Summary for Reach WR 2: West 2

Inflow Area = 0.0067 sm, Inflow Depth = 4.58" for 50-year event
Inflow = 32.78 cfs @ 11.97 hrs, Volume= 1.638 af
Outflow = 32.78 cfs @ 11.97 hrs, Volume= 1.638 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Reach WR 2: West 2

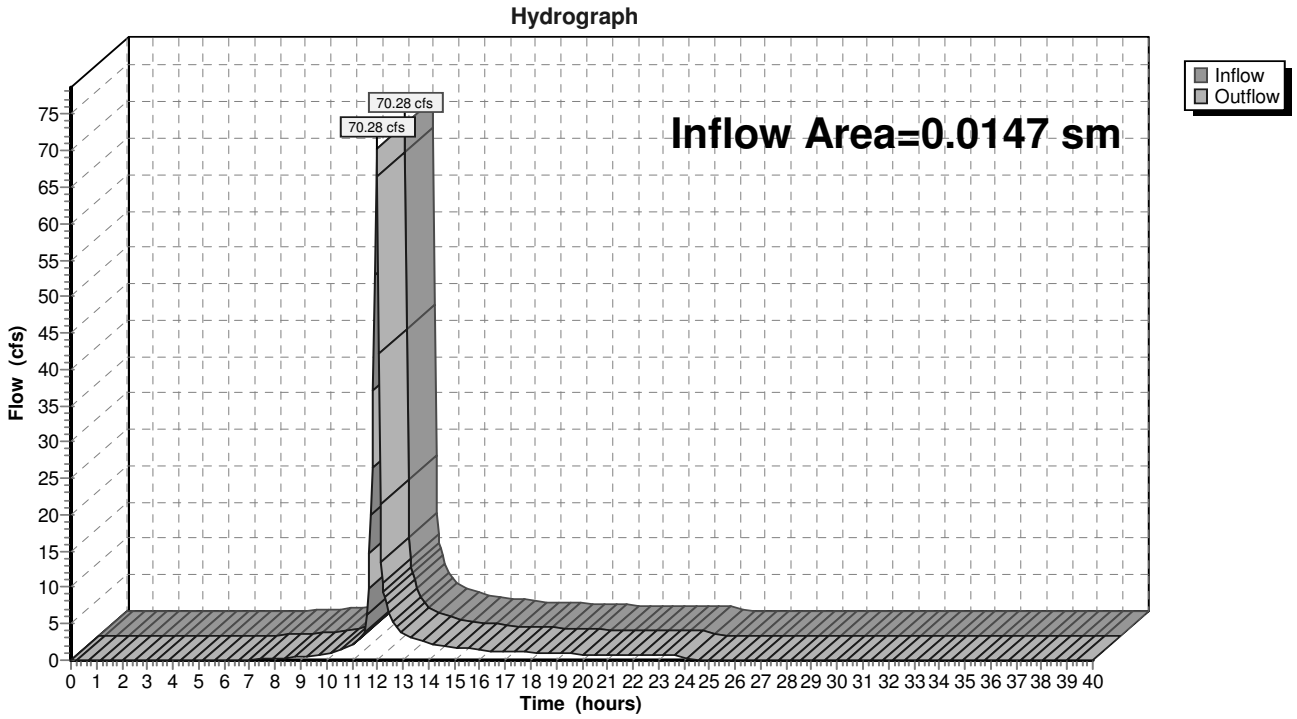


Summary for Reach WR 3: West 3

Inflow Area = 0.0147 sm, Inflow Depth = 4.47" for 50-year event
Inflow = 70.28 cfs @ 11.97 hrs, Volume= 3.492 af
Outflow = 70.28 cfs @ 11.97 hrs, Volume= 3.492 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Reach WR 3: West 3



Summary for Pond Outlet Culvert: Outlet Culvert

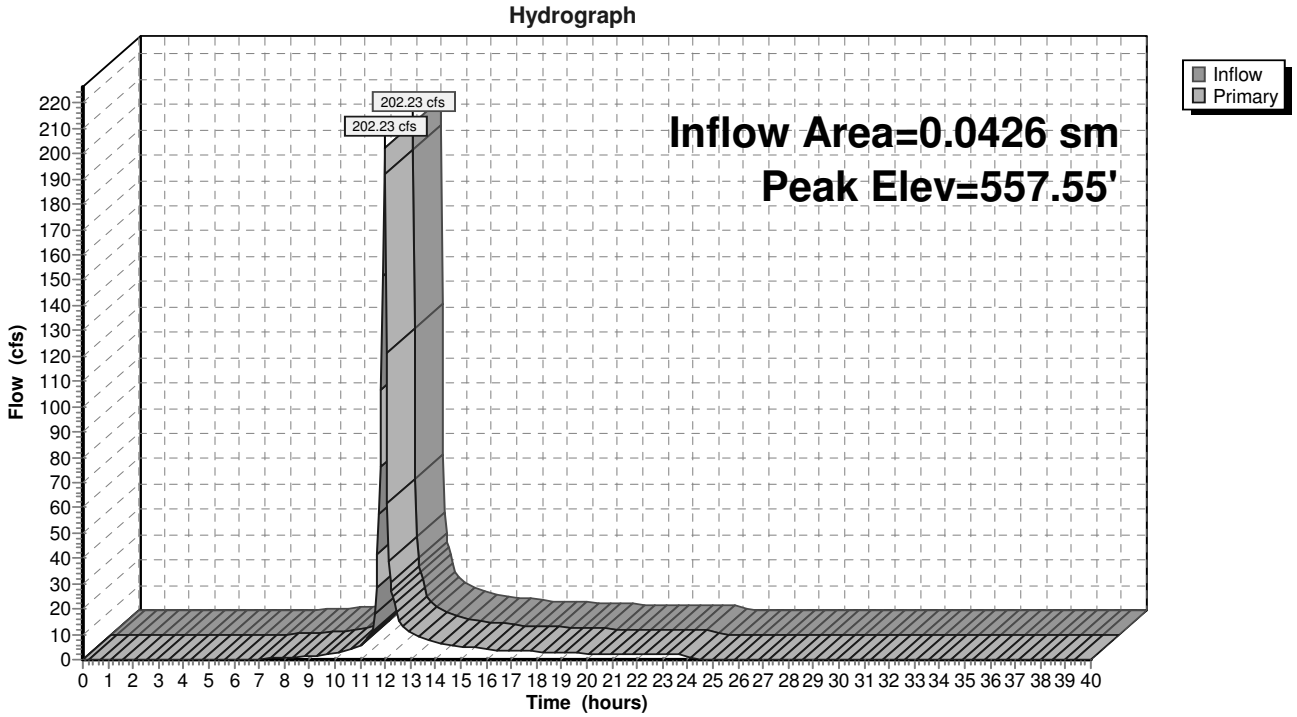
Inflow Area = 0.0426 sm, Inflow Depth = 4.41" for 50-year event
Inflow = 202.23 cfs @ 11.97 hrs, Volume= 10.014 af
Outflow = 202.23 cfs @ 11.97 hrs, Volume= 10.014 af, Atten= 0%, Lag= 0.0 min
Primary = 202.23 cfs @ 11.97 hrs, Volume= 10.014 af

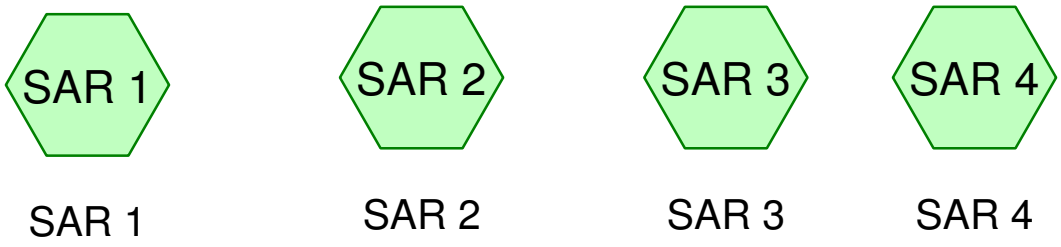
Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Peak Elev= 557.55' @ 11.97 hrs
Flood Elev= 558.00'

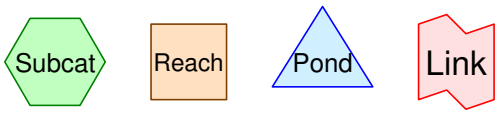
Device	Routing	Invert	Outlet Devices
#1	Primary	545.00'	**36.0" Round Culvert X 2.00** L= 145.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 545.00' / 536.00' S= 0.0621 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf
#2	Device 1	554.00'	**3.2" x 10.0" Horiz. Orifice/Grate X 5.00 columns** X 20 rows C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=196.00 cfs @ 11.97 hrs HW=557.36' (Free Discharge)
└─**1=Culvert** (Passes 196.00 cfs of 224.27 cfs potential flow)
└─**2=Orifice/Grate** (Orifice Controls 196.00 cfs @ 8.82 fps)

Pond Outlet Culvert: Outlet Culvert







Routing Diagram for HydroCAD_Perm Cond_Perm Chan_SlopeAccessRoad
Prepared by AMEC, Printed 8/16/2015
HydroCAD® 10.00 s/n 08086 © 2013 HydroCAD Software Solutions LLC

Summary for Subcatchment SAR 1: SAR 1

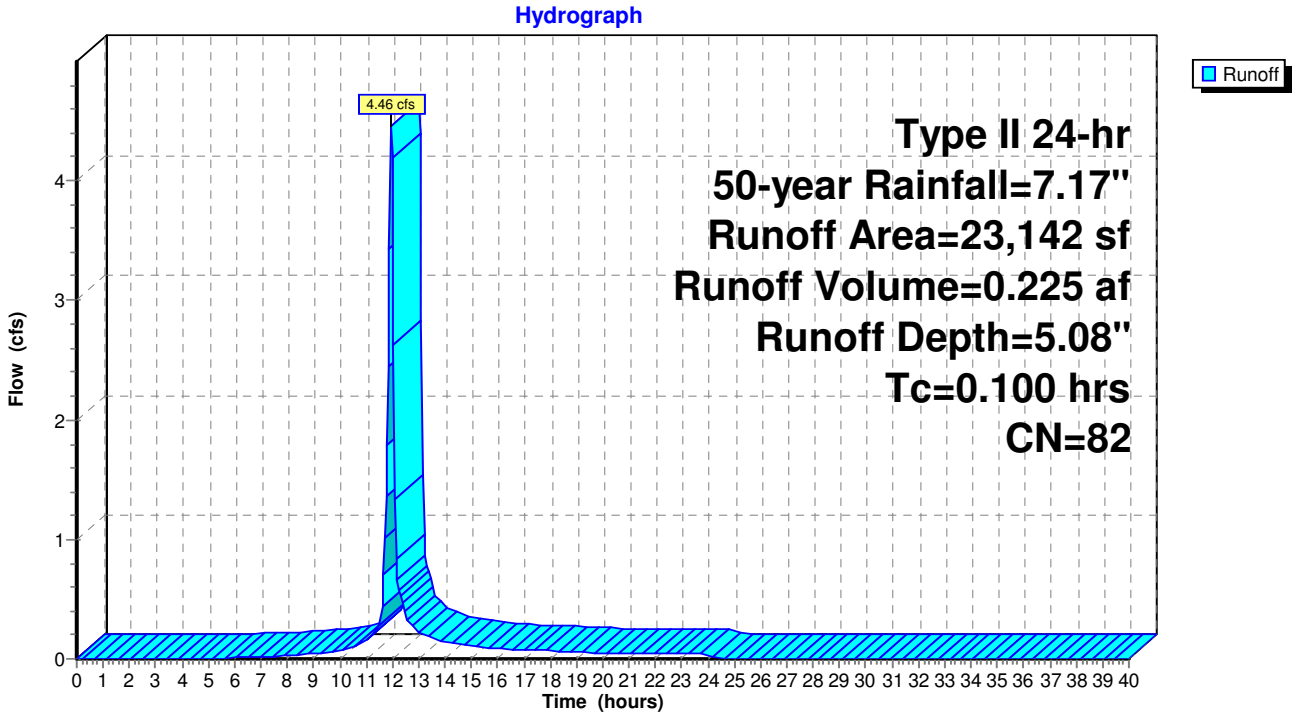
Runoff = 4.46 cfs @ 11.97 hrs, Volume= 0.225 af, Depth= 5.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sf)	CN	Description
11,571	89	Gravel roads, HSG C
11,571	74	>75% Grass cover, Good, HSG C
23,142	82	Weighted Average

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

Subcatchment SAR 1: SAR 1



Summary for Subcatchment SAR 2: SAR 2

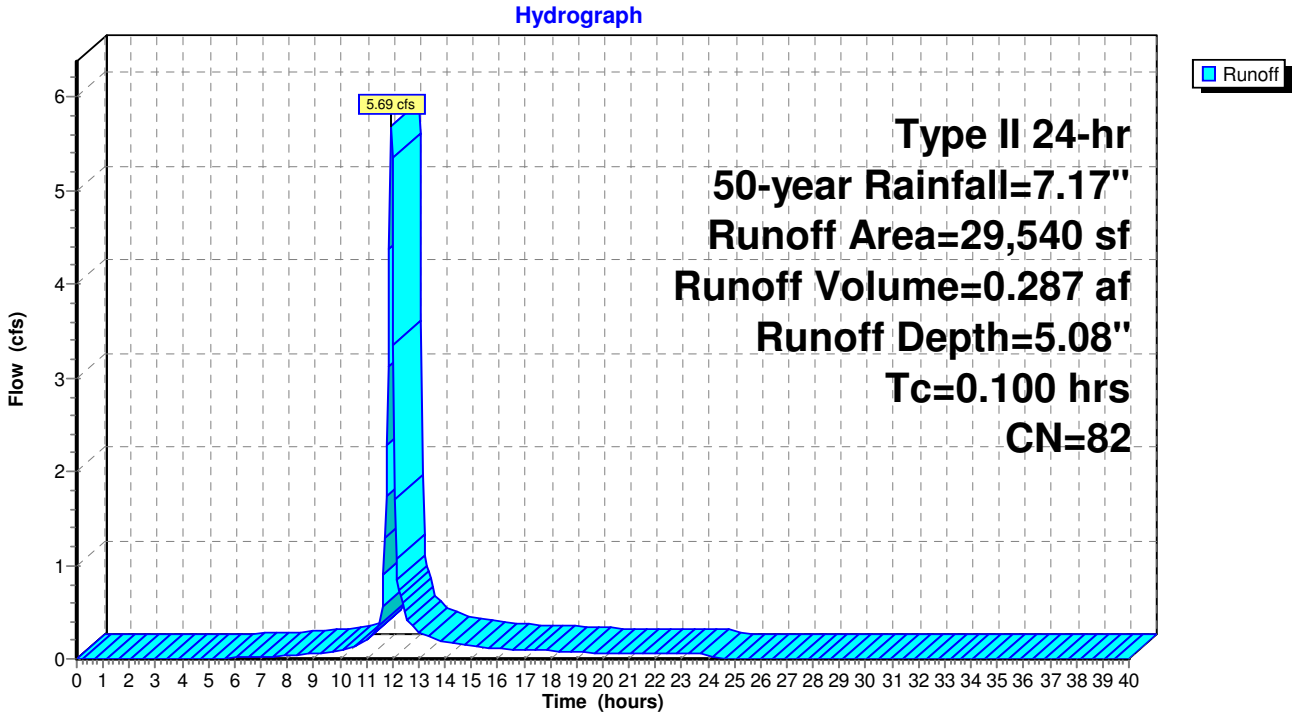
Runoff = 5.69 cfs @ 11.97 hrs, Volume= 0.287 af, Depth= 5.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sf)	CN	Description
14,770	89	Gravel roads, HSG C
14,770	74	>75% Grass cover, Good, HSG C
29,540	82	Weighted Average

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

Subcatchment SAR 2: SAR 2



Summary for Subcatchment SAR 3: SAR 3

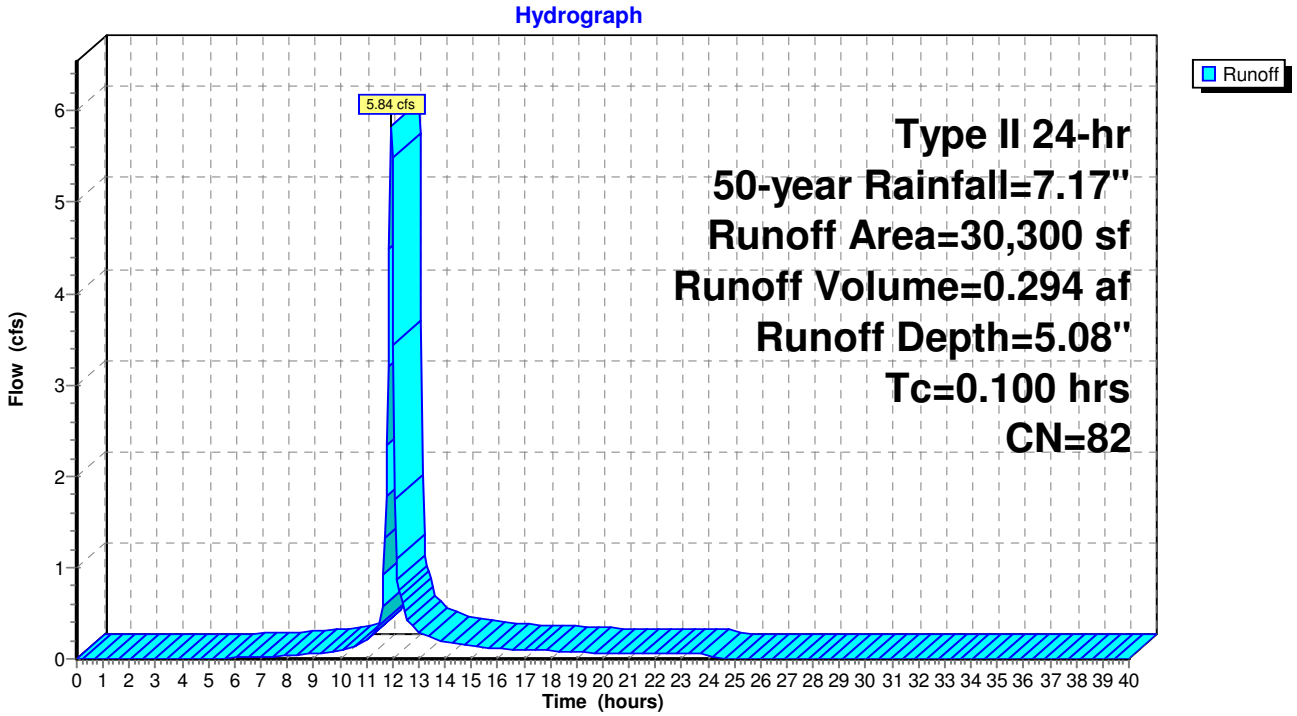
Runoff = 5.84 cfs @ 11.97 hrs, Volume= 0.294 af, Depth= 5.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sf)	CN	Description
15,150	89	Gravel roads, HSG C
15,150	74	>75% Grass cover, Good, HSG C
30,300	82	Weighted Average

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

Subcatchment SAR 3: SAR 3



Summary for Subcatchment SAR 4: SAR 4

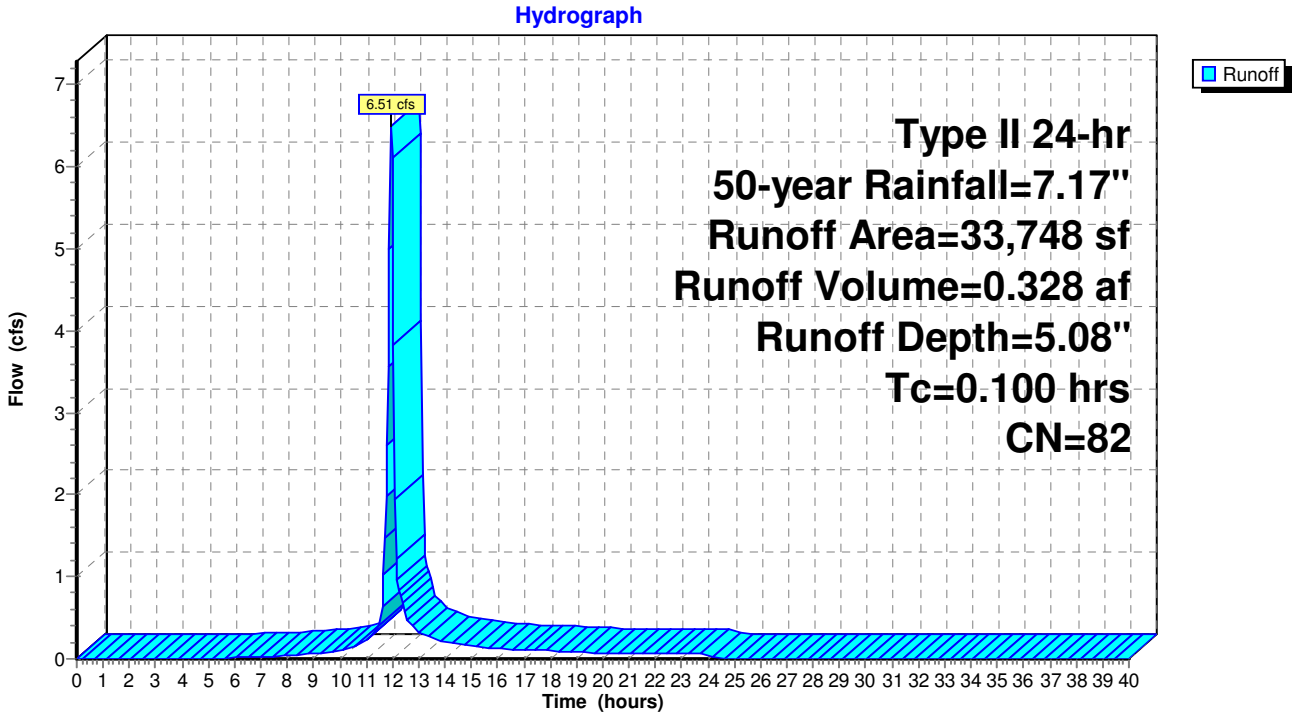
Runoff = 6.51 cfs @ 11.97 hrs, Volume= 0.328 af, Depth= 5.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-year Rainfall=7.17"

Area (sf)	CN	Description
16,874	89	Gravel roads, HSG C
16,874	74	>75% Grass cover, Good, HSG C
33,748	82	Weighted Average

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

Subcatchment SAR 4: SAR 4



REFERENCE 3

North Carolina Department of Environment and Natural Resources, “Erosion and Sediment Control Planning and Design Manual”, Revised May 2013.

Table 8.03e Runoff curve numbers of urban areas[1]

Cover Description: Cover type and hydrologic condition	Average percent impervious area[2]	Curve number for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [4]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1. Average runoff condition, and Ia = 0.2S.
2. The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using Figure 8.03c or 8.03d.
3. CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4. Composite CN's to use for the design of temporary measures during grading and construction should be computed using Figure 8.03c or 8.03d based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

The permissible velocity procedure is recommended for the design of vegetative channels because of common usage and the availability of reliable design tables. The tractive force approach is recommended for design of channels with temporary synthetic liners or riprap liners. The tractive force procedure is described in full in the U.S. Department of Transportation, Federal Highway Administration Bulletin, *Design of Roadside Channels with Flexible Linings*.

Permissible Velocity Procedure

The permissible velocity procedure uses two equations to calculate flow:

Manning's equation,

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

where:

V	=	average velocity in the channel in ft/sec.
n	=	Manning's roughness coefficient, based upon the lining of the channel
R	=	hydraulic radius, wetted cross-sectional area/wetted perimeter in ft
S	=	slope of the channel in ft/ft

and the continuity equation,

$$Q = AV$$

where:

Q	=	flow in the channel in cfs
A	=	cross-sectional area of flow within the channel in ft^2
V	=	average velocity in the channel in ft/sec.

Manning's equation and the continuity equation are used together to determine channel capacity and flow velocity. A nomograph for solving Manning's equation is given in Figure 8.05a.

Selecting Permanent Channel Lining

Channel lining materials include such flexible materials as grass, riprap and gabions, as well as rigid materials such as paving blocks, flag stone, gunite, asphalt, and concrete. The design of concrete and similar rigid linings is generally not restricted by flow velocities. However, flexible channel linings do have maximum permissible flow velocities beyond which they are susceptible to erosion. The designer should select the type of liner that best fits site conditions.

Table 8.05a lists maximum permissible velocities for established grass linings and soil conditions. Before grass is established, permissible velocity is determined by the choice of temporary liner. Permissible velocities for riprap linings are higher than for grass and depend on the stone size selected.

Table 8.05a
Maximum Allowable Design Velocities[1]
for Vegetated Channels

Typical Channel Slope Application	Soil Characteristics[2]	Grass Lining	Permissible Velocity[3] for Established Grass Lining (ft/sec)
0-5%	Easily Erodible Non-plastic (Sands & Silts)	Bermudagrass	5.0
		Tall fescue	4.5
		Bahiagrass	4.5
		Kentucky bluegrass	4.5
		Grass-legume mixture	3.5
	Erosion Resistant Plastic (Clay mixes)	Bermudagrass	6.0
		Tall fescue	5.5
		Bahiagrass	5.5
		Kentucky bluegrass	5.5
		Grass-legume mixture	4.5
5-10%	Easily Erodible Non-plastic (Sands & Silts)	Bermudagrass	4.5
		Tall fescue	4.0
		Bahiagrass	4.0
		Kentucky bluegrass	4.0
		Grass-legume mixture	3.0
	Erosion Resistant Plastic (Clay mixes)	Bermudagrass	5.5
		Tall fescue	5.0
		Bahiagrass	5.0
		Kentucky bluegrass	5.0
		Grass-legume mixture	3.5
>10%	Easily Erodible Non-plastic (Sands & Silts)	Bermudagrass	3.5
		Tall fescue	2.5
		Bahiagrass	2.5
		Kentucky bluegrass	2.5
	Erosion Resistant Plastic (Clay mixes)	Bermudagrass	4.5
		Tall fescue	3.5
		Bahiagrass	3.5
		Kentucky bluegrass	3.5

Source: USDA-SCS Modified

NOTE: [1]Permissible Velocity based on 10-year storm peak runoff
[2]Soil erodibility based on resistance to soil movement from concentrated flowing water.
[3]Before grass is established, permissible velocity is determined by the type of temporary liner used.

Selecting Channel Cross-Section Geometry

To calculate the required size of an open channel, assume the design flow is uniform and does not vary with time. Since actual flow conditions change throughout the length of a channel, subdivide the channel into design reaches, and design each reach to carry the appropriate capacity.

The three most commonly used channel cross-sections are “V”-shaped, parabolic, and trapezoidal. Figure 8.05b gives mathematical formulas for the area, hydraulic radius and top width of each of these shapes.

Design Procedure-Permissible Velocity

The following is a step-by-step procedure for designing a runoff conveyance channel using Manning's equation and the continuity equation:

Step 1. Determine the required flow capacity, Q, by estimating peak runoff rate for the design storm (*Appendix 8.03*).

Step 2. Determine the slope and select channel geometry and lining.

Step 3. Determine the permissible velocity for the lining selected, or the desired velocity, if paved. (see Table 8.05a, page 8.05.4)

Step 4. Make an initial estimate of channel size—divide the required Q by the permissible velocity to reach a "first try" estimate of channel flow area. Then select a geometry, depth, and top width to fit site conditions.

Step 5. Calculate the hydraulic radius, R, from channel geometry (Figure 8.05b, page 8.05.5).

Step 6. Determine roughness coefficient *n*.

Structural Linings—see Table 8.05b, page 8.05.6.

Grass Lining:

a. Determine retardance class for vegetation from Table 8.05c, page 8.05.8. To meet stability requirement, use retardance for newly mowed condition (generally C or D). To determine channel capacity, use at least one retardance class higher.

b. Determine *n* from Figure 8.05c, page 8.05.7.

Step 7. Calculate the actual channel velocity, V, using Manning's equation (Figure 8.05a, pg. 8.05.3), and calculate channel capacity, Q, using the continuity equation.

Step 8. Check results against permissible velocity and required design capacity to determine if design is acceptable.

Step 9. If design is not acceptable, alter channel dimensions as appropriate. For trapezoidal channels, this adjustment is usually made by changing the bottom width.

Table 8.05b
Manning's *n* for Structural Channel Linings

Channel Lining	Recommended *n* values
Asphaltic concrete, machine placed	0.014
Asphalt, exposed prefabricated	0.015
Concrete	0.015
Metal, corrugated	0.024
Plastic	0.013
Shotcrete	0.017
Gabion	0.030
Earth	0.020

Source: American Society of Civil Engineers (modified)

Step 10. For grass-lined channels once the appropriate channel dimensions have been selected for low retardance conditions, repeat steps 6 through 8 using a higher retardance class, corresponding to tall grass. Adjust capacity of the channel by varying depth where site conditions permit.

NOTE 1: If design velocity is greater than 2.0 ft/sec., a temporary lining may be required to stabilize the channel until vegetation is established. The temporary liner may be designed for peak flow from the 2-year storm. If a channel requires a temporary lining, the designer should analyze shear stresses in the channel to select the liner that provides protection and promotes establishment of vegetation. For the design of temporary liners, use tractive force procedure.

NOTE 2: Design Tables—Vegetated Channels and Diversions at the end of this section may be used to design grass-lined channels with parabolic cross-sections.

Step 11. Check outlet for carrying capacity and stability. If discharge velocities exceed allowable velocities for the receiving stream, an outlet protection structure will be required (Table 8.05d, page 8.05.9).

Sample Problem 8.05a illustrates the design of a grass-lined channel.

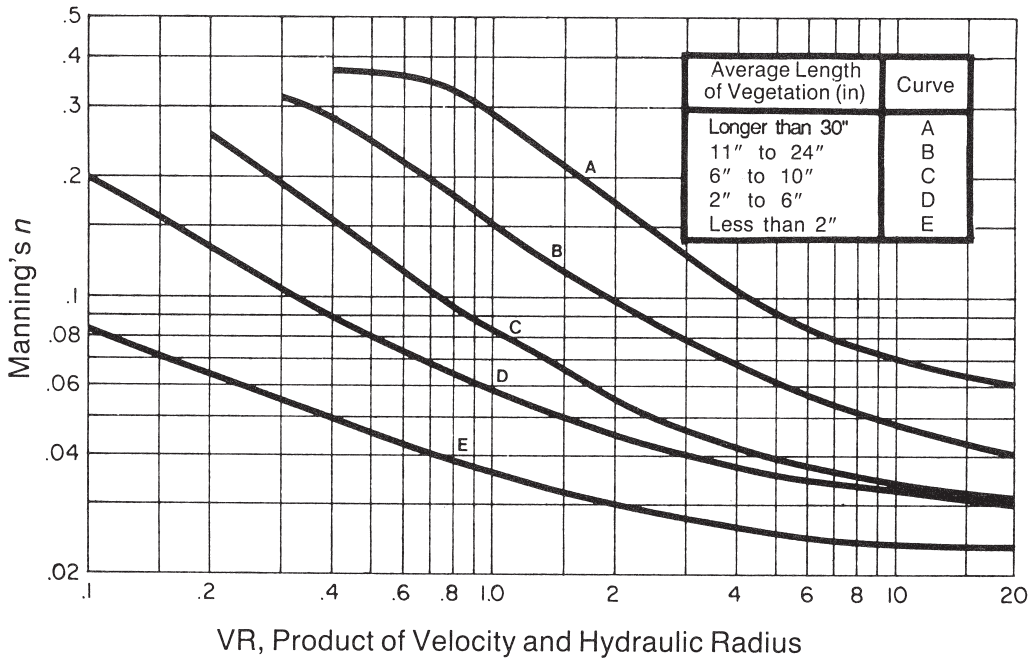


Figure 8.05c Manning's *n* related to velocity, hydraulic radius, and vegetal retardance.
Note: From Sample Problem 8.05a multiply Vp x Hydralulic Radius (4.5x0.54=2.43), then enter the product of VR and extend a straight line up to Retardance class "D", next project a straight line to the left to determine a trial manning's *n*.

Table 8.05d Maximum Permissible Velocities for Unprotected Soils in Existing Channels.

Materials	Maximum Permissible Velocities (fps)
Fine Sand (noncolloidal)	2.5
Sand Loam (noncolloidal)	2.5
Silt Loam (noncolloidal)	3.0
Ordinary Firm Loam	3.5
Fine Gravel	5.0
Stiff Clay (very colloidal)	5.0
Graded, Loam to Cobbles (noncolloidal)	5.0
Graded, Silt to Cobbles (colloidal)	5.5
Alluvial Silts (noncolloidal)	3.5
Alluvial Silts (colloidal)	5.0
Coarse Gravel (noncolloidal)	6.0
Cobbles and Shingles	5.5

Sample Problem 8.05a Design of a Grass-lined Channel.

Given:

Design Q_{10} = 16.6 cfs

Proposed channel grade = 2%
Proposed vegetation: Tall fescue
Soil: Creedmoor (easily erodible)
Permissible velocity, V_p = 4.5 ft/s (Table 8.05a)
Retardance class: "B" uncut, "D" cut (Table 8.05c).
Trapezoidal channel dimensions:
designing for low retardance condition (retardance class D)
design to meet V_p.

Find:

Channel dimensions

Solution:

Make an initial estimate of channel size

A = Q/V, 16.6 cfs/4.5 ft/sec = 3.69 ft^2
Try bottom width = 3.0 ft w/side slopes of 3:1

Z = 3
$A = bd + Zd^2$
$P = b + 2d\sqrt{Z^2 + 1}$
R = AP

An iterative solution using Figure 8.05a to relate flow depth to Manning's *n* proceeds as follows: Manning's equation is used to check velocities.
*From Fig. 8.05c, pg. 8.05.7, Retardance Class d (VR=4.5x0.54=2.43)

d (ft)	A (ft^2)	R (ft)	*n	Vt (fps)	Q (cfs)	Comments
0.8	4.32	0.54	0.043	3.25	14.0	$V<V_p$ OK, $Q<Q_{10}$
						(too small, try deeper channel)
0.9	5.13	0.59	0.042	3.53	18.10	$V<V_p$, OK, $Q>Q_{10}$, OK

Now design for high retardance (class B):

For the ease of construction and maintenance assume and try d = 1.5 ft and trial velocity V_t = 3.0 ft/sec

d (ft)	A (ft^2)	R (ft)	V_t (fps)	n	V (fps)	Q (cfs)	Comments
1.5	11.25	0.90	3.0	0.08	2.5	28	reduce V_t
			2.0	0.11	1.8	20	reduce V_t
			1.6	0.12	1.6	18	
			**1.5	0.13	1.5	17	$Q>Q_{10}$ OK

** These assumptions = actual V (fps.) (chart continued on next page)

(continued) Sample Problem 8.05a Design of a Grass-lined Channel.

Channel summary:
Trapezoidal shape, Z = 3, b = 3 ft, d = 1.5 ft, grade = 2%

Note: In Sample Problem 8.05a the "n-value" is first chosen based on a permissible velocity and not a design velocity criteria. Therefore, the use of Table 8.05c may not be as accurate as individual retardance class charts when a design velocity is the determining factor.

Tractive Force Procedure

The design of riprap-lined channels and temporary channel linings is based on analysis of tractive force.

NOTE: This procedure is for uniform flow in channels and is *not* to be used for design of deenergizing devices and may not be valid for larger channels.

To calculate the required size of an open channel, assume the design flow is uniform and does not vary with time. Since actual flow conditions change through the length of a channel, subdivide the channel into design reaches as appropriate.

PERMISSIBLE SHEAR STRESS
The permissible shear stress, T_d, is the force required to initiate movement of the lining material. Permissible shear stress for the liner is not related to the erodibility of the underlying soil. However, if the lining is eroded or broken, the bed material will be exposed to the erosive force of the flow.

COMPUTING NORMAL DEPTH
The first step in selecting an appropriate lining is to compute the design flow depth (the normal depth) and determine the shear stress.

Normal depths can be calculated by Manning's equation as shown for trapezoidal channels in Figure 8.05d. Values of the Manning's roughness coefficient for different ranges of depth are provided in Table 8.05e for temporary linings and Table 8.05f for riprap. The coefficient of roughness generally decreases with increasing flow depth.

Table 8.05e Manning's Roughness Coefficients for Temporary Lining Materials

	n* value for Depth Ranges		
Lining Type	**0-0.5 ft**	**0.5-2.0 ft**	**>2.0 ft**
Woven Paper Net	0.016	0.015	0.015
Jute Net	0.028	0.022	0.019
Fiberglass Roving	0.028	0.021	0.019
Straw with Net	0.065	0.033	0.025
Curled Wood Mat	0.066	0.035	0.028
Synthetic Mat	0.036	0.025	0.021

* Adapted from: FHWA-HEC 15, Pg. 37 - April 1988

Table 8.05f Manning's Roughness Coefficient

Lining Category	Lining Type	*n* - value: *n* value for Depth Ranges 0-0.5 ft (0-15 cm)	0.5-2.0 ft (15-60 cm)	2.0 ft (>60 cm)
Rigid	Concrete	0.015	0.013	0.013
	Grouted Riprap	0.040	0.030	0.028
	Stone Masonry	0.042	0.032	0.030
	Soil Cement	0.025	0.022	0.020
	Asphalt	0.018	0.016	0.016
Unlined	Bare Soil	0.023	0.020	0.020
	Rock Cut	0.045	0.035	0.025
Gravel Riprap	1-inch (2.5-cm) D_{50}	0.044	0.033	0.030
	2-inch (5-cm) D_{50}	0.066	0.041	0.034
Rock Riprap	6-inch (15-cm) D_{50}	0.104	0.069	0.035
	12-inch (30-cm) D_{50}	--	0.078	0.040

Note: Values listed are representative values for the respective depth ranges. Manning's roughness coefficients, *n*, vary with the flow depth.

DETERMINING SHEAR STRESS

Shear stress, T, at normal depth is computed for the lining by the following equation:

$$T = yds$$

$$T_d = \text{Permissible shear stress}$$

where:

T = shear stress in lb/ft^2
y = unit weight of water, 62.4 lb/ft^3
d = flow depth in ft
s = channel gradient in ft/ft

If the permissible shear stress, T_d, given in Table 8.05g is greater than the computed shear stress, the riprap or temporary lining is considered acceptable. If a lining is unacceptable, select a lining with a higher permissible shear stress and repeat the calculations for normal depth and shear stress. In some cases it may be necessary to alter channel dimensions to reduce the shear stress.

Computing tractive force around a channel bend requires special considerations because the change in flow direction imposes higher shear stress on the channel bottom and banks. The maximum shear stress in a bend, T_b, is given by the following equation:

$$T_b = K_b T$$

where:

T_b = bend shear stress in lb/ft^2
k_b = bend factor
T = computed stress for straight channel in lb/ft^2

The value of k_b is related to the radius of curvature of the channel at its center line, R_c, and the bottom width of the channel, B, Figure 8.05e. The length of channel requiring protection downstream from a bend, L_p, is a function of the roughness of the lining material and the hydraulic radius as shown in Figure 8.05f.

REFERENCE 4

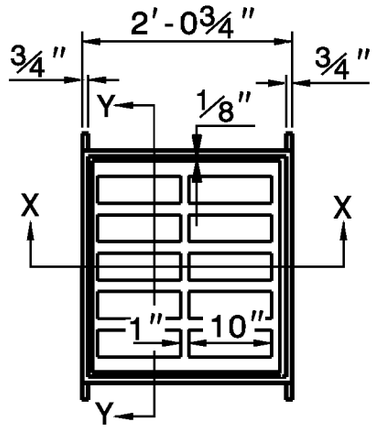
“Standard Specifications for Roads and Structures”, North Carolina Department of Transportation, Raleigh, January 2012.

STATE OF
NORTH CAROLINA
DEPT. OF TRANSPORTATION
DIVISION OF HIGHWAYS
RALEIGH, N.C.

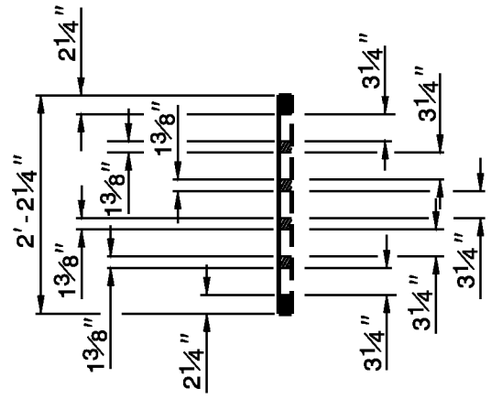
1-12

ENGLISH STANDARD DRAWING FOR

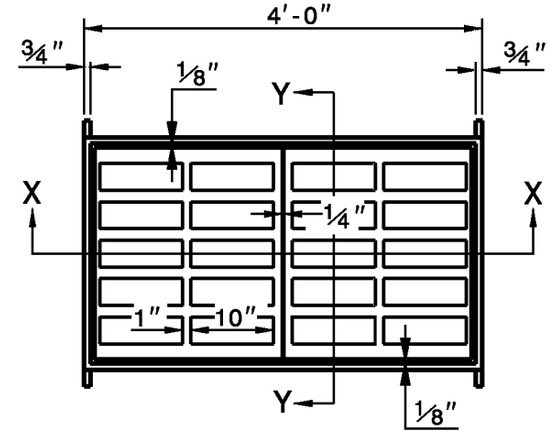
FRAMES AND WIDE SLOT FLAT GRATES



PLAN



GRATE SECTION Y-Y



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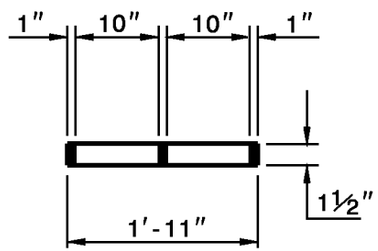
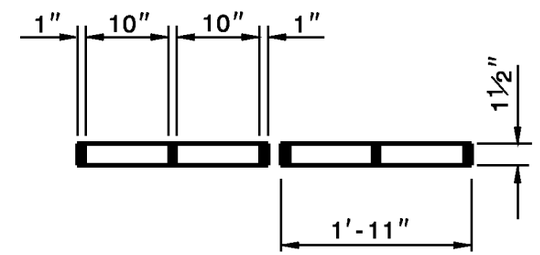


GRATE SECTION X-X

NOTE:
SEE STD. DWG. 840.25
FOR FRAME ANCHORAGE.



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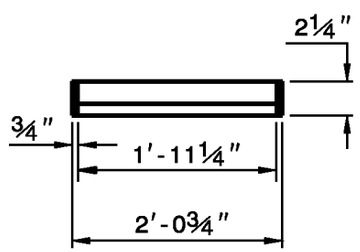

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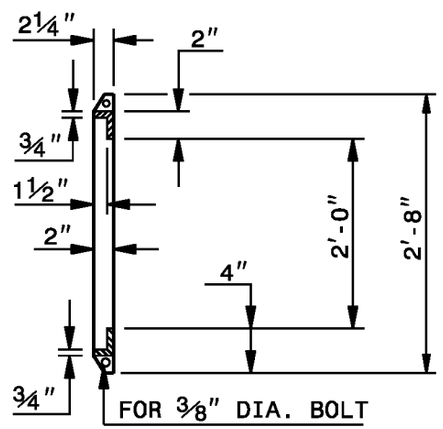
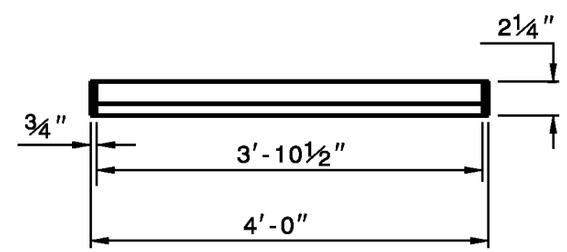


FRAME SECTION Y-Y



FRAME SECTION X-X

SHEET 1 OF 1

840.20

STATE OF
NORTH CAROLINA
DEPT. OF TRANSPORTATION
DIVISION OF HIGHWAYS
RALEIGH, N.C.

1-12

ENGLISH STANDARD DRAWING FOR

FRAMES AND WIDE SLOT FLAT GRATES

SHEET 1 OF 1

840.20

REFERENCE 5

United States Department of Agriculture, “Urban Hydrology for Small Watersheds”, Technical Release 44, June 1986.

Manning's equation is:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad \text{[eq. 3-4]}$$

where:

V = average velocity (ft/s)
r = hydraulic radius (ft) and is equal to a/p_w
a = cross sectional flow area (ft^2)
p_w = wetted perimeter (ft)
s = slope of the hydraulic grade line (channel slope, ft/ft)
n = Manning's roughness coefficient for open channel flow.

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1959) or Linsley et al. (1982). After average velocity is computed using equation 3-4, T_t for the channel segment can be estimated using equation 3-1.

Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

Limitations

- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 3-3 was developed for use with the four standard rainfall intensity-duration relationships.

- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T_c. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.

- The minimum T_c used in TR-55 is 0.1 hour.

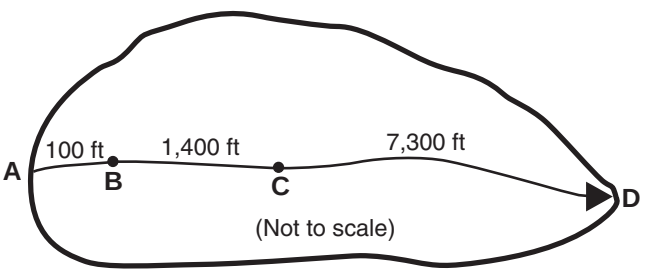
- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

Example 3-1

The sketch below shows a watershed in Dyer County, northwestern Tennessee. The problem is to compute T_c at the outlet of the watershed (point D). The 2-year 24-hour rainfall depth is 3.6 inches. All three types of flow occur from the hydraulically most distant point (A) to the point of interest (D). To compute T_c, first determine T_t for each segment from the following information:

Segment AB: Sheet flow; dense grass; slope (s) = 0.01 ft/ft; and length (L) = 100 ft. Segment BC: Shallow concentrated flow; unpaved; s = 0.01 ft/ft; and L = 1,400 ft. Segment CD: Channel flow; Manning's n = .05; flow area (a) = 27 ft^2; wetted perimeter (p_w) = 28.2 ft; s = 0.005 ft/ft; and L = 7,300 ft.

See figure 3-2 for the computations made on worksheet 3.



APPENDIX VI-3

Corrugated HDPE Pipe Stability Calculation

Calculation Title:
Corrugated HDPE Pipe Stability Calculation

Summary:
The cover height and backfill requirements should be selected based on the pipe size and class of backfill as summarized in the table herein.

Notes:

Revision Log:

No.	Description	Originator	Verifier	Technical Reviewer
00	Initial Submittal	Chris Jordan	Lee Eaves	Cedric H. Ruhl

OBJECTIVE:

The objective of this calculation is to provide design guidelines for soil cover over corrugated HDPE pipe for the proposed Dan River Landfill.

METHOD:

The structural stability of the corrugated HDPE pipe was evaluated in accordance with the methodology described by the Plastic Pipe Institute [Ref. 1].

CALCULATIONS:

1.0 Corrugated HDPE Pipe Cover Requirements

Corrugated HDPE pipe will be utilized in various stormwater applications including underdrains and culverts. The minimum cover is dependent on the pipe diameter, and the backfill envelope should provide a minimum modulus of soil reaction (E') of 1,000 psi [Ref. 1].

The minimum cover depth and degree of compaction is summarized in the following table:

Table 1: Corrugated HDPE Pipe Cover Requirements

Inside Pipe Diameter {ID} (in) [Ref. 1]	Minimum Cover {H} (ft) [Ref. 1]	Minimum Standard Proctor Backfill Requirements to Achieve E' > 1,000 psi			
		Class I Backfill[1] [Ref. 1]	Class II Backfill[2] {GW, GP, SW, SP} [Ref. 1]	Class III Backfill[3] {GM, GC, SM, SC} [Ref. 1]	Class IVA Backfill[4] {ML, CL} [Ref. 1]
3 - 48	1	dumped	85%	90%	95%
54 - 60	1.5				

Notes:
1. Class I backfill consists of clean manufactured aggregates.
2. Class II backfill consists of clean, coarse-grained soils.
3. Class III backfill consists of coarse-grained soils with fines.
4. Class IV backfill consists of inorganic fine-grained soils.

DISCUSSION:

The cover height and backfill requirements should be selected based on the pipe size and class of backfill.

REFERENCES:

1. "Corrugated Polyethylene Pipe Design Manual and Installation Guide", Plastics Pipe Institute.

REFERENCE 1

“Corrugated Polyethylene Pipe Design Manual and Installation Guide”, Plastics Pipe Institute.

Minimum & Maximum Cover Limitations

The design procedure described in the prior section can be time-consuming and may provide an unnecessarily high level of detail for many installations. The information in this section is designed to provide answers to common cover height questions much more quickly. The two typical cover height concerns are minimum cover in trafficked areas and maximum burial depths. Both can be considered “worst case” situations from a load perspective.

Minimum Cover in Trafficked Applications

Pipe in traffic areas (AASHTO loads) should have at least 1 ft. (0.3 m) of cover over the pipe crown for 4" - 48" (0.1 m - 1.2 m) diameter pipe and 1.5 ft. (0.5 m) of cover for 54" and 60" (1.55 m - 1.5 m) diameter pipe. In theory, the pipe can be buried with slightly less cover, but application variables are such that 1 ft. (0.3 m) is the conservative limit. The backfill envelope should provide a minimum E' value of 1,000 psi (6,900 kPa). In Table 5-4, this condition is represented by a Class III material compacted to 90% Standard Proctor Density, although other material can provide similar strength at slightly lower levels of compaction. Structural backfill material should extend 6 in. (0.15 m) over the crown of the pipe; the remaining cover should be appropriate for the installation. If settlement or rutting is a concern, it may be appropriate to extend the structural backfill to grade. Where pavement is involved, subbase material can be used.

The pavement layer can sometimes be included as part of the minimum cover. For flexible pavement, the paving equipment load and the amount of the cover over the pipe must be considered to determine if the resultant load can be supported by the pipe/backfill system.

Minimum cover calculated for flexible pavement is measured from the top of the pipe to the bottom of the pavement section.

Minimum cover calculated for rigid pavement is measured from the top of the pipe to the top of the pavement section.

Table 5-4

Note: Minimum covers presented here were calculated based on a minimum of 6 in. (0.15 m) of structural backfill material over the pipe crown with an additional layer of compacted native soil for a total cover as shown. In shallow trafficked installations, especially where pavement is involved, it may be best to use a good quality compacted material to grade, to prevent surface settlement and rutting.

Inside Diameter, ID in (mm)	Minimum Cover, H ft (m)
3 (75)	1 (0.3)
4 (100)	1 (0.3)
6 (150)	1 (0.3)
8 (200)	1 (0.3)
10 (250)	1 (0.3)
12 (300)	1 (0.3)
15 (375)	1 (0.3)

Inside Diameter, ID in (mm)	Minimum Cover, H ft (m)
18 (450)	1 (0.3)
21 (525)	1 (0.3)
24 (600)	1 (0.3)
30 (750)	1 (0.3)
36 (900)	1 (0.3)
42 (1050)	1 (0.3)
48 (1200)	1 (0.3)
54 (1350)	1.5 (0.5)
60 (1500)	1.5 (0.5)

Table 5-4: Minimum Cover Requirements for Corrugated Polyethylene Pipe

Based on Class III Backfill Compacted to 90% Standard Proctor Density and AASHTO HS-25 Load

Maximum Cover

The prism load was assumed in the design procedure, which results in very conservative maximum cover limits. Highway loads have negligible effect in deep burials, as shown in Table 5-3. Maximum cover limits for corrugated polyethylene pipe are shown in Table 5-5 for a variety of backfill conditions. This table was developed based on pipe properties from Table 5-1.

Table 5-5

	Class I		Class II				Class III		
Pipe Dia.	uncompacted	compacted	85%	90%	95%	100%	85%	90%	95%
4	17(ft)*	59(ft)	17(ft)	24(ft)	37(ft)	59(ft)	15(ft)	18(ft)	24(ft)
6	16	57	16	24	36	57	15	17	24
8	14	51	14	21	32	51	13	15	22
10	13	50	13	20	31	50	12	14	21
12	13	49	13	20	31	49	12	14	21
15	13	49	13	20	31	49	12	14	21
18	13	49	13	20	31	49	12	14	21
24	13	51	13	21	32	51	12	14	21
30	13	51	13	21	32	51	12	14	21
36	13	50	13	20	31	50	12	14	21
42	11	47	11	19	29	47	10	13	19
48	11	46	11	18	29	46	10	12	19
54	11	44	11	18	28	44	10	12	18
60	11	45	11	18	28	45	10	12	19

Note: Alternate backfill materials and compaction levels not shown in the table may also be acceptable. This is a general guideline based on Table 5-1. Contact the manufacturer for further detail. *All cover heights measured in feet.

Table 5-5: Maximum Cover Heights based on Table 5-1 Section Properties

Table 6-4

Backfill Class and Quality

Pipe Embedment Material						E', psi (kPa) for Degree of Embedment Compaction				
ASTM D 2321*		ASTM D 2487		AASHTO M43 Notation	Min. Std. Proctor Density (%)	Lift Placement Depth	Dumped	Slightly < 85%	Moderate 85% - 95%	High > 95%
Class	Description	Notation	Description							
IA	Open-graded, clean manu-factured aggregates	N/A	Angular crushed stone or rock, crushed gravel, crushed slag; large voids with little or no fines	5 56	Dumped	18" (0.45 m)	1000 (6,900)	3000 (20,700)	3000 (20,700)	3000 (20,700)
IB	Dense-graded, clean manu-factured, processed aggregates	N/A	Angular crushed stone or other Class IA material and stone/sand mixtures; little or no fines							
II	Clean, coarse-grained soils	GW	Well-graded gravel, gravel/sand mixtures; little or no fines	57 6 67	85%	12" (0.30 m)	N/R	1000 (6,900)	2000 (13,800)	3000 (20,700)
		GP	Poorly graded gravel, gravel/sand mixtures; little or no fines							
		SW	Well-graded sands, gravelly sands; little or no fines							
		SP	Poorly graded sands, gravelly sands; little or no fines							
III	Coarse-grained soils with fines	GM	Silty gravels, gravel/sand/silt mixtures	Gravel and sand with <10% fines	90%	9" (0.20 m)	N/R	N/R	1000 (6,900)	2000 (13,800)
		GC	Clayey gravels, gravel/sand/clay mixtures							
		SM	Silty sands, sand/ silt mixtures							
		SC	Clayey sands, sand/clay mixtures							
IVA**	Inorganic fine-grained soils	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity				N/R	N/R	N/R	1000 (6,900)
		CL	Inorganic clays of low to medium plasticity; gravelly, sandy or silty clays; lean clays							
IVB	Inorganic fine-grained soils	MH	Inorganic silts, macaceous or diamaceous fine sandy or silty soils, elastic soils				N/R	N/R	N/R	N/R
		CH	Inorganic clays of high plasticity, fat clays							
V	Organic or highly organic soils	OL	Organic silts and organic silty clays of low plasticity				N/R	N/R	N/R	N/R
		OH	Organic clays of medium to high plasticity, organic silts							
		PT	Peat and other high organic soils							

N/R: Use not recommended by ASTM D 2321 for part of the backfill envelope.
*Refer to ASTM D 2321 for more complete soil descriptions.
**Use under the direction of a soils expert.

CONSTRUCTION PLAN APPLICATION

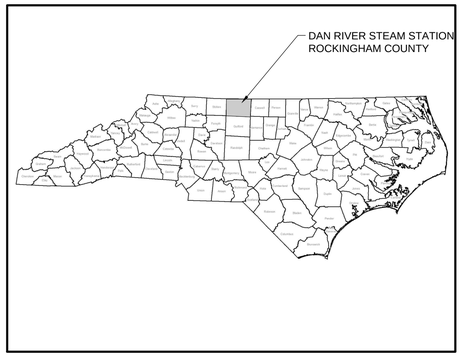
DAN RIVER LANDFILL

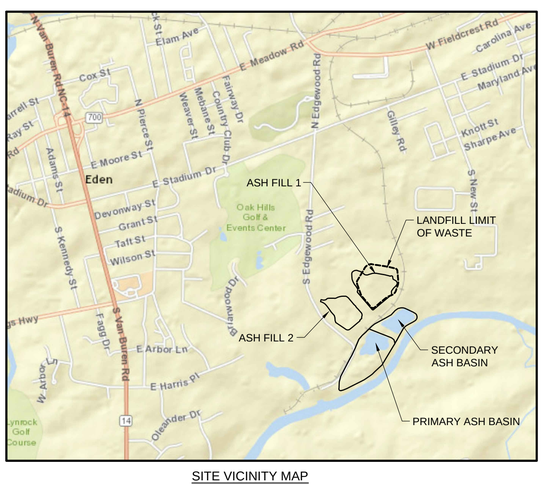
DUKE ENERGY - DAN RIVER STEAM STATION

ROCKINGHAM COUNTY, NORTH CAROLINA

PREPARED FOR:

DUKE ENERGY CAROLINAS, LLC





SITE VICINITY MAP
NOT TO SCALE

SITE AERIAL IMAGE
1"=1000'

SHEET LIST TABLE

SHEET NUMBER	SHEET TITLE
C-0.0	COVER SHEET
C-1.1	SITE AERIAL
C-1.2	SITE EXISTING CONDITIONS
C-2.1	ASH FILL 1 EXISTING CONDITIONS
C-2.2	ASH FILL 1 ESTIMATED POST-EXCAVATION GRADES
C-3.1	LANDFILL CELL 1 COMPACTED SOIL LINER SUBGRADE
C-3.2	LANDFILL CELL 1 GEOSYNTHETIC LINER SUBGRADE
C-3.3	LANDFILL CELL 1 TOP OF PROTECTIVE COVER
C-3.4	LANDFILL CELL 1 LEAK DETECTION SYSTEM
C-3.5	LANDFILL CELL 1 LEACHATE COLLECTION SYSTEM
C-4.1	LANDFILL CELL 2 COMPACTED SOIL LINER SUBGRADE
C-4.2	LANDFILL CELL 2 GEOSYNTHETIC LINER SUBGRADE
C-4.3	LANDFILL CELL 2 TOP OF PROTECTIVE COVER
C-4.4	LANDFILL CELL 2 LEAK DETECTION SYSTEM
C-4.5	LANDFILL CELL 2 LEACHATE COLLECTION SYSTEM
C-5.1	LANDFILL CELL 3 COMPACTED SOIL LINER SUBGRADE
C-5.2	LANDFILL CELL 3 GEOSYNTHETIC LINER SUBGRADE
C-5.3	LANDFILL CELL 3 TOP OF PROTECTIVE COVER
C-5.4	LANDFILL CELL 3 LEAK DETECTION SYSTEM
C-5.5	LANDFILL CELL 3 LEACHATE COLLECTION SYSTEM
C-6.1	LANDFILL CLOSURE GRADES
C-6.2	LANDFILL CLOSURE STORMWATER
C-7.1	POTENTIAL STOCKPILE AREAS
C-8.1	BEDROCK SURFACE MAP
C-8.2	GROUNDWATER SURFACE MAP
C-9.1	CROSS SECTIONS
D-1.1	GENERAL DETAILS 1
D-1.2	GENERAL DETAILS 2
D-2.1	LCRS DETAILS 1
D-2.2	LCRS DETAILS 2
D-2.3	LCRS DETAILS 3
D-2.4	LCRS DETAILS 4
D-3.1	STORMWATER DETAILS 1
D-4.1	OPERATIONS DETAILS 1
D-4.2	OPERATIONS DETAILS 2
D-4.3	OPERATIONS DETAILS 3
D-5.1	CLOSURE DETAILS 1
D-5.2	CLOSURE DETAILS 2
D-5.3	CLOSURE DETAILS 3
D-5.4	CLOSURE DETAILS 4
D-5.5	CLOSURE DETAILS 5

PRELIMINARY
NOT FOR CONSTRUCTION

NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUHL

AMEC LICENSE No. F-1253

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	ENG.	APPR.
0	26	08	2015	SUBMITTED FOR PERMIT REVIEW	CHR	KRD

CLIENT LOGO: DUKE ENERGY.

CLIENT:
DUKE ENERGY CAROLINAS, LLC
EDEN, NORTH CAROLINA

Amec Foster Wheeler Environment & Infrastructure, Inc.
2801 YORKMONT ROAD, SUITE 100
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TEL: (704) 357-8600 FAX: (704) 357-8638
LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL CONSTRUCTION PLAN APPLICATION

TITLE: COVER SHEET

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-0.0

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-0.0 COVER SHEET August 26, 2015 09:43:05am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-0.0 COVER SHEET.dwg

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DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: SITE AERIAL

PROJECT NO.: 7810-14-0065
REVISION NO.: 0
DATE: 8/26/2015
DRAWING NO.: C-1.1

LEGEND

700	EXISTING MAJOR CONTOUR (10') [REF. 1]
	EXISTING MINOR CONTOUR (2') [REF. 1]
	EXISTING PROPERTY BOUNDARY
	EXISTING 100-YEAR FLOODPLAIN
	EXISTING STREAM
	EXISTING WETLAND
FM	EXISTING SANITARY SEWER FORCE MAIN
SS	EXISTING GRAVITY SANITARY SEWER PIPE
S	EXISTING SANITARY SEWER MANHOLE
G	EXISTING NATURAL GAS PIPELINE
G	EXISTING NATURAL GAS PIPELINE (NOT SURVEYED)
OHW	EXISTING OVERHEAD ELECTRIC UTILITY
	EXISTING UTILITY EASEMENT
	EXISTING FENCE
	EXISTING VEGETATION BOUNDARY
	EXISTING PIPES
	EXISTING RIPRAP
	TEST PIT (SEE NOTE 1)
	AMEC FOSTER WHEELER HISTORIC BORING
	AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY LANDFILL BORING
	AMEC FOSTER WHEELER HISTORIC OBSERVATION WELL
	AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY OBSERVATION WELL
	AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY OBSERVATION WELL PAIR
	DUKE ENERGY VOLUNTARY WELL PAIR
	DUKE ENERGY COMPLIANCE WELL
	DUKE ENERGY COMPLIANCE WELL PAIR
	CPT
	HDR, INC. GROUNDWATER ASSESSMENT WELL
	HDR, INC. GROUNDWATER ASSESSMENT WELL CLUSTER
	DPT

NOTES:
1. LINE INDICATES TEST PIT, DOT INDICATES LIMIT OF ASH IF ENCOUNTERED.

200 0 200 400 FT

REFERENCES
1. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON FEBRUARY 7, 2014 BY LDSI, INC.

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NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUHL

AMEC LICENSE No. F-1253

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	ENG.	APPR.
0	26	08	2015	SUBMITTED FOR PERMIT REVIEW	CHR	KRD

CLIENT LOGO: DUKE ENERGY.

CLIENT: DUKE ENERGY CAROLINAS, LLC
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LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

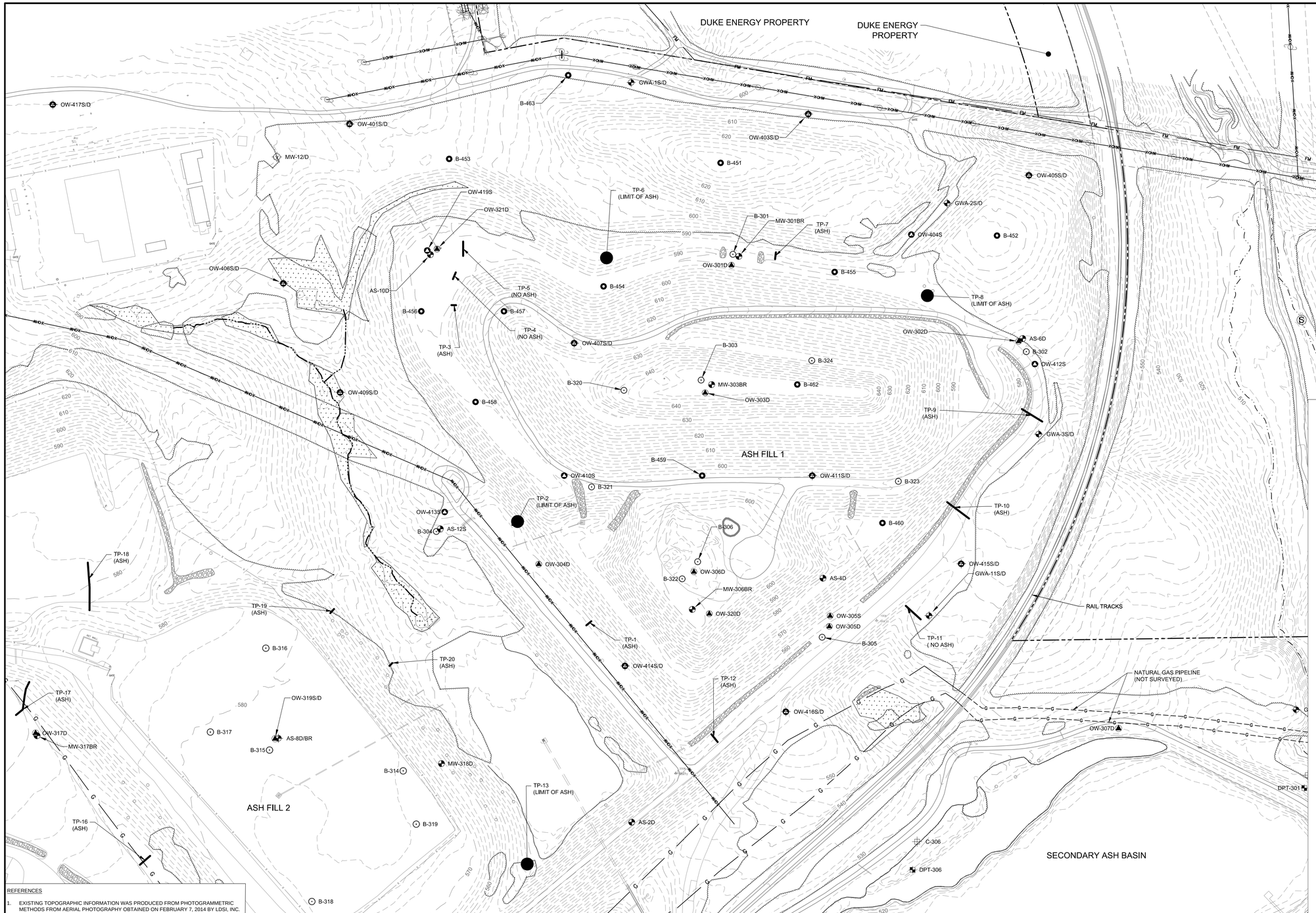
DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: SITE EXISTING CONDITIONS

PROJECT NO.:	7810-14-0065
REVISION NO.	0
DATE:	8/26/2015
DRAWING NO.	C-1.2

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-1.2 SITE EXISTING CONDITIONS August 26, 2015 09:44:25am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-1.2 SITE EXISTING CONDITIONS.dwg



REFERENCES

1. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON FEBRUARY 7, 2014 BY LDSI, INC.

LEGEND

700	EXISTING MAJOR CONTOUR (10') [REF. 1]
	EXISTING MINOR CONTOUR (2') [REF. 1]
	EXISTING PROPERTY BOUNDARY
	EXISTING 100-YEAR FLOODPLAIN
	EXISTING STREAM
	EXISTING WETLAND
FM	EXISTING SANITARY SEWER FORCE MAIN
SS	EXISTING GRAVITY SANITARY SEWER PIPE
S	EXISTING SANITARY SEWER MANHOLE
G	EXISTING NATURAL GAS PIPELINE
G	EXISTING NATURAL GAS PIPELINE (NOT SURVEYED)
XOW	EXISTING OVERHEAD ELECTRIC UTILITY
	EXISTING UTILITY EASEMENT
	EXISTING FENCE
	EXISTING VEGETATION BOUNDARY
	EXISTING PIPES
	EXISTING RIPRAP
	TEST PIT (SEE NOTE 1)
	AMEC FOSTER WHEELER HISTORIC BORING
	AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY LANDFILL BORING
	AMEC FOSTER WHEELER HISTORIC OBSERVATION WELL
	AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY OBSERVATION WELL
	AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY OBSERVATION WELL PAIR
V	DUKE ENERGY VOLUNTARY WELL PAIR
C	DUKE ENERGY COMPLIANCE WELL
C	DUKE ENERGY COMPLIANCE WELL PAIR
	CPT
	HDR, INC. GROUNDWATER ASSESSMENT WELL
	HDR, INC. GROUNDWATER ASSESSMENT WELL CLUSTER
	DPT

NOTES:
1. LINE INDICATES TEST PIT, DOT INDICATES LIMIT OF ASH IF ENCOUNTERED.

100 0 100 200 FT

PRELIMINARY
NOT FOR CONSTRUCTION

NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUHL
AMEC LICENSE No. F-1253

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	ENG.	APPR.
0	26	08	2015	SUBMITTED FOR PERMIT REVIEW	CHR	KRD

CLIENT LOGO: DUKE ENERGY.

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LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

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DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: ASH FILL 1 EXISTING CONDITIONS

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-2.1

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LEGEND

- EXISTING MAJOR CONTOUR (10') [REF. 1]
- EXISTING MINOR CONTOUR (2') [REF. 1]
- PROPOSED MAJOR CONTOUR (10') (SEE NOTE 1)
- PROPOSED MINOR CONTOUR (2') (SEE NOTE 1)
- EXISTING PROPERTY BOUNDARY
- EXISTING 100-YEAR FLOODPLAIN
- EXISTING STREAM
- EXISTING WETLAND
- EXISTING SANITARY SEWER FORCE MAIN
- EXISTING GRAVITY SANITARY SEWER PIPE
- EXISTING SANITARY SEWER MANHOLE
- EXISTING NATURAL GAS PIPELINE
- EXISTING NATURAL GAS PIPELINE (NOT SURVEYED)
- EXISTING OVERHEAD ELECTRIC UTILITY
- EXISTING UTILITY EASEMENT
- EXISTING FENCE
- EXISTING VEGETATION BOUNDARY
- EXISTING PIPES
- EXISTING RIPRAP

NOTES:
1. PROPOSED GRADES SHOW APPROXIMATE GROUND ELEVATION AFTER CCR REMOVAL AND SUBJECT TO CHANGE BASED ON FIELD CONDITIONS.

REFERENCES
1. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON FEBRUARY 7, 2014 BY LDSI, INC.

PRELIMINARY
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NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUHL
AMEC LICENSE No. F-1253

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	ENG.	APPR.
0	26	08	2015	SUBMITTED FOR PERMIT REVIEW	CHR	KRD

CLIENT LOGO: DUKE ENERGY.

CLIENT:
DUKE ENERGY CAROLINAS, LLC
EDEN, NORTH CAROLINA

Amec Foster Wheeler Environment & Infrastructure, Inc.
2801 YORKMONT ROAD, SUITE 100
CHARLOTTE, NC 28208
TEL: (704) 357-8600 FAX: (704) 357-8638
LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

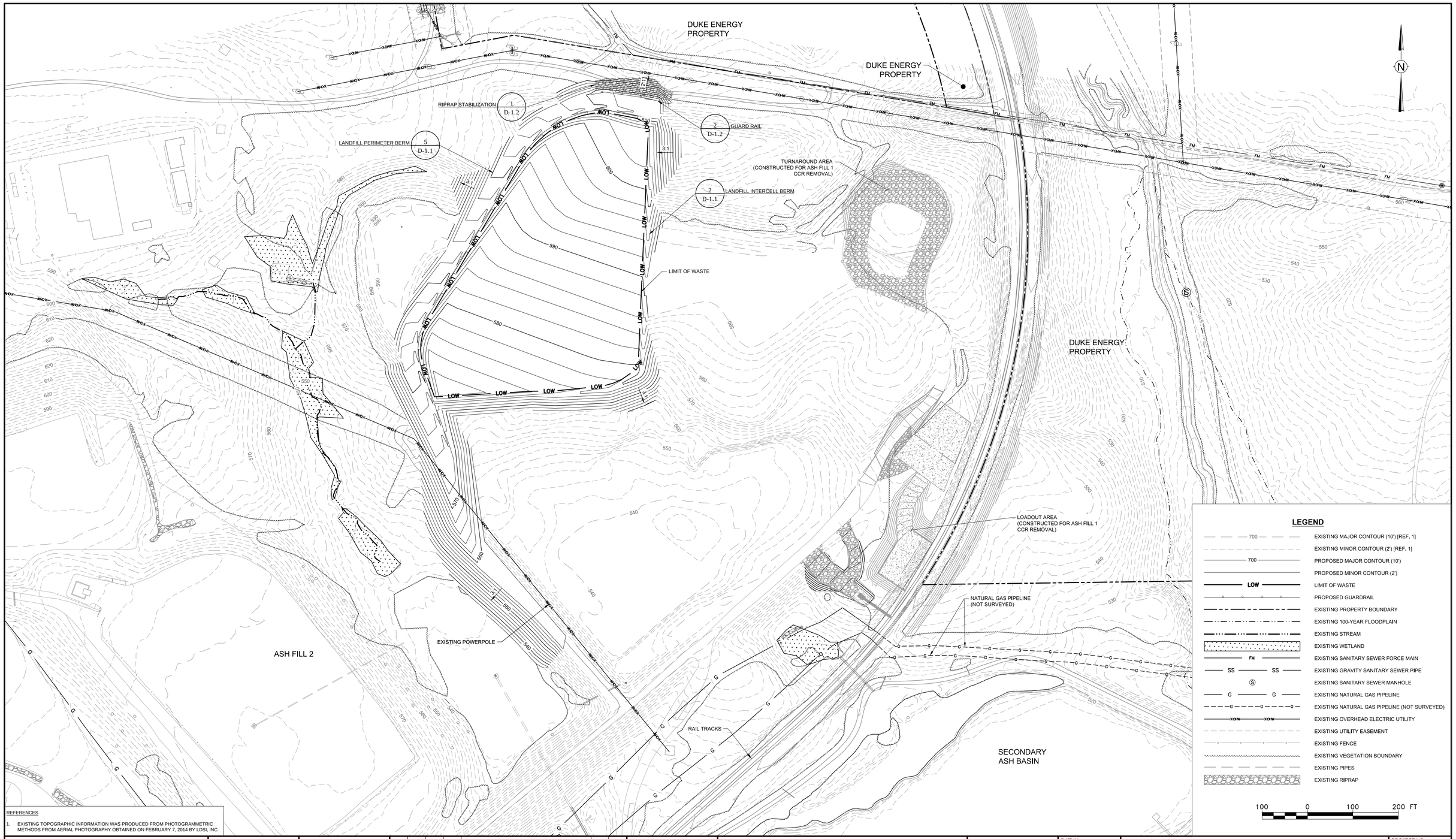
amec foster wheeler

DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL CONSTRUCTION PLAN APPLICATION

TITLE: ASH FILL 1 ESTIMATED POST-EXCAVATION GRADES

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-2.2



REFERENCES

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LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

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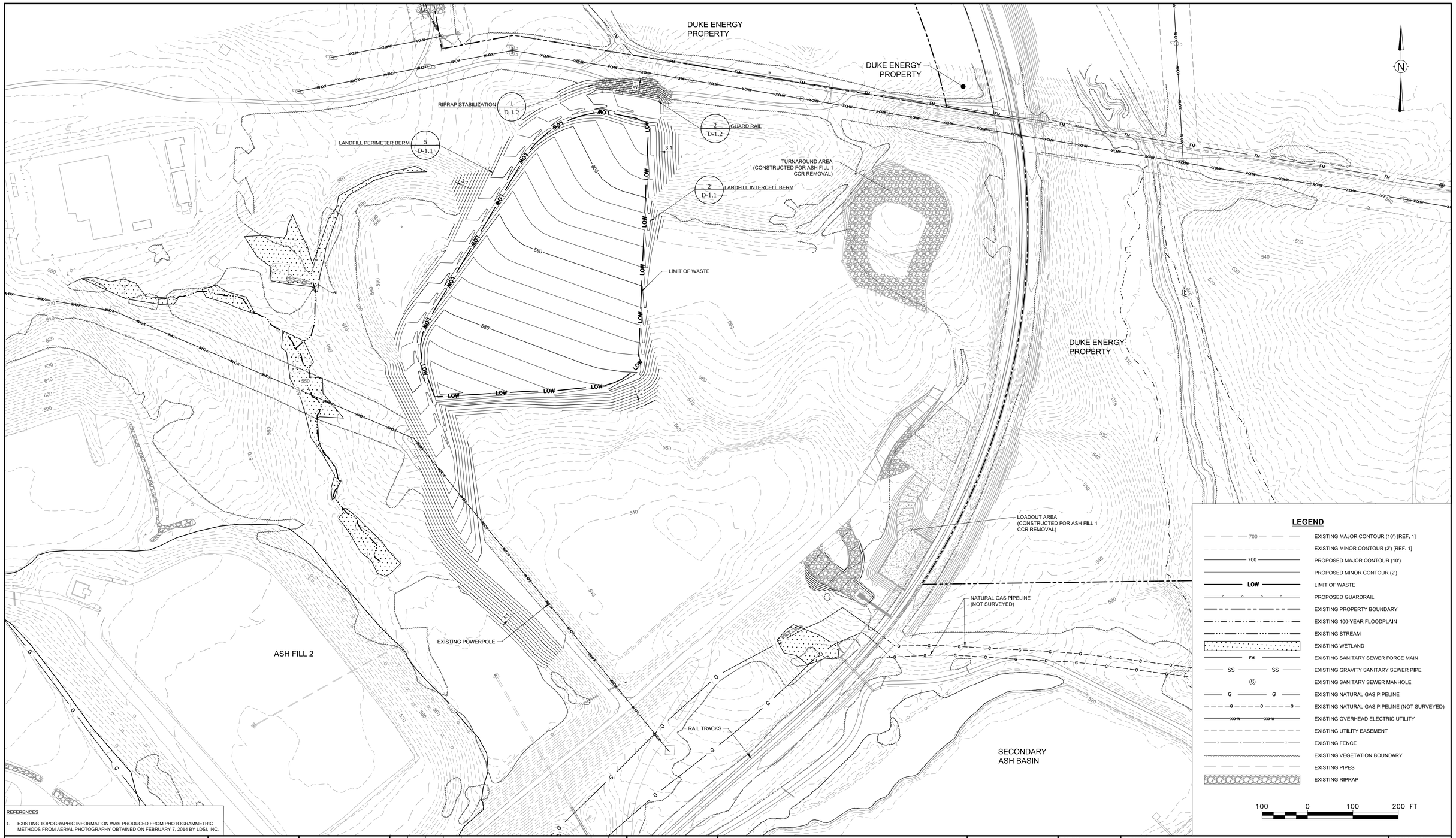
DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 1 COMPACTED
SOIL LINER SUBGRADE

PROJECT NO.:	7810-14-0065
REVISION NO.	0
DATE:	8/26/2015
DRAWING NO.	C-3.1

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-3.1 LANDFILL CELL 1 COMPACTED SOIL LINER SUBGRADE August 26, 2015 09:46:44am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-3.1 LANDFILL CELL 1 COMPACTED SOIL LINER SUBGRADE.dwg



REFERENCES

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AMEC LICENSE No. F-1253

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TEL: (704) 357-8600 FAX: (704) 357-8638
LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

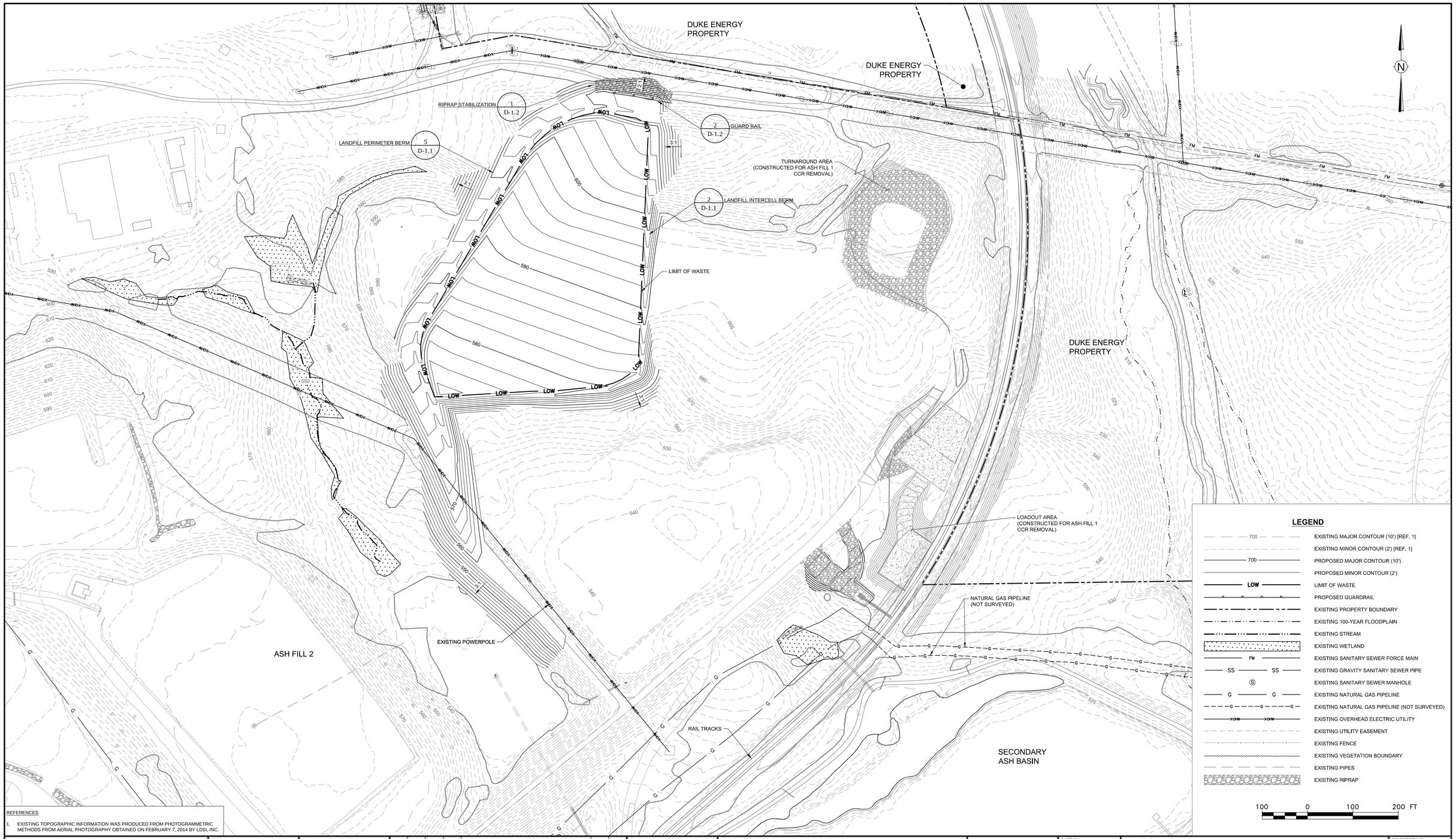
DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 1 GEOSYNTHETIC LINER SUBGRADE

PROJECT NO.:	7810-14-0065
REVISION NO.	0
DATE:	8/26/2015
DRAWING NO.	C-3.2

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-3.2 LANDFILL CELL 1 GEOSYNTHETIC LINER SUBGRADE August 26, 2015 09:47:38am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill
Design\C-3.2 LANDFILL CELL 1 GEOSYNTHETIC SOIL LINER SUBGRADE.dwg



REFERENCES

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DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 1 TOP OF PROTECTIVE COVER

PROJECT NO.:	7810-14-0065
REVISION NO.	0
DATE:	8/26/2015
DRAWING NO.	C-3.3

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-3.3 LANDFILL CELL 1 TOP OF PROTECTIVE COVER August 26, 2015 09:48:35am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-3.3
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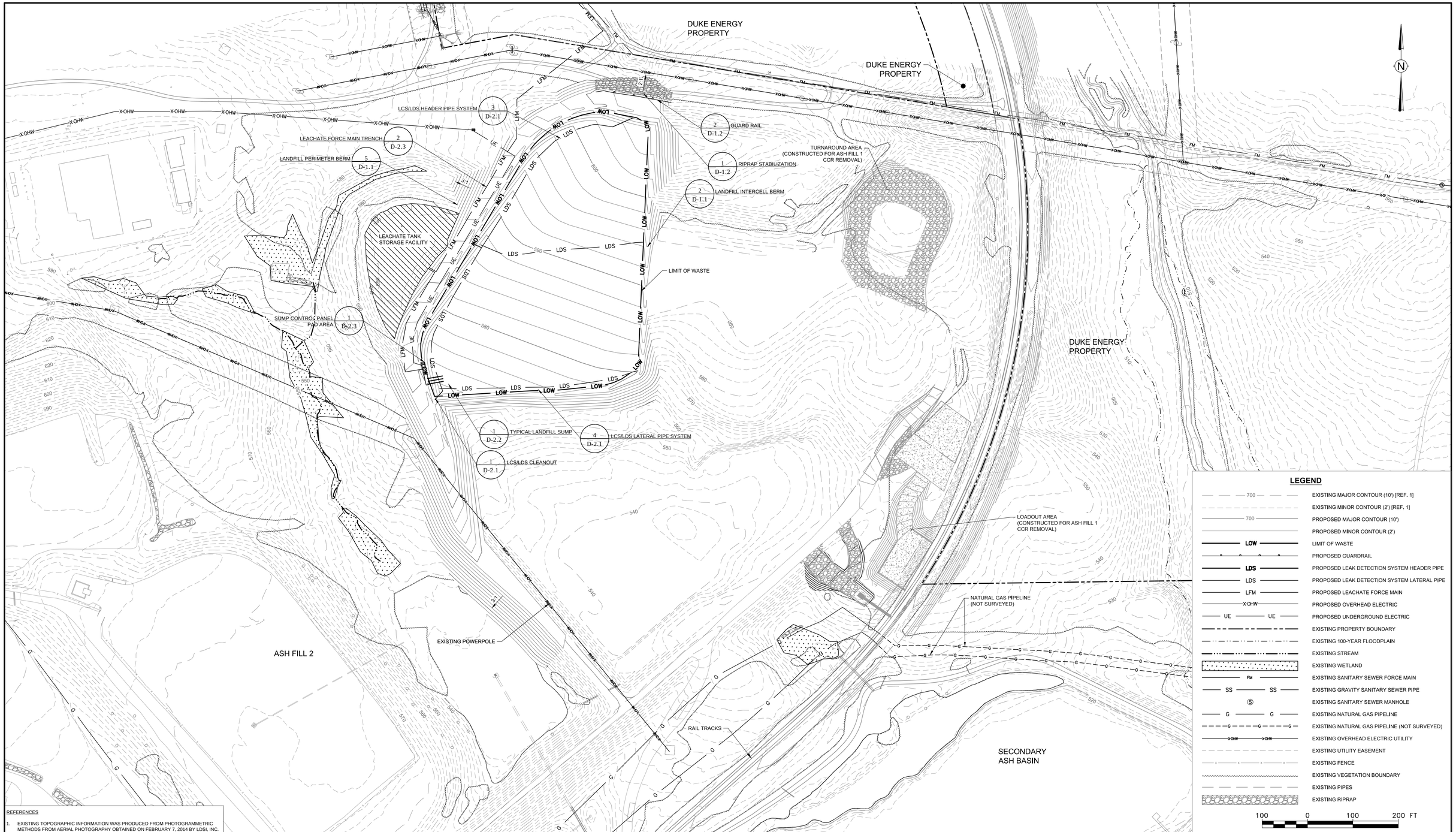

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LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

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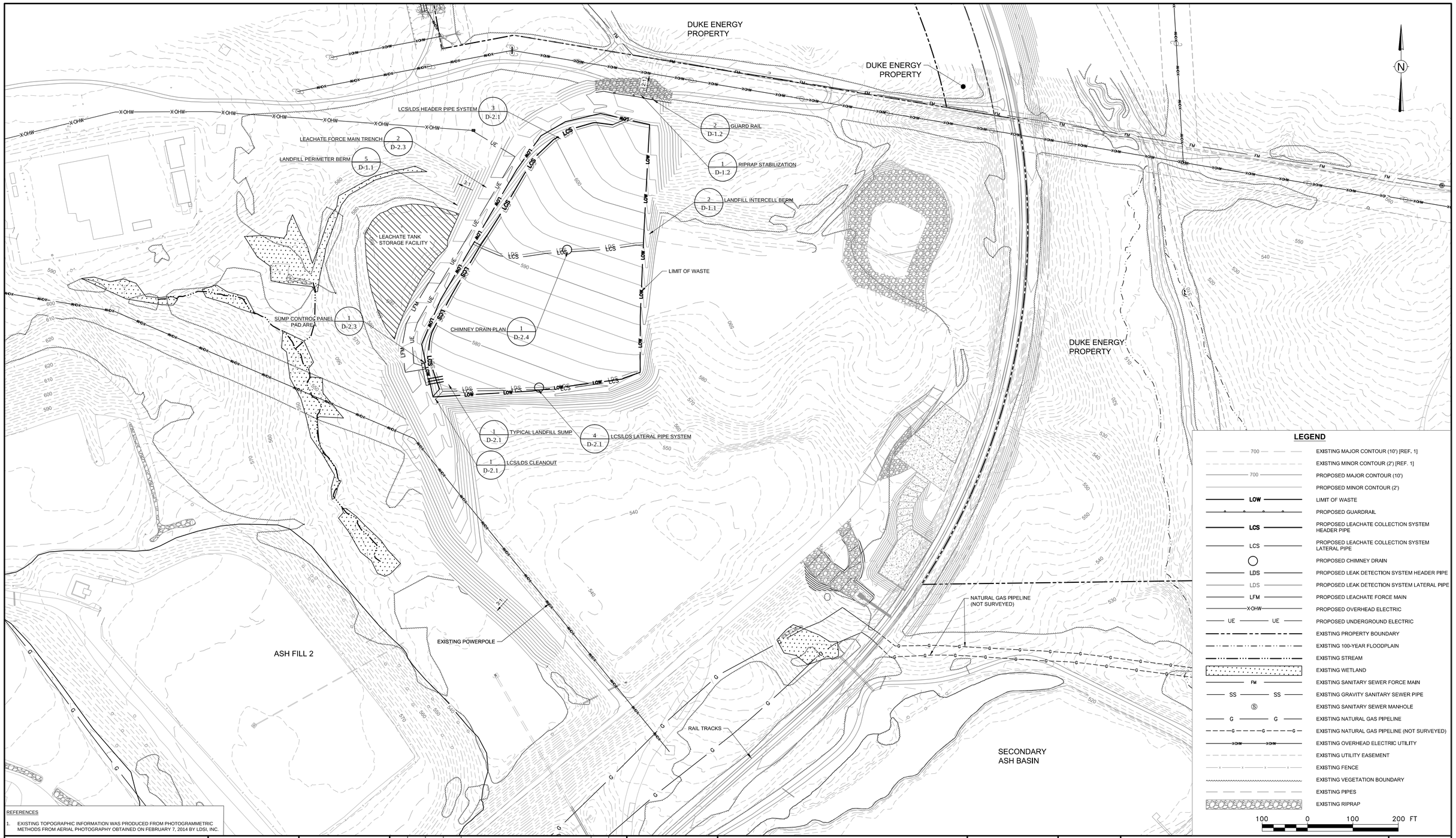
DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 1 LEAK DETECTION SYSTEM

PROJECT NO.:	7810-14-0065
REVISION NO.	0
DATE:	8/26/2015
DRAWING NO.	C-3.4

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-3.4 LANDFILL CELL 1 LEAK DETECTION SYSTEM August 26, 2015 09:49:30am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-3.4 LANDFILL CELL 1 LEAK DETECTION SYSTEM.dwg



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AMEC LICENSE No. F-1253

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LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

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DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 1 LEACHATE COLLECTION SYSTEM

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-3.5

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-3.5 LANDFILL CELL 1 LEACHATE COLLECTION SYSTEM August 26, 2015 09:50:27am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill
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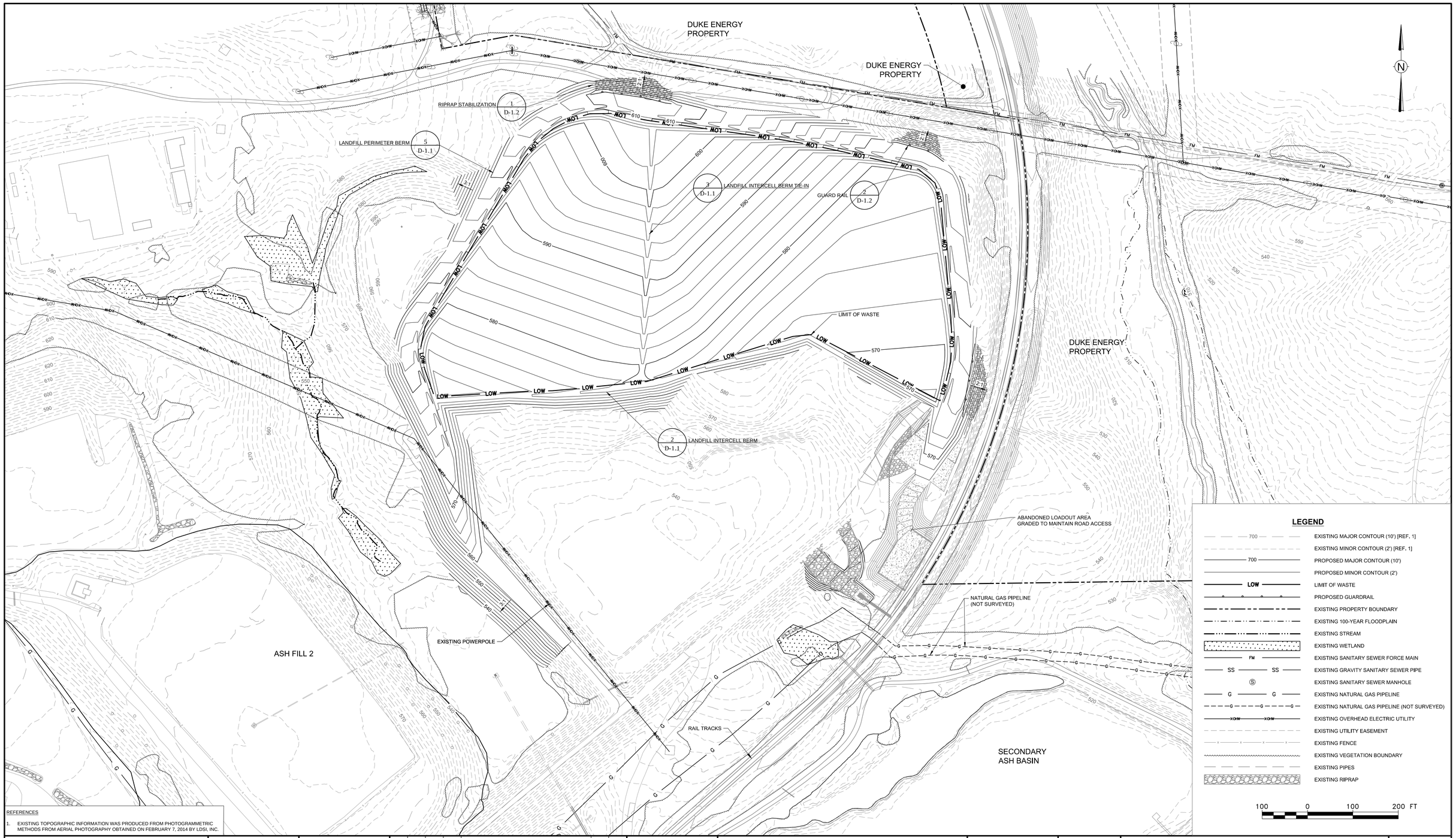

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TEL: (704) 357-8600 FAX: (704) 357-8638
LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

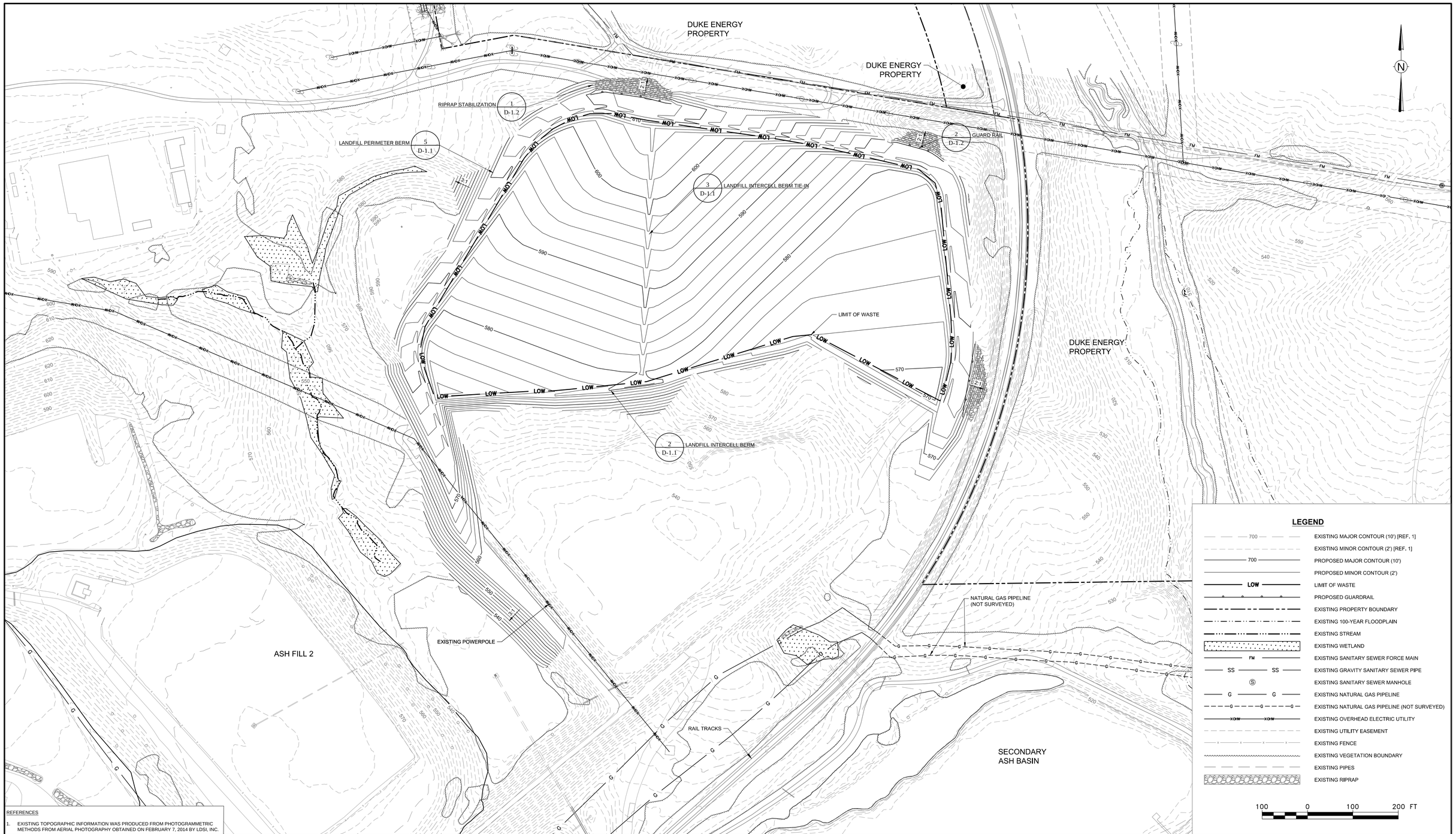
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 2 COMPACTED SOIL LINER SUBGRADE

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-4.1

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-4.1 LANDFILL CELL 2 COMPACTED SOIL LINER SUBGRADE August 26, 2015 09:51:27am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-4.1 LANDFILL CELL 2 COMPACTED SOIL LINER SUBGRADE.dwg



REFERENCES

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NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER GERRIT H. BUHL

AMEC LICENSE No. F-1253

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0	26	08	2015	SUBMITTED FOR PERMIT REVIEW	CHR	KRD

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EDEN, NORTH CAROLINA

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2801 YORKMONT ROAD, SUITE 100
CHARLOTTE, NC 28208
TEL: (704) 357-8600 FAX: (704) 357-8638
LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 2 GEOSYNTHETIC LINER SUBGRADE

PROJECT NO.:	7810-14-0065
REVISION NO.	0
DATE:	8/26/2015
DRAWING NO.	C-4.2

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-4.2 LANDFILL CELL 2 GEOSYNTHETIC LINER SUBGRADE August 26, 2015 09:52:25am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-4.2 LANDFILL CELL 2 GEOSYNTHETIC SOIL LINER SUBGRADE.dwg

DUKE ENERGY PROPERTY

DUKE ENERGY PROPERTY

RIPRAP STABILIZATION 1 / D-1.2

LANDFILL PERIMETER BERM 5 / D-1.1

2 / D-1.2 GUARD RAIL

3 / D-1.1 LANDFILL INTERCELL BERM TIE-IN

LIMIT OF WASTE

DUKE ENERGY PROPERTY

2 / D-1.1 LANDFILL INTERCELL BERM

EXISTING POWERPOLE

ASH FILL 2

NATURAL GAS PIPELINE (NOT SURVEYED)

RAIL TRACKS

SECONDARY ASH BASIN

REFERENCES

1. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON FEBRUARY 7, 2014 BY LDSI, INC.

LEGEND

700	EXISTING MAJOR CONTOUR (10') [REF. 1]
	EXISTING MINOR CONTOUR (2') [REF. 1]
700	PROPOSED MAJOR CONTOUR (10')
	PROPOSED MINOR CONTOUR (2')
LOW	LIMIT OF WASTE
	PROPOSED GUARDRAIL
	EXISTING PROPERTY BOUNDARY
	EXISTING 100-YEAR FLOODPLAIN
	EXISTING STREAM
	EXISTING WETLAND
FM	EXISTING SANITARY SEWER FORCE MAIN
SS	EXISTING GRAVITY SANITARY SEWER PIPE
Ⓢ	EXISTING SANITARY SEWER MANHOLE
G	EXISTING NATURAL GAS PIPELINE
G	EXISTING NATURAL GAS PIPELINE (NOT SURVEYED)
XOHW	EXISTING OVERHEAD ELECTRIC UTILITY
	EXISTING UTILITY EASEMENT
	EXISTING FENCE
	EXISTING VEGETATION BOUNDARY
	EXISTING PIPES
	EXISTING RIPRAP

100 0 100 200 FT

PRELIMINARY

NOT FOR CONSTRUCTION

NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER GERRIT H. BUHL

AMEC LICENSE No. F-1253

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LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

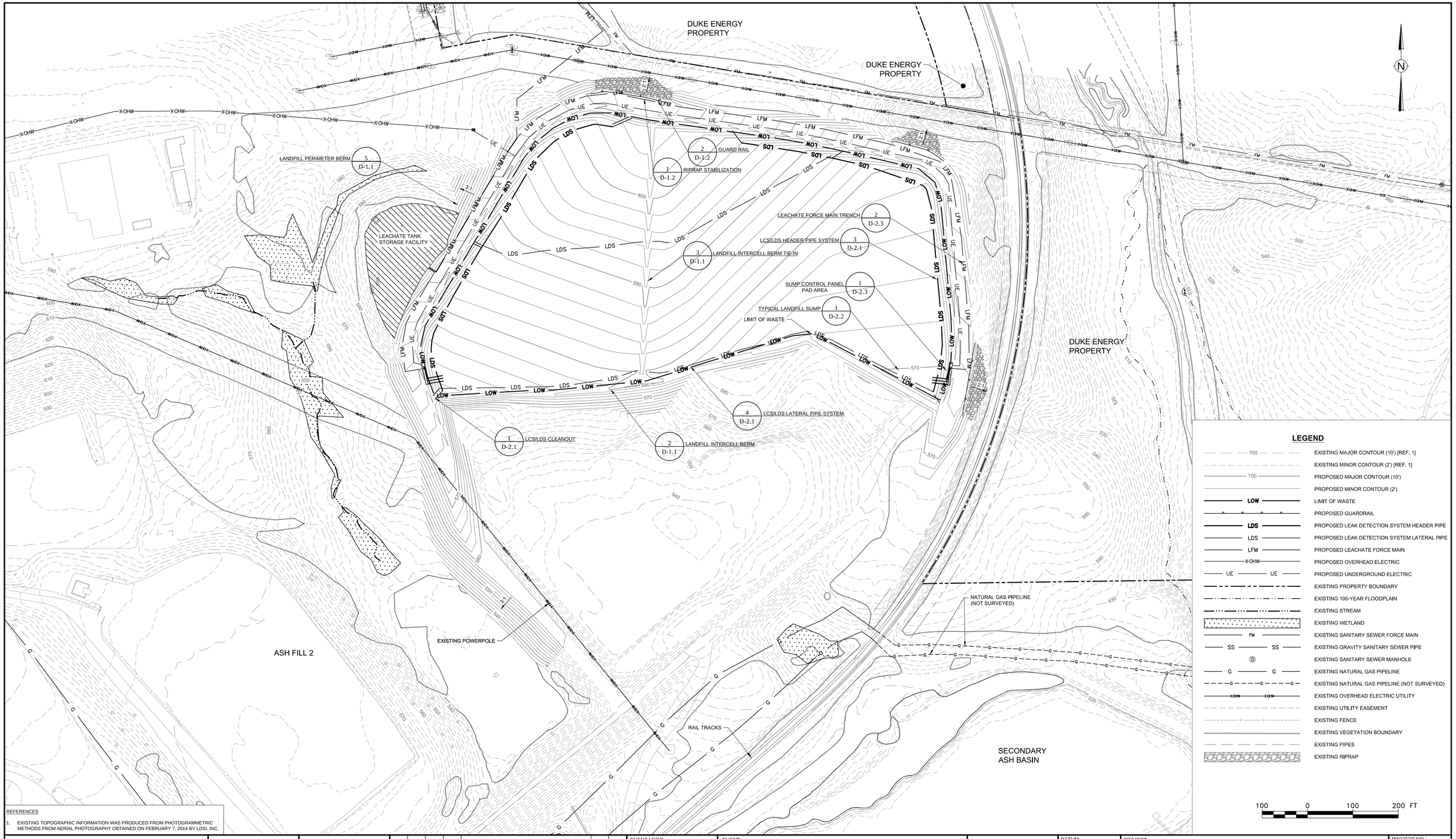
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 2 TOP OF PROTECTIVE COVER

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-4.3

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-4.3 LANDFILL CELL 2 TOP OF PROTECTIVE COVER August 26, 2015 09:53:23am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-4.3



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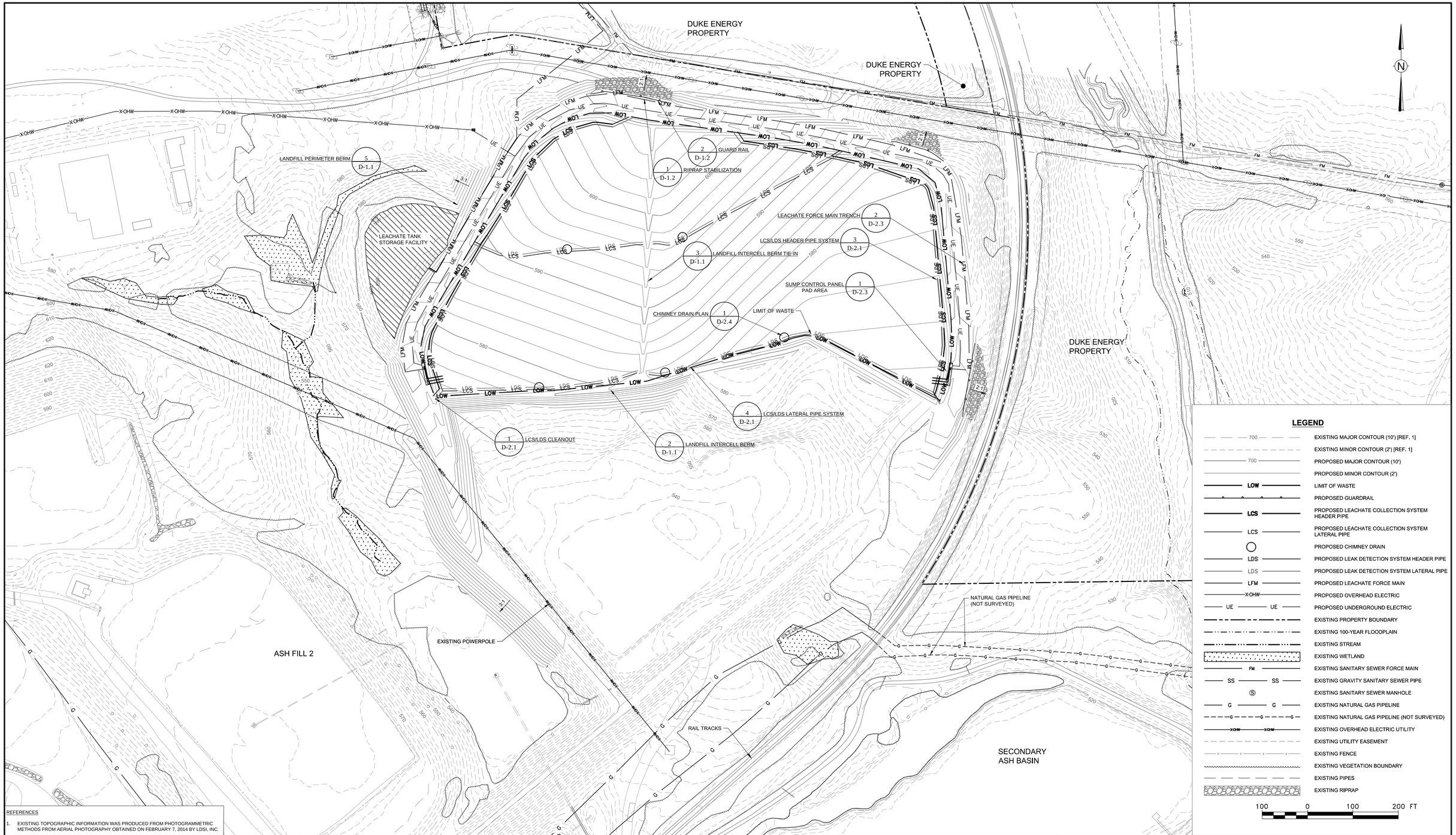
DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 2 LEAK DETECTION SYSTEM

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-4.4

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-4.4 LANDFILL CELL 2 LEAK DETECTION SYSTEM August 26, 2015 09:54:15am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-4.4 LANDFILL CELL 2 LEAK DETECTION SYSTEM.dwg



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amec foster wheeler

DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 2 LEACHATE COLLECTION SYSTEM

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-4.5

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-4.5 LANDFILL CELL 2 LEACHATE DETECTION SYSTEM August 26, 2015 09:55:09am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-4.5
LANDFILL CELL 2 LEACHATE DETECTION SYSTEM.dwg

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DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 3 COMPACTED SOIL LINER SUBGRADE

PROJECT NO.:	7810-14-0065
REVISION NO.	0
DATE:	8/26/2015
DRAWING NO.	C-5.1

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-5.1 LANDFILL CELL 3 COMPACTED SOIL LINER SUBGRADE August 26, 2015 09:55:49am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill
Design\C-5.1 LANDFILL CELL 3 COMPACTED SOIL LINER SUBGRADE.dwg

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CHARLOTTE, NC 28208
TEL: (704) 357-8600 FAX: (704) 357-8638
LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

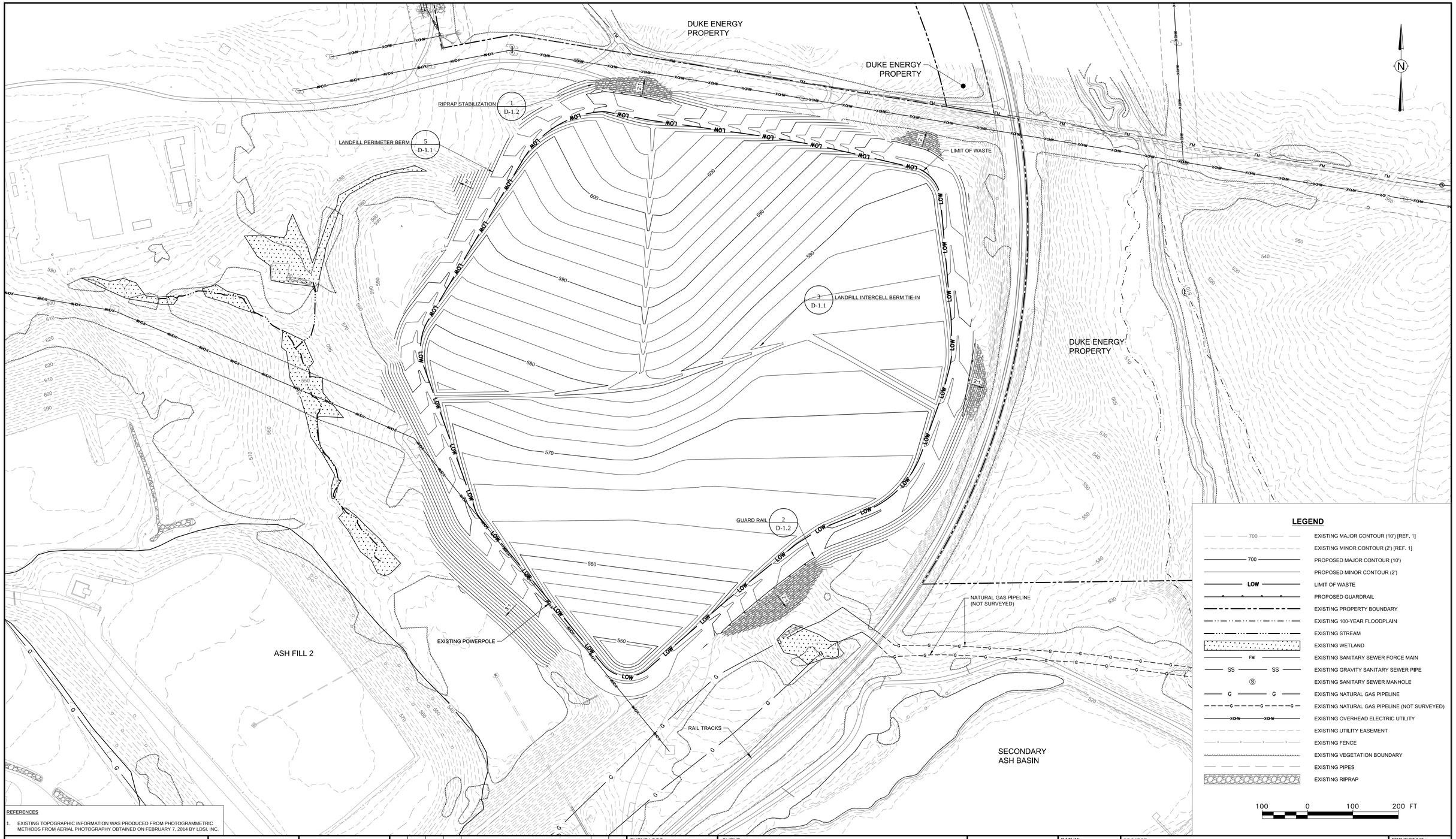
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 3 GEOSYNTHETIC LINER SUBGRADE

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-5.2

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-5.2 LANDFILL CELL 3 GEOSYNTHETIC LINER SUBGRADE August 26, 2015 09:56:29am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-5.2 LANDFILL CELL 3 GEOSYNTHETIC LINER SUBGRADE.dwg



REFERENCES

1. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON FEBRUARY 7, 2014 BY LDSI, INC.

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NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUNK

AMEC LICENSE No. F-1253

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0	26	08	2015	SUBMITTED FOR PERMIT REVIEW	CHR	KRD

CLIENT LOGO: DUKE ENERGY.

CLIENT: DUKE ENERGY CAROLINAS, LLC
EDEN, NORTH CAROLINA

Amec Foster Wheeler Environment & Infrastructure, Inc.
2801 YORKMONT ROAD, SUITE 100
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TEL: (704) 357-8600 FAX: (704) 357-8638
LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 3 TOP OF PROTECTIVE COVER

PROJECT NO.:	7810-14-0065
REVISION NO.	0
DATE:	8/26/2015
DRAWING NO.	C-5.3

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-5.3 LANDFILL CELL 3 TOP OF PROTECTIVE COVER August 26, 2015 09:57:10am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-5.3
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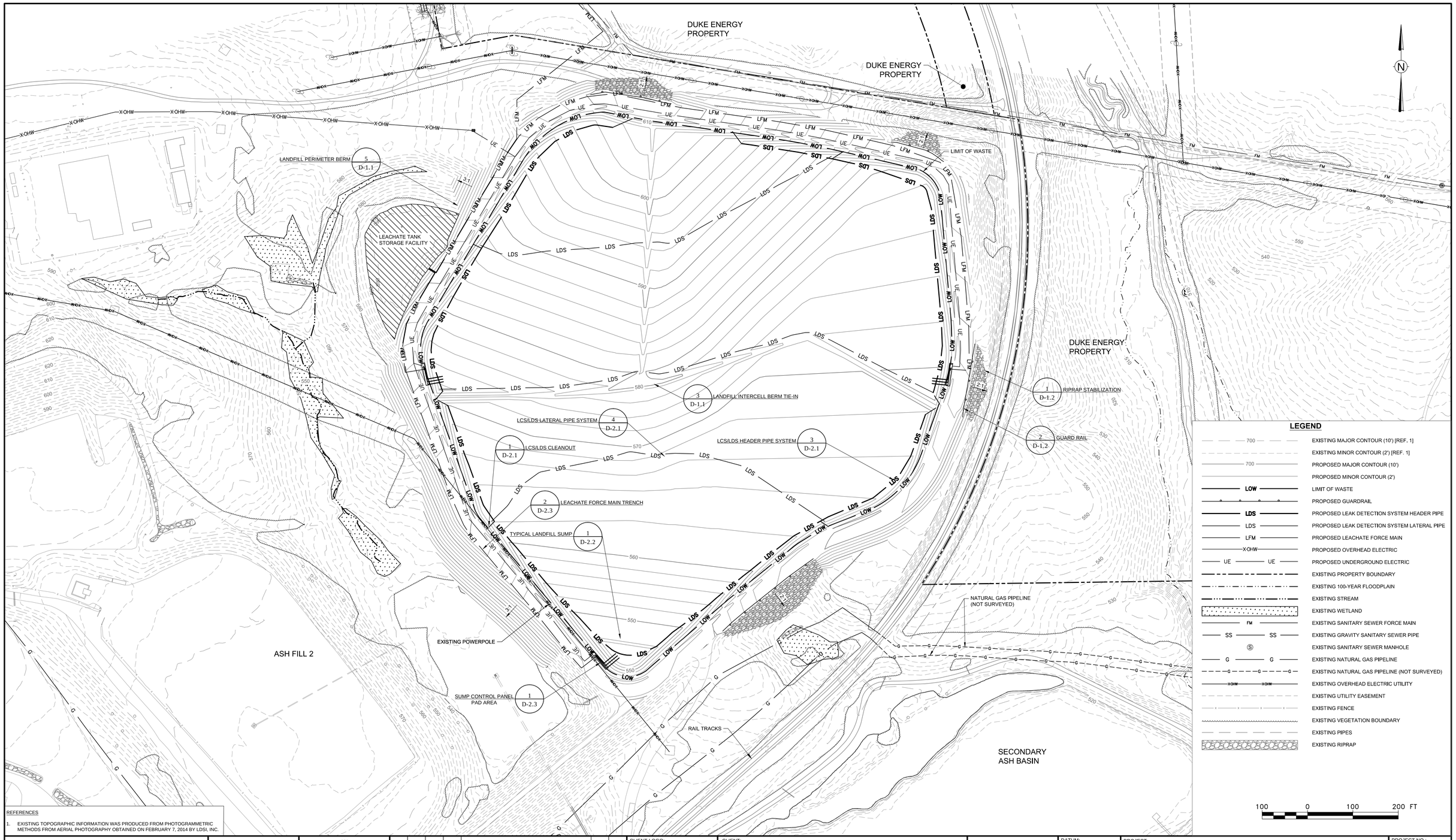

REFERENCES

1. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON FEBRUARY 7, 2014 BY LDSI, INC.

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-5.4 LANDFILL CELL 3 LEAK DETECTION SYSTEM August 26, 2015 09:57:48am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-5.4

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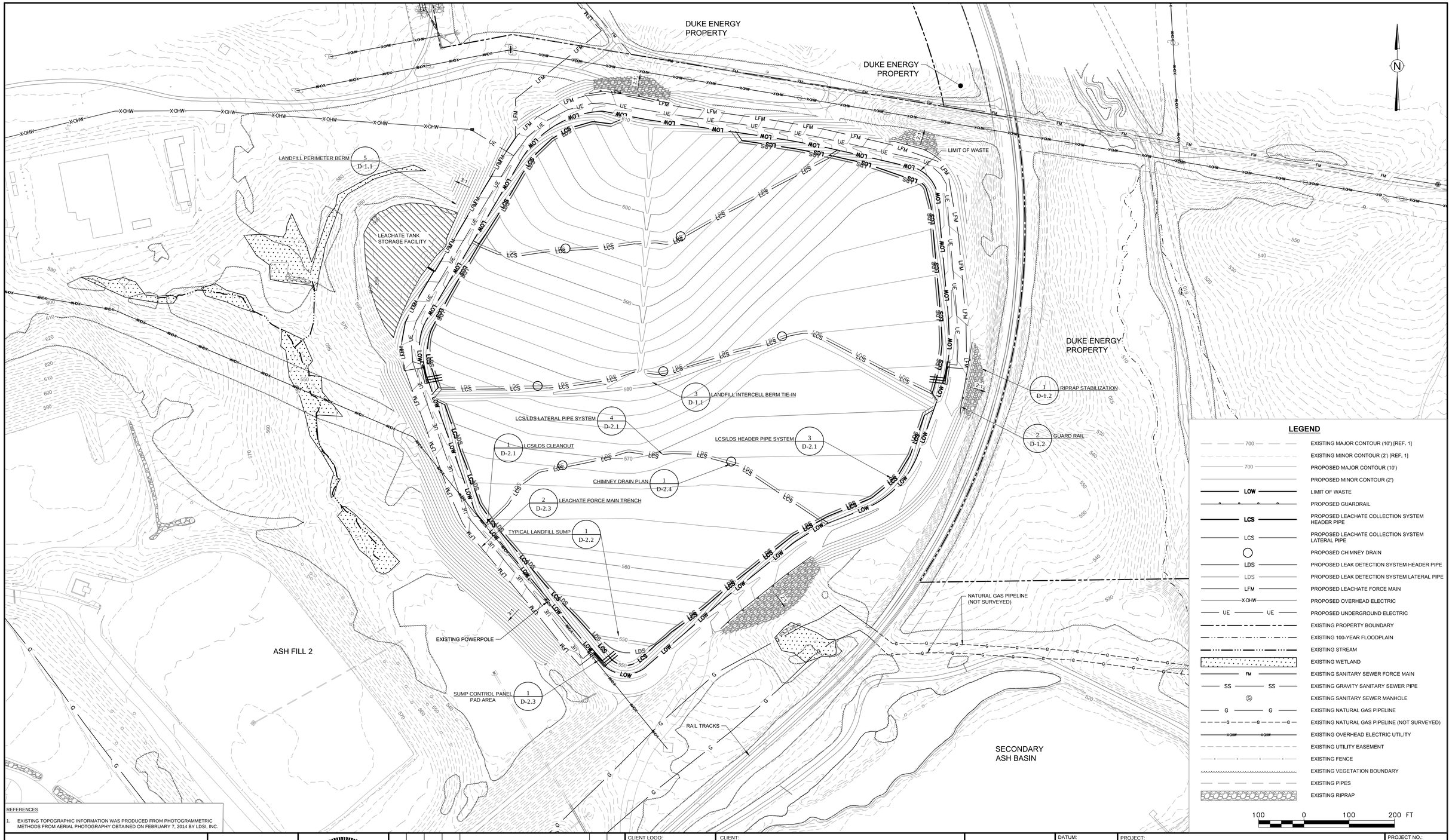
DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 3 LEAK DETECTION SYSTEM

PROJECT NO.:	7810-14-0065
REVISION NO.	0
DATE:	8/26/2015
DRAWING NO.	C-5.4



REFERENCES

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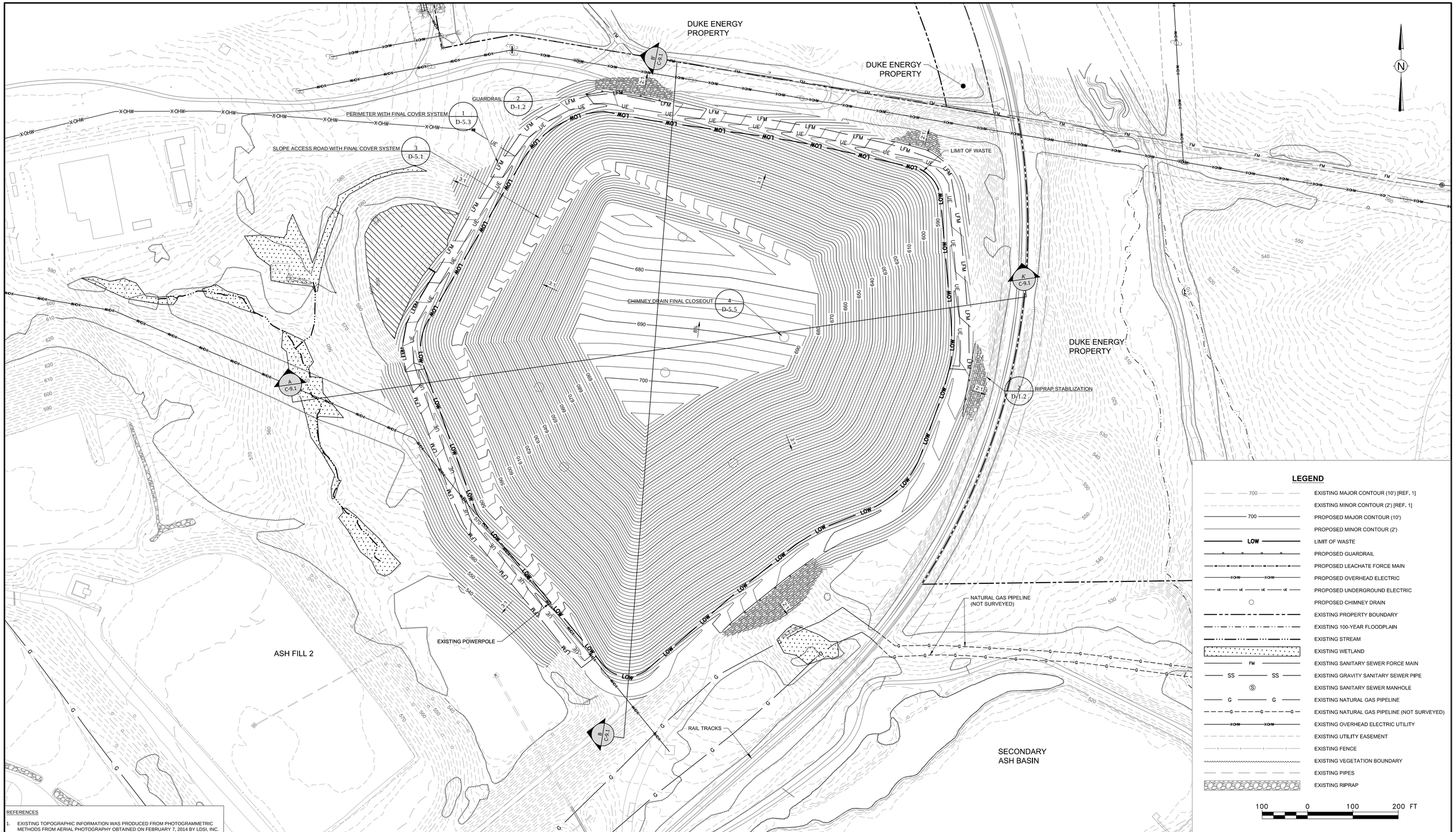
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CELL 3 LEACHATE COLLECTION SYSTEM

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-5.5

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-5.5 LANDFILL CELL 3 LEACHATE COLLECTION SYSTEM August 26, 2015 09:58:29am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-5.5 LANDFILL CELL 3 LEACHATE COLLECTION SYSTEM.dwg



LEGEND

- EXISTING MAJOR CONTOUR (10') [REF. 1]
- EXISTING MINOR CONTOUR (2') [REF. 1]
- PROPOSED MAJOR CONTOUR (10')
- PROPOSED MINOR CONTOUR (2')
- LIMIT OF WASTE
- PROPOSED GUARDRAIL
- PROPOSED LEACHATE FORCE MAIN
- PROPOSED OVERHEAD ELECTRIC
- PROPOSED UNDERGROUND ELECTRIC
- PROPOSED CHIMNEY DRAIN
- EXISTING PROPERTY BOUNDARY
- EXISTING 100-YEAR FLOODPLAIN
- EXISTING STREAM
- EXISTING WETLAND
- EXISTING SANITARY SEWER FORCE MAIN
- EXISTING GRAVITY SANITARY SEWER PIPE
- EXISTING SANITARY SEWER MANHOLE
- EXISTING NATURAL GAS PIPELINE
- EXISTING NATURAL GAS PIPELINE (NOT SURVEYED)
- EXISTING OVERHEAD ELECTRIC UTILITY
- EXISTING UTILITY EASEMENT
- EXISTING FENCE
- EXISTING VEGETATION BOUNDARY
- EXISTING PIPES
- EXISTING RIPRAP

100 0 100 200 FT

REFERENCES

1. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON FEBRUARY 7, 2014 BY LDSI, INC.

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LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

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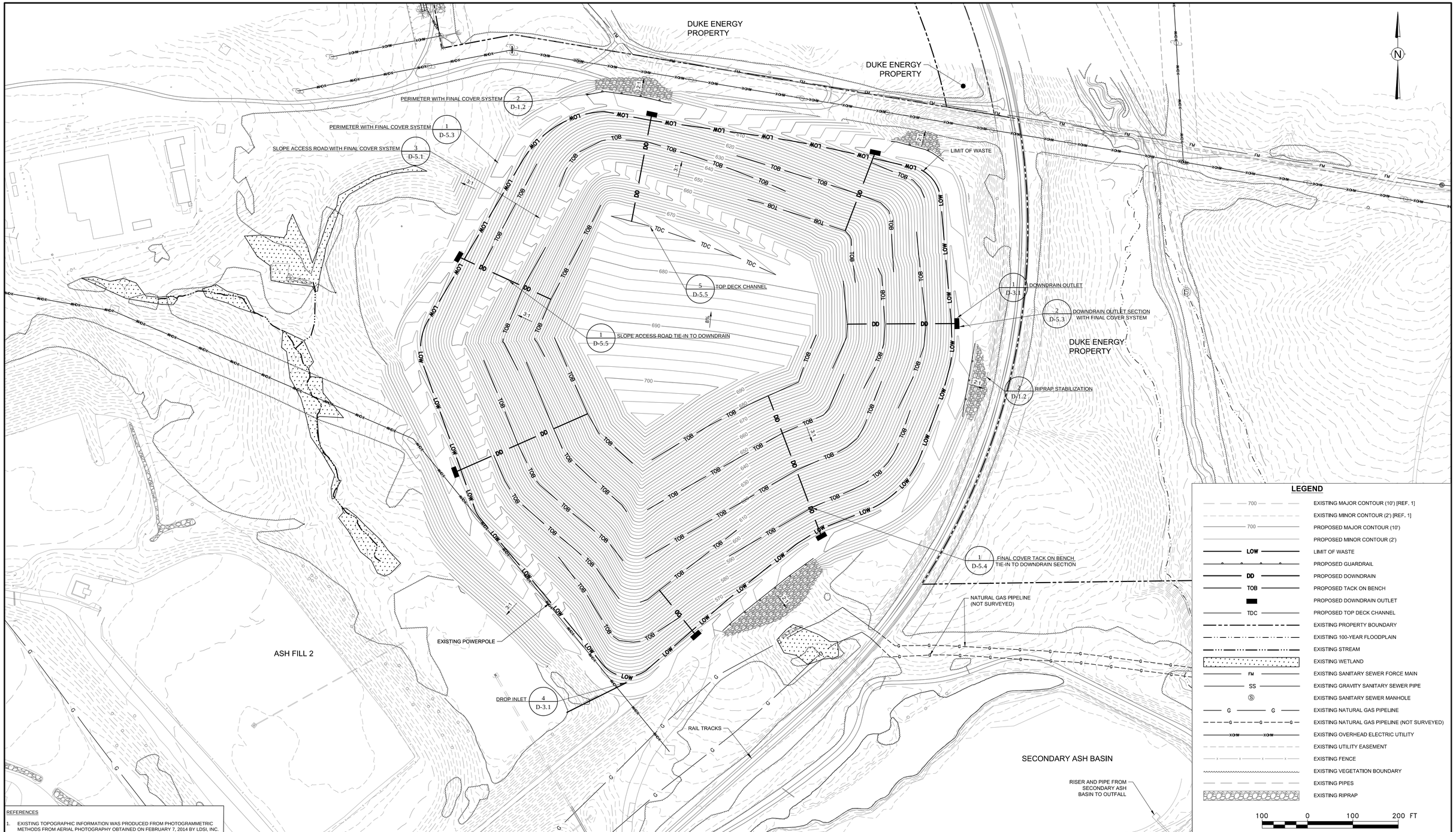
DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CLOSURE GRADES

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-6.1

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-6.1 LANDFILL CLOSURE GRADES August 26, 2015 01:11:48pm Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-6.1 LANDFILL CLOSURE GRADES.dwg



REFERENCES

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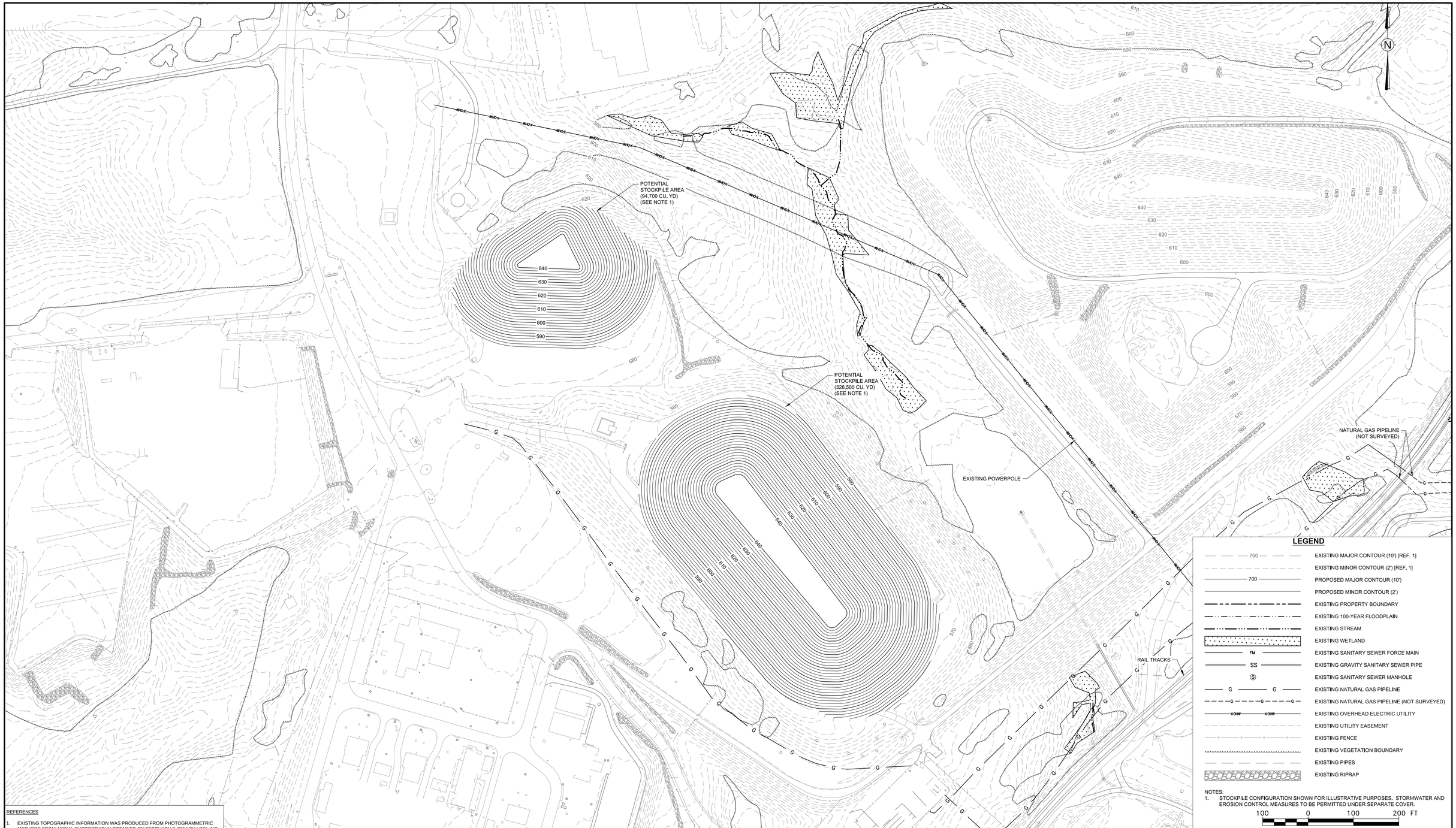
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: LANDFILL CLOSURE STORMWATER

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-6.2

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-6.2 LANDFILL CLOSURE STORMWATER August 26, 2015 09:59:52am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-6.2 LANDFILL CLOSURE STORMWATER.dwg



REFERENCES

1. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON FEBRUARY 7, 2014 BY LDSI, INC.

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AMEC LICENSE No. F-1253

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amec foster wheeler

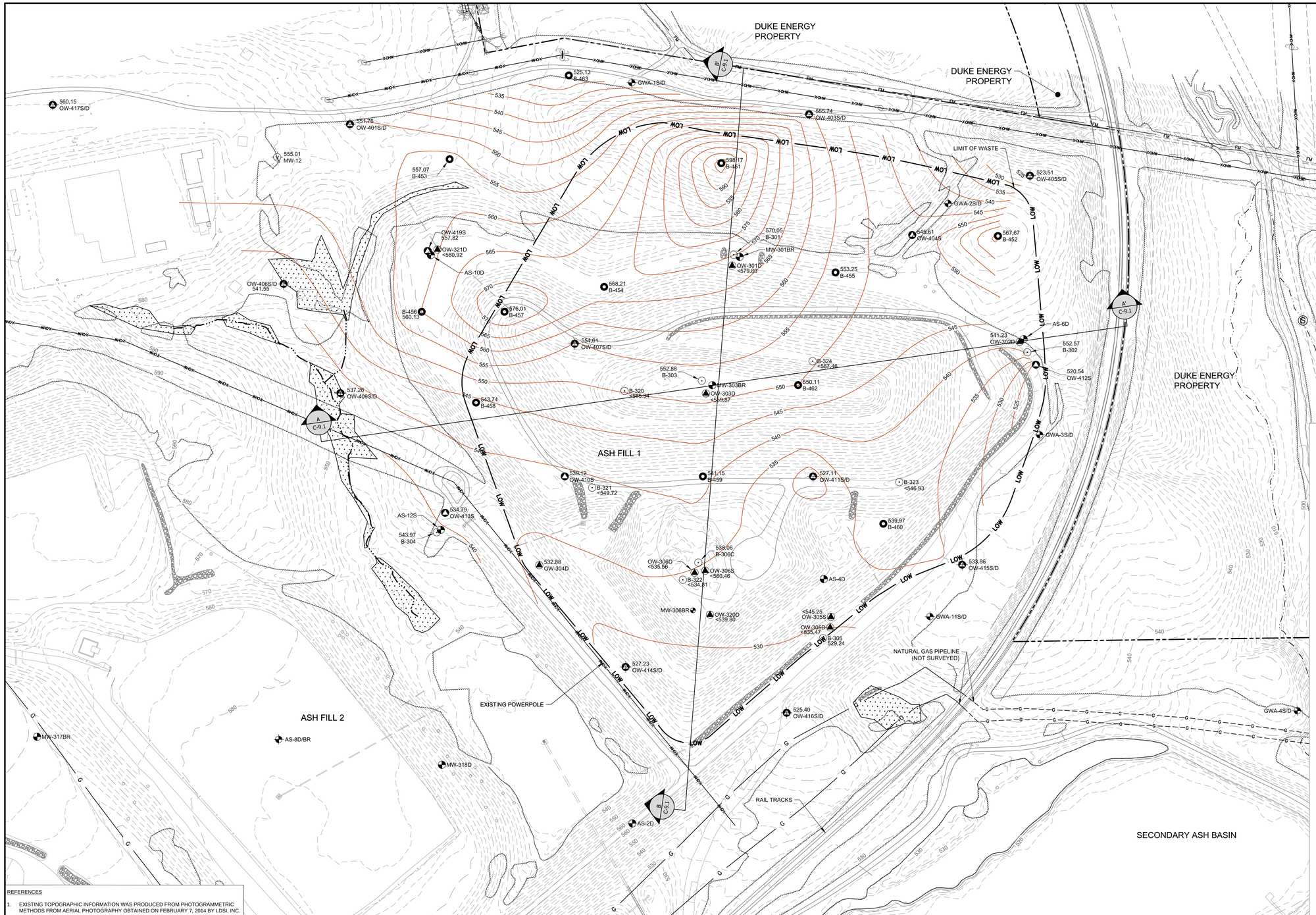
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL CONSTRUCTION PLAN APPLICATION

TITLE: POTENTIAL STOCKPILE AREAS

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-7.1

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-7.1 POTENTIAL STOCKPILE AREAS August 26, 2015 10:00:31am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-7.1 POTENTIAL STOCKPILE AREAS.dwg



LEGEND

700	EXISTING MAJOR CONTOUR (10') [REF. 1]
	EXISTING MINOR CONTOUR (2') [REF. 1]
700	BEDROCK SURFACE CONTOUR (5') (SEE NOTE 1)
LOW	LIMIT OF WASTE
	EXISTING PROPERTY BOUNDARY
	EXISTING 100-YEAR FLOODPLAIN
	EXISTING STREAM
	EXISTING WETLAND
FM	EXISTING SANITARY SEWER FORCE MAIN
SS	EXISTING GRAVITY SANITARY SEWER PIPE
S	EXISTING SANITARY SEWER MANHOLE
G	EXISTING NATURAL GAS PIPELINE
G	EXISTING NATURAL GAS PIPELINE (NOT SURVEYED)
XOHW	EXISTING OVERHEAD ELECTRIC UTILITY
	EXISTING UTILITY EASEMENT
	EXISTING FENCE
	EXISTING VEGETATION BOUNDARY
	EXISTING PIPES
	EXISTING RIPRAP
	AMEC FOSTER WHEELER HISTORIC BORING
	AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY LANDFILL BORING
	AMEC FOSTER WHEELER HISTORIC OBSERVATION WELL
	AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY OBSERVATION WELL
	AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY OBSERVATION WELL PAIR
V	DUKE ENERGY VOLUNTARY WELL PAIR
C	DUKE ENERGY COMPLIANCE WELL
C	DUKE ENERGY COMPLIANCE WELL PAIR
	HDR, INC. GROUNDWATER ASSESSMENT WELL
	HDR, INC. GROUNDWATER ASSESSMENT WELL CLUSTER

NOTES:
1. BEDROCK CONTOURS BASED ON AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY BORINGS AND WELLS.

100 0 100 200 FT

REFERENCES
1. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON FEBRUARY 7, 2014 BY LDSI, INC.

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AMEC LICENSE No. F-1253

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TEL: (704) 357-8600 FAX: (704) 357-8638
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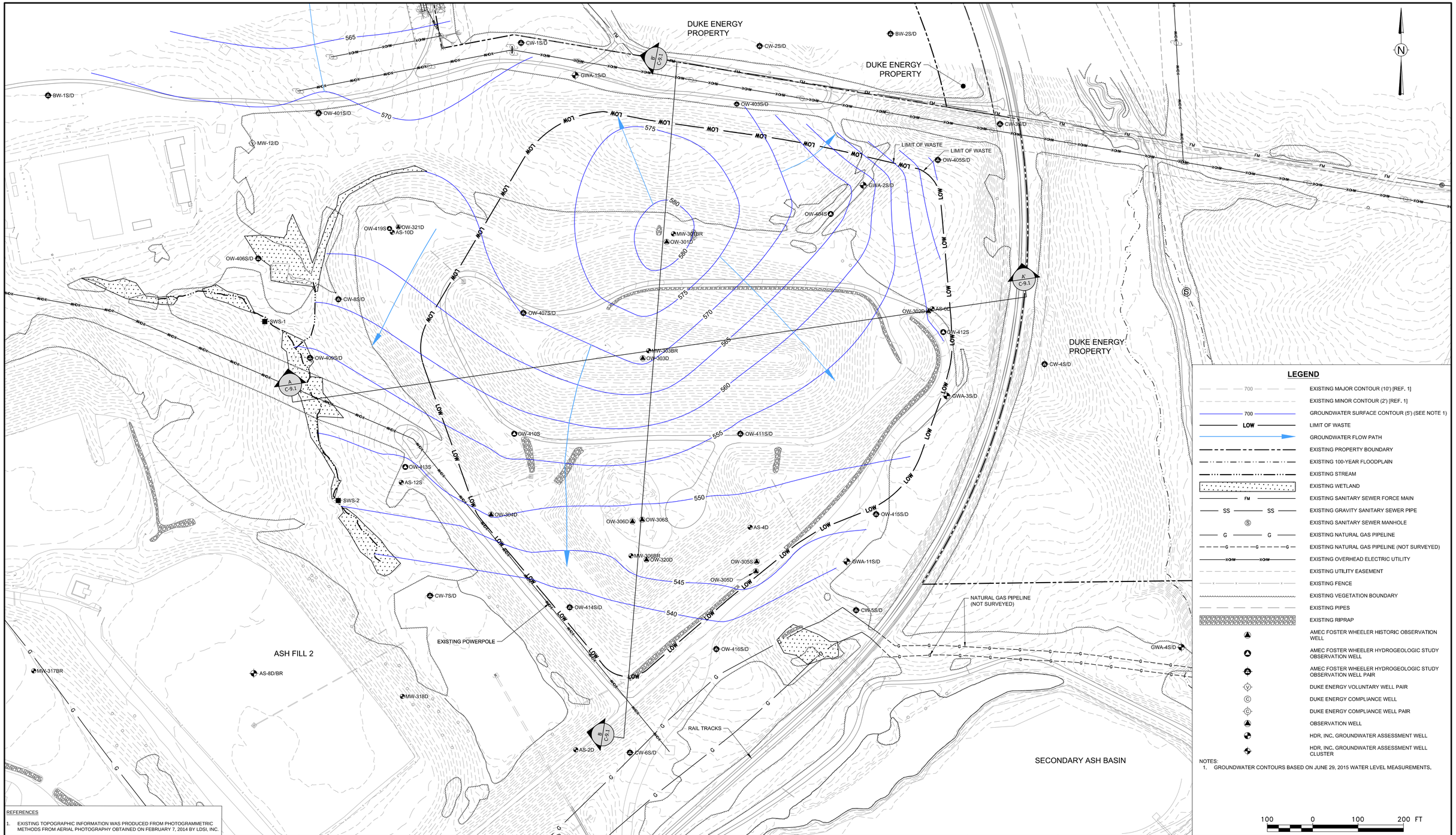
DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: BEDROCK SURFACE MAP

PROJECT NO.: 7810-14-0065
REVISION NO.: 0
DATE: 8/26/2015
DRAWING NO.: C-8.1

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-8.1 BEDROCK SURFACE MAP August 26, 2015 10:01:03am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-8.1 BEDROCK SURFACE MAP.dwg



LEGEND

700	EXISTING MAJOR CONTOUR (10') [REF. 1]
	EXISTING MINOR CONTOUR (2') [REF. 1]
700	GROUNDWATER SURFACE CONTOUR (5') (SEE NOTE 1)
LOW	LIMIT OF WASTE
	GROUNDWATER FLOW PATH
	EXISTING PROPERTY BOUNDARY
	EXISTING 100-YEAR FLOODPLAIN
	EXISTING STREAM
	EXISTING WETLAND
FM	EXISTING SANITARY SEWER FORCE MAIN
SS	EXISTING GRAVITY SANITARY SEWER PIPE
S	EXISTING SANITARY SEWER MANHOLE
G	EXISTING NATURAL GAS PIPELINE
G	EXISTING NATURAL GAS PIPELINE (NOT SURVEYED)
XOW	EXISTING OVERHEAD ELECTRIC UTILITY
	EXISTING UTILITY EASEMENT
	EXISTING FENCE
	EXISTING VEGETATION BOUNDARY
	EXISTING PIPES
	EXISTING RIPRAP
	AMEC FOSTER WHEELER HISTORIC OBSERVATION WELL
	AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY OBSERVATION WELL
	AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY OBSERVATION WELL PAIR
V	DUKE ENERGY VOLUNTARY WELL PAIR
C	DUKE ENERGY COMPLIANCE WELL
C	DUKE ENERGY COMPLIANCE WELL PAIR
	OBSERVATION WELL
	HDR, INC. GROUNDWATER ASSESSMENT WELL
	HDR, INC. GROUNDWATER ASSESSMENT WELL CLUSTER

NOTES:
1. GROUNDWATER CONTOURS BASED ON JUNE 29, 2015 WATER LEVEL MEASUREMENTS.

100 0 100 200 FT

REFERENCES
1. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON FEBRUARY 7, 2014 BY LDSI, INC.

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AMEC LICENSE No. F-1253

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DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

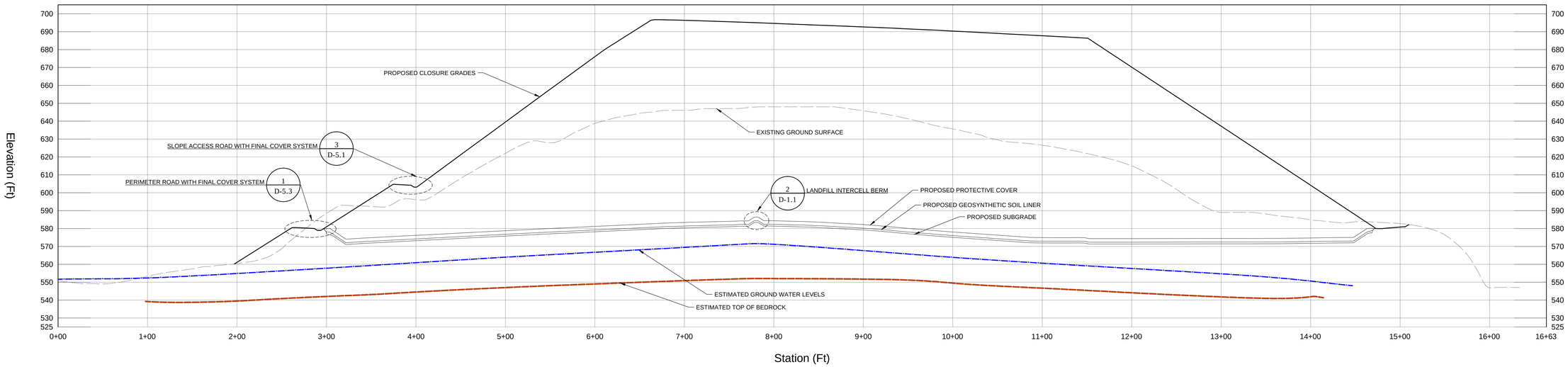
PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: GROUNDWATER SURFACE MAP

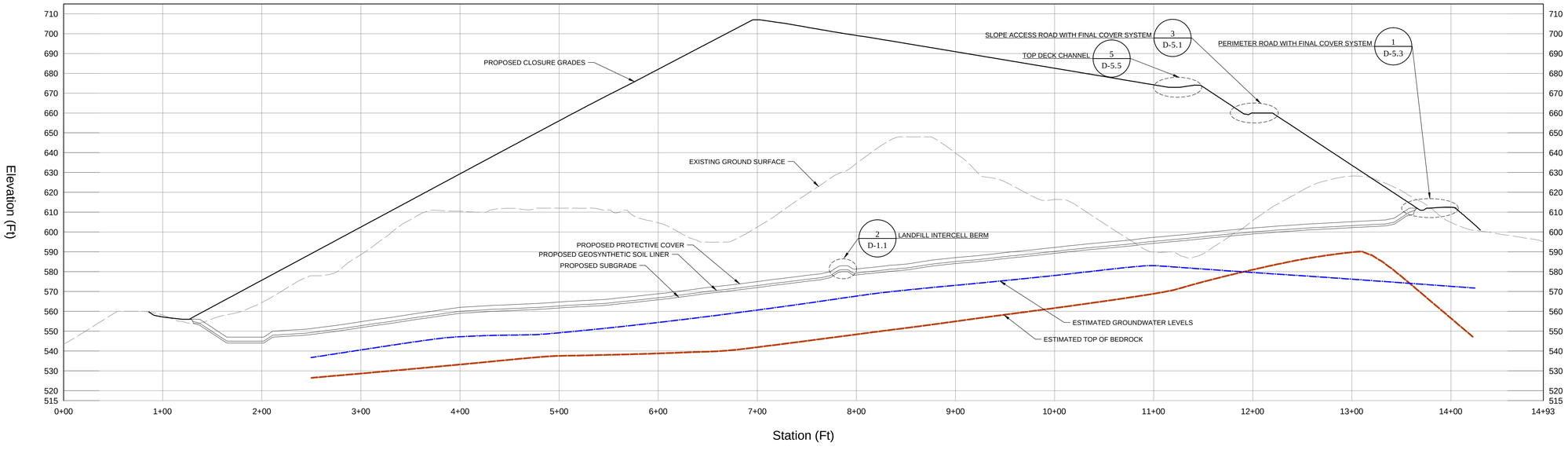
PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-8.2

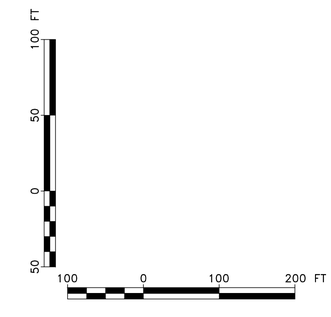
Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-8.2 GROUNDWATER SURFACE MAP August 26, 2015 10:01:39am Q:\Duke\DanRiver\7810140065_ASSAT Dan River Off Site LF\Plansheets\Landfill Design\C-8.2 GROUNDWATER SURFACE MAP.dwg

A-A'



B-B'





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AMEC LICENSE No. F-1253

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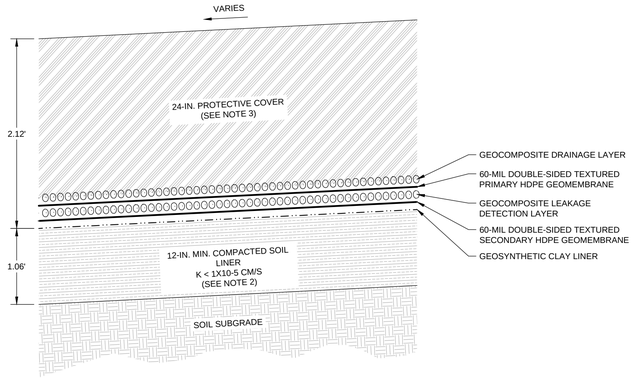
DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: CROSS SECTIONS

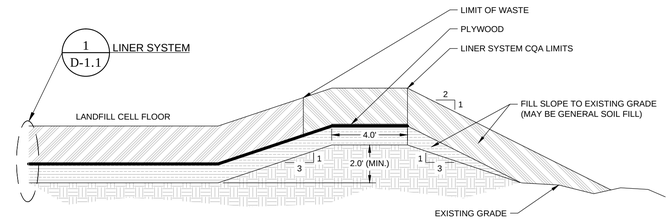
PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. C-9.1

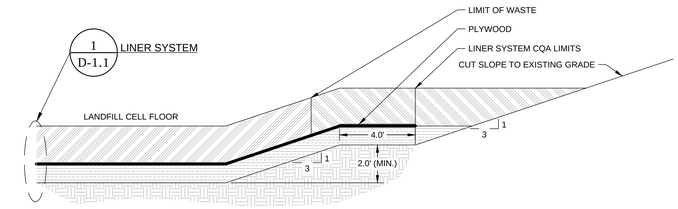
Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:C-9.1 CROSS SECTIONS August 26, 2015 10:02:10am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\C-9.1 CROSS SECTIONS.dwg



NOTES:
1. GEOSYNTHETIC COMPONENTS SHOWN AT EXAGGERATED SCALE.
2. THE THICKNESS OF COMPACTED SOIL LINER SHALL BE MEASURED FROM THE TOP OF SOIL SUBGRADE TO THE TOP OF COMPACTED SOIL LINER (LINER SYSTEM SUBGRADE) IN THE VERTICAL DIRECTION. ASSUMING A MAXIMUM SLOPE OF 3H:1V, THE CONVERSION FROM PERPENDICULAR THICKNESS TO VERTICAL THICKNESS IS A FACTOR OF 1.06.
3. PROTECTIVE COVER MAY CONSIST OF SOIL OR CCR MATERIAL WITHIN THE LIMIT OF WASTE FOOTPRINT. PROTECTIVE COVER MUST CONSIST OF SOIL OUTSIDE THE LIMIT OF WASTE FOOTPRINT. THE THICKNESS OF PROTECTIVE COVER SHALL BE MEASURED FROM THE TOP OF COMPACTED SOIL LINER (LINER SYSTEM SUBGRADE) TO THE TOP OF THE PROTECTIVE COVER IN THE VERTICAL DIRECTION. ASSUMING A MAXIMUM SLOPE OF 3H:1V, THE CONVERSION FROM PERPENDICULAR THICKNESS TO VERTICAL THICKNESS IS A FACTOR OF 1.06.

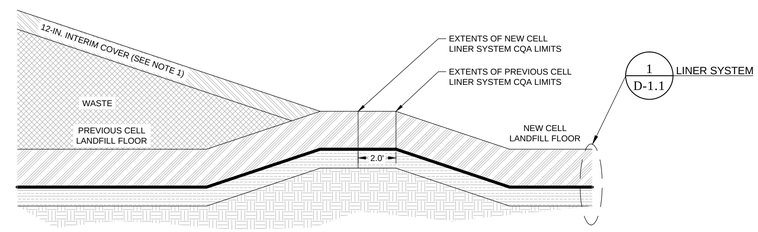
1 / D-1.1 LINER SYSTEM
SCALE: 1" = 1'





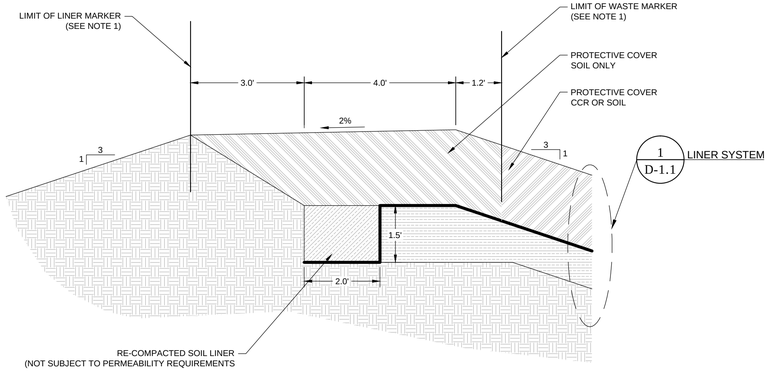
NOTES:
1. INTERIM COVER FOR INTERIOR SIDE SLOPES MAY NOT BE REQUIRED DEPENDING ON THE PHASING OF LANDFILL CONSTRUCTION AND OPERATIONS.

2 / D-1.1 LANDFILL INTERCELL BERM
SCALE: 1" = 4'



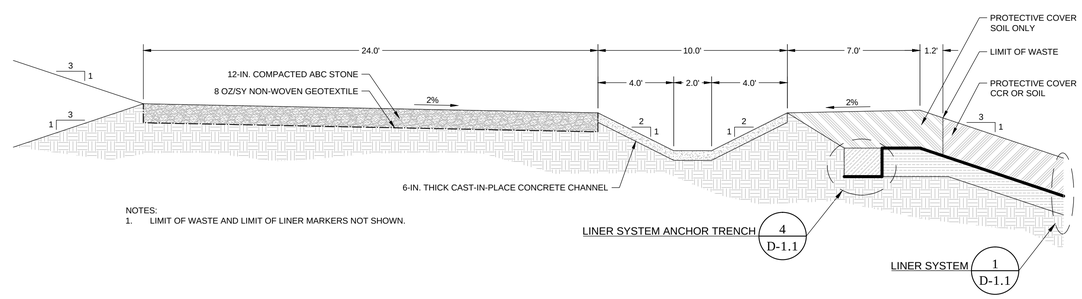
NOTES:
1. INTERIM COVER FOR INTERIOR SIDE SLOPES MAY NOT BE REQUIRED DEPENDING ON THE PHASING OF LANDFILL CONSTRUCTION AND OPERATIONS.

3 / D-1.1 LANDFILL INTERCELL BERM TIE-IN
SCALE: 1" = 4'



NOTES:
1. REMOVE EXISTING MARKERS PRIOR TO INSTALLATION OF FINAL COVER SYSTEM FOR RE-USE. INSTALL MARKERS USING METHOD THAT WILL NOT DAMAGE LINER SYSTEM SUCH AS A HAND AUGER. SELECT MARKER LENGTH SUCH THAT VISIBLE PORTION ABOVE GROUND SHALL BE 3-FT. MINIMUM.
2. OUTSIDE OF THE INDICATED LIMIT OF WASTE, ASH MAY NOT BE USED AS PROTECTIVE COVER.

4 / D-1.1 LINER SYSTEM ANCHOR TRENCH
SCALE: 1" = 1'



NOTES:
1. LIMIT OF WASTE AND LIMIT OF LINER MARKERS NOT SHOWN.

5 / D-1.1 LANDFILL PERIMETER BERM
SCALE: 1" = 4'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
- WASTE
- INTERIM SOIL COVER
- FINAL SOIL COVER
- VEGETATIVE SOIL COVER
- NCDOT 78M DRAINAGE AGGREGATE
- ASTM C-33 CONCRETE SAND
- RIPRAP
- CONCRETE
- COMPACTED ABC STONE
- GEOSYNTHETIC CLAY LINER (GCL)
- 60-MIL DOUBLE-SIDED TEXTURED HDPE GEOMEMBRANE
- GEOCOMPOSITE DRAINAGE LAYER
- GEOTEXTILE
- LINER SYSTEM
- PIPE (HIDDEN)
- PIPE (EXPOSED)

PRELIMINARY
NOT FOR CONSTRUCTION

NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER GERRIT H. RUHL
AMEC LICENSE No. F-1253

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	ENG.	APPR.
0	26	08	2015	SUBMITTED FOR PERMIT REVIEW	CHR	KRD

CLIENT LOGO: DUKE ENERGY.

CLIENT:
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TEL: (704) 357-8600 FAX: (704) 357-8638
LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

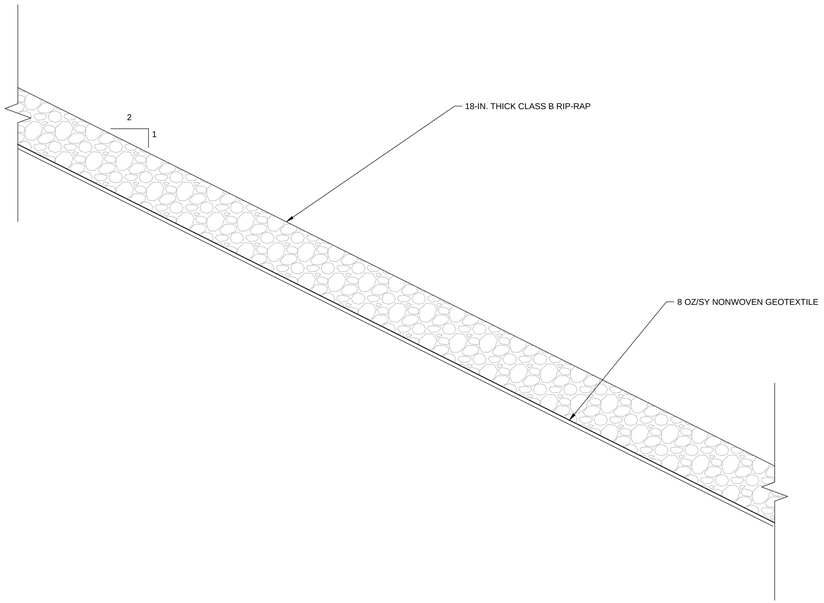
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL CONSTRUCTION PLAN APPLICATION

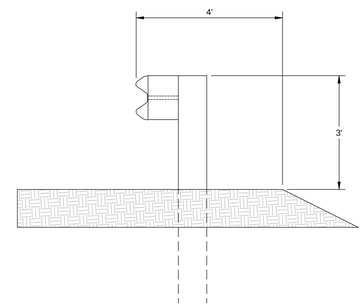
TITLE: GENERAL DETAILS 1

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. D-1.1

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:D-1.1 GENERAL DETAILS 1 August 26, 2015 10:02:42am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\D-1.1 GENERAL DETAILS.dwg



1 / D-1.2 RIPRAP SLOPE PROTECTION
SCALE: 1" = 2'



NOTES:
1. INSTALL GUARD RAIL IN ACCORDANCE WITH NCDOT SPECIFICATIONS.

2 / D-1.2 GUARD RAIL
SCALE: 1" = 2'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
- WASTE
- INTERIM SOIL COVER
- FINAL SOIL COVER
- VEGETATIVE SOIL COVER
- NCDOT 78M DRAINAGE AGGREGATE
- ASTM C-33 CONCRETE SAND
- RIPRAP
- CONCRETE
- COMPACTED ABC STONE
- GEOSYNTHETIC CLAY LINER (GCL)
- 60-MIL DOUBLE-SIDED TEXTURED HDPE GEOMEMBRANE
- GEOCOMPOSITE DRAINAGE LAYER
- GEOTEXTILE
- LINER SYSTEM
- PIPE (HIDDEN)
- PIPE (EXPOSED)

PRELIMINARY
NOT FOR CONSTRUCTION

NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUHL
AMEC LICENSE No. F-1253

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	ENG.	APPR.
0	26	08	2015	SUBMITTED FOR PERMIT REVIEW	CHR	KRD

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CLIENT:
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LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

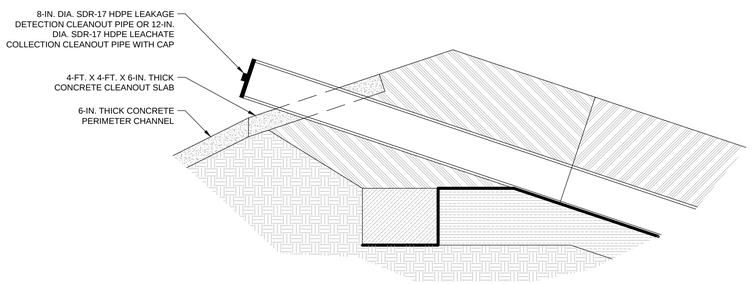
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

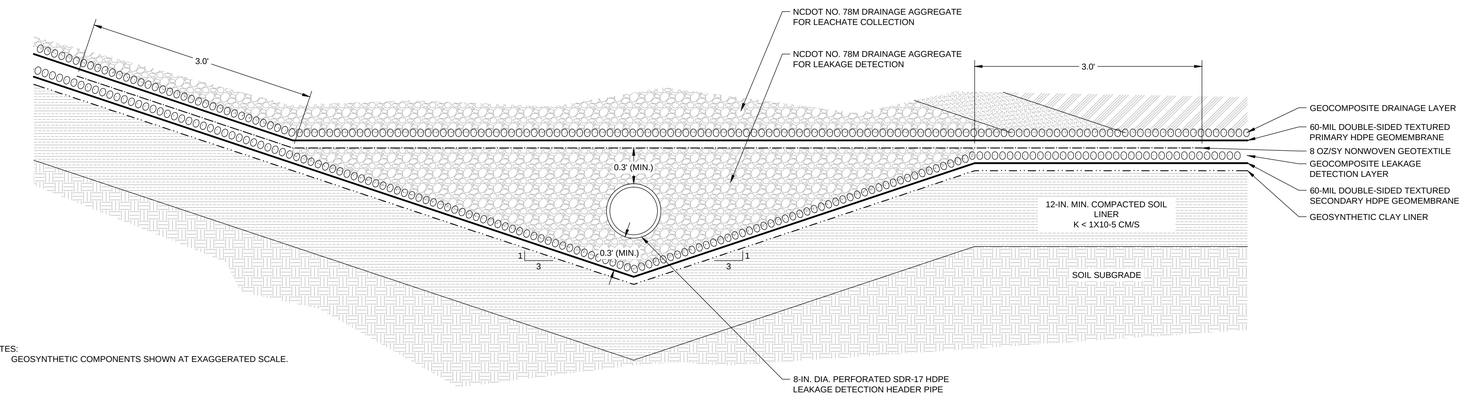
TITLE: GENERAL DETAILS 2

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. D-1.2

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:D-1.2 GENERAL DETAILS 2 August 26, 2015 10:03:09am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\D-1.2 GENERAL DETAILS 2.dwg

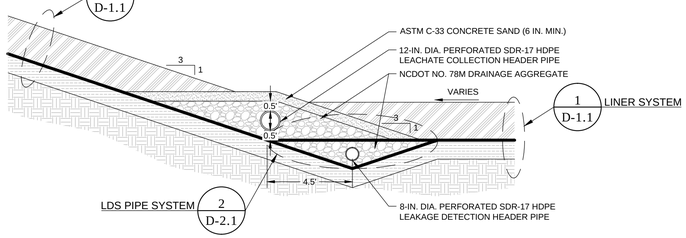


1 / D-2.1 LCS/LDS CLEANOUT
SCALE: 1" = 2'

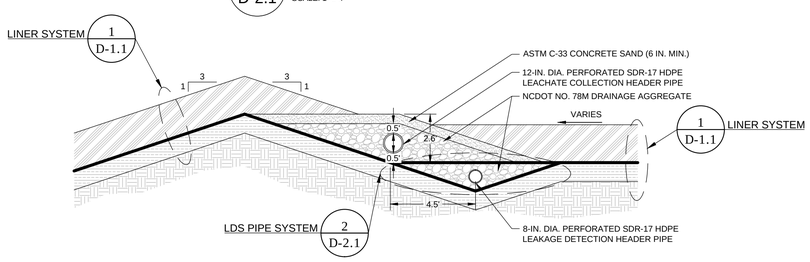


NOTES:
1. GEOSYNTHETIC COMPONENTS SHOWN AT EXAGGERATED SCALE.

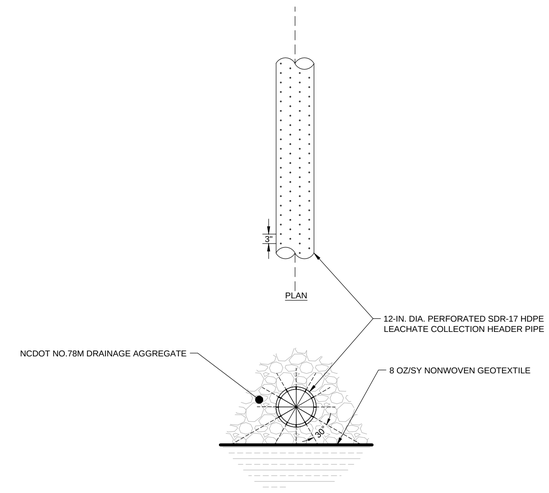
2 / D-2.1 LDS PIPE SYSTEM
SCALE: 1" = 1'



3 / D-2.1 LCS/LDS HEADER PIPE SYSTEM
SCALE: 1" = 4'



4 / D-2.1 LCS/LDS LATERAL PIPE SYSTEM
SCALE: 1" = 4'



5 / D-2.1 LCS & LDS PIPE PERFORATIONS
SCALE: 1" = 2'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
- WASTE
- INTERIM SOIL COVER
- FINAL SOIL COVER
- VEGETATIVE SOIL COVER
- NCDOT 78M DRAINAGE AGGREGATE
- ASTM C-33 CONCRETE SAND
- RIPRAP
- CONCRETE
- COMPACTED ABC STONE
- GEOSYNTHETIC CLAY LINER (GCL)
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- GEOCOMPOSITE DRAINAGE LAYER
- GEOTEXTILE
- LINER SYSTEM
- PIPE (HIDDEN)
- PIPE (EXPOSED)

PRELIMINARY
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NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER GERRID H. RUHL
AMEC LICENSE No. F-1253

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0	26	08	2015	SUBMITTED FOR PERMIT REVIEW	CHR	KRD

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TEL: (704) 357-8600 FAX: (704) 357-8638
LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

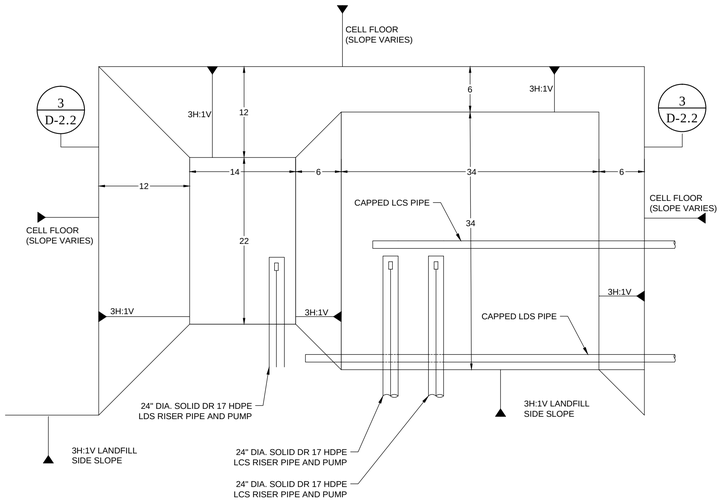
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL CONSTRUCTION PLAN APPLICATION

TITLE: LCRS DETAILS 1

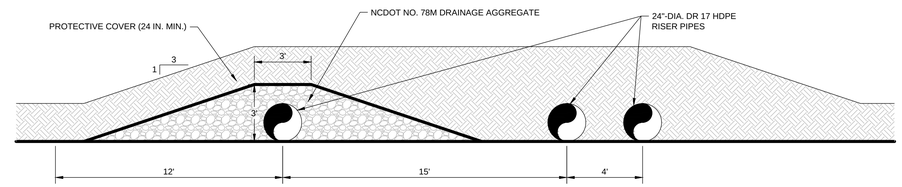
PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. D-2.1

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:D-2.1 LCRS DETAILS 1 August 26, 2015 10:03:39am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\D-2.1 LCRS DETAILS 1.dwg



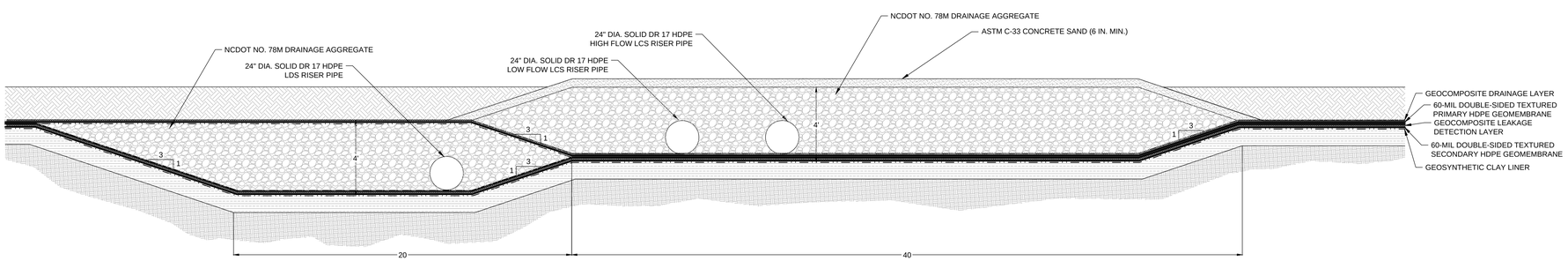
1 / D-2.2 TYPICAL LANDFILL SUMP

SCALE: 1" = 10'



2 / D-2.2 LANDFILL SUMP SECTION 1

SCALE: 1" = 4'



3 / D-2.2 LANDFILL SUMP SECTION 2

SCALE: 1" = 4'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
- WASTE
- INTERIM SOIL COVER
- FINAL SOIL COVER
- VEGETATIVE SOIL COVER
- NCDOT 78M DRAINAGE AGGREGATE
- ASTM C-33 CONCRETE SAND
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- GEOTEXTILE
- LINER SYSTEM
- PIPE (HIDDEN)
- PIPE (EXPOSED)

PRELIMINARY

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NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUHL

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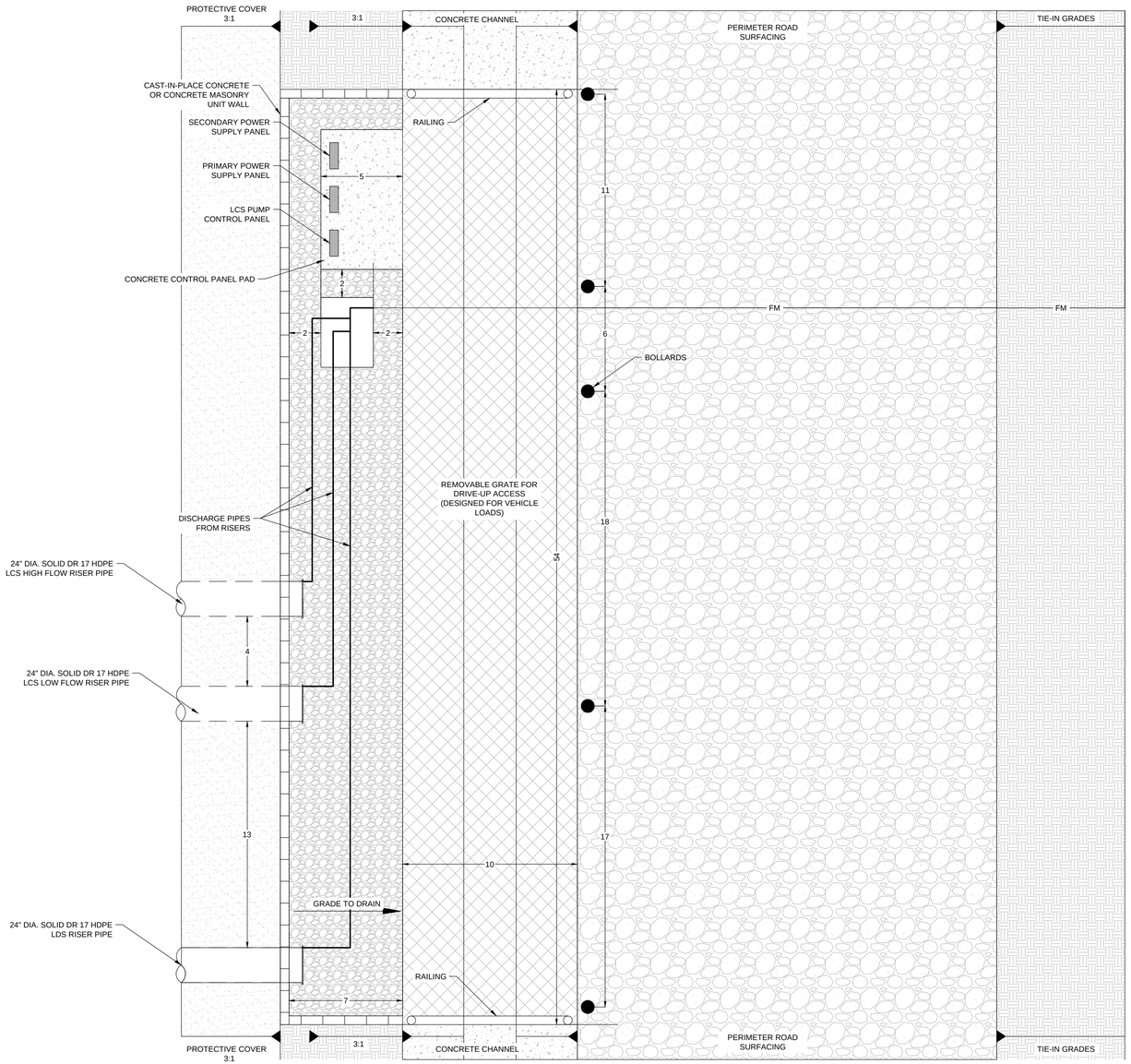
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: LCRS DETAILS 2

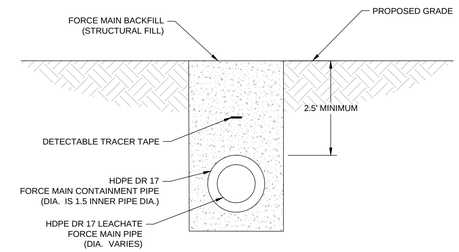
PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. D-2.2

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:D-2.2 LCRS DETAILS 2 August 26, 2015 10:04:07am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\D-2.2 LCRS DETAILS 2.dwg



1 / D-2.3 SUMP CONTROL PANEL PAD AREA

SCALE: 1" = 4'



2 / D-2.3 LEACHATE FORCE MAIN TRENCH

SCALE: 1" = 2'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
- WASTE
- INTERIM SOIL COVER
- FINAL SOIL COVER
- VEGETATIVE SOIL COVER
- NCDOT 78M DRAINAGE AGGREGATE
- ASTM C-33 CONCRETE SAND
- RIPRAP
- CONCRETE
- COMPACTED ABC STONE
- GEOSYNTHETIC CLAY LINER (GCL)
- 60-MIL DOUBLE-SIDED TEXTURED HDPE GEOMEMBRANE
- GEOCOMPOSITE DRAINAGE LAYER
- GEOTEXTILE
- LINER SYSTEM
- PIPE (HIDDEN)
- PIPE (EXPOSED)

PRELIMINARY

NOT FOR CONSTRUCTION

NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUHL

AMEC LICENSE No. F-1253

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EDEN, NORTH CAROLINA

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TEL: (704) 357-8600 FAX: (704) 357-8638
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amec foster wheeler

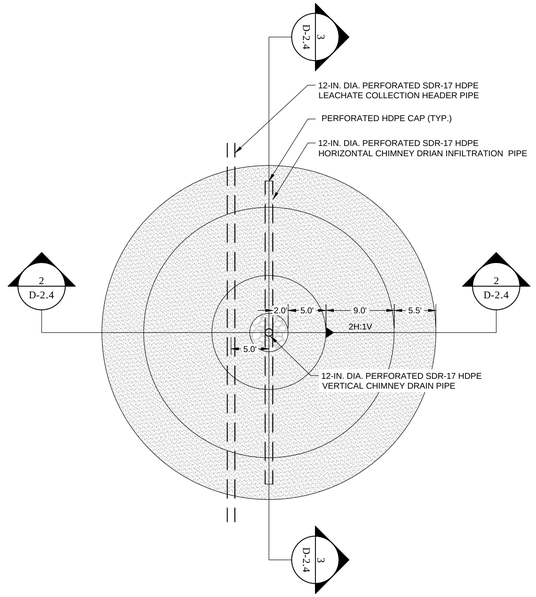
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

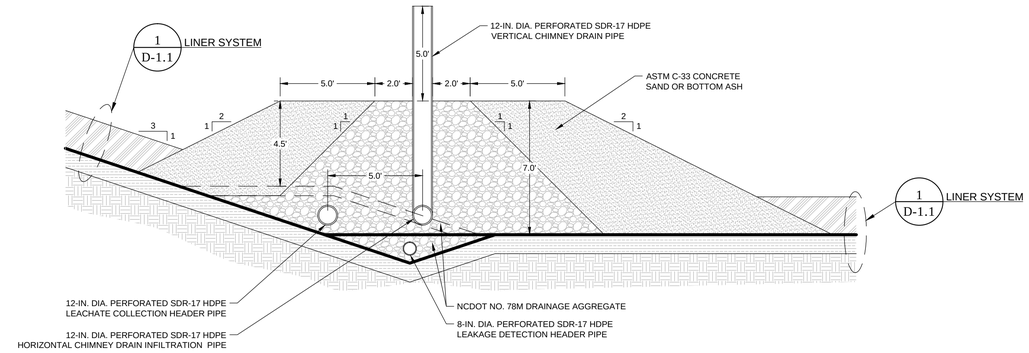
TITLE: LCRS DETAILS 3

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. D-2.3

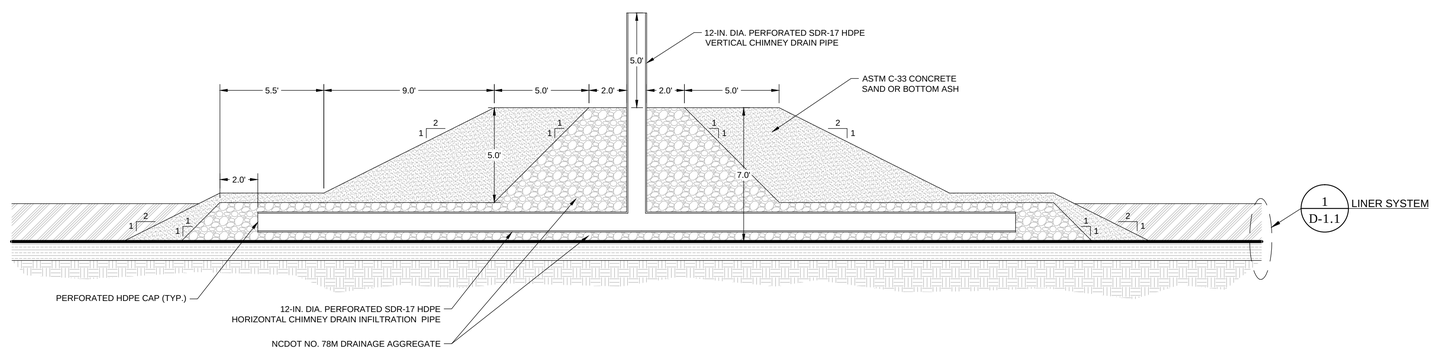
Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:D-2.3 LCRS DETAILS 3 August 26, 2015 10:04:34am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\D-2.3 LCRS DETAILS 3.dwg



1 / D-2.4 CHIMNEY DRAIN PLAN
SCALE: 1" = 10'



2 / D-2.4 CHIMNEY DRAIN SECTION 1
SCALE: 1" = 4'



3 / D-2.4 CHIMNEY DRAIN SECTION 2
SCALE: 1" = 4'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
- WASTE
- INTERIM SOIL COVER
- FINAL SOIL COVER
- VEGETATIVE SOIL COVER
- NCDOT 78M DRAINAGE AGGREGATE
- ASTM C-33 CONCRETE SAND
- RIPRAP
- CONCRETE
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- GEOTEXTILE
- LINER SYSTEM
- PIPE (HIDDEN)
- PIPE (EXPOSED)

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NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUHL
AMEC LICENSE No. F-1253

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LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

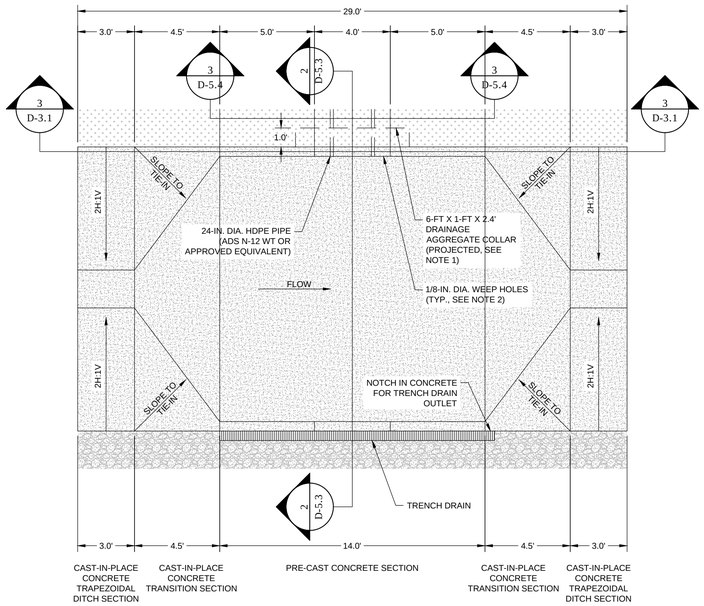
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: LCRS DETAILS 4

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. D-2.4

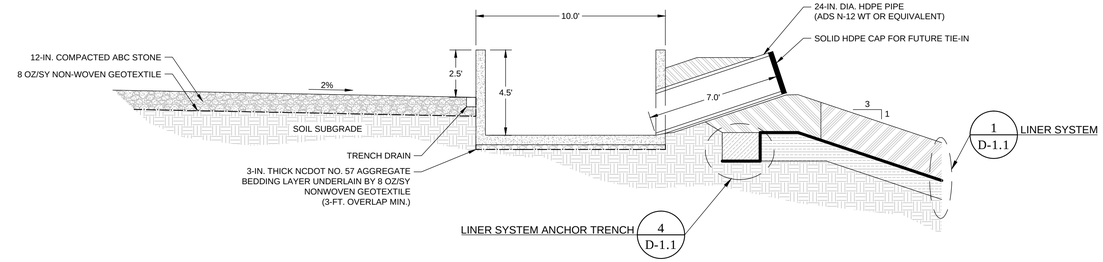
Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:D-2.4 LCRS DETAILS 4 August 26, 2015 10:05:04am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\D-2.4 LCRS DETAILS 4.dwg



NOTES:
1. INSTALL NCDOT NO. 78M DRAINAGE AGGREGATE COLLAR WITH 8 OZ/SY NONWOVEN GEOTEXTILE WRAP AT THE DOWNDRAIN TERMINATION BEHIND THE DOWNDRAIN OUTLET STRUCTURE. THE DRAINAGE AGGREGATE COLLAR SHALL BE 6 FEET WIDE, 1 FOOT DEEP, AND 1 PIPE DIAMETER IN HEIGHT. IT IS NOT NECESSARY TO PLACE GEOTEXTILE BETWEEN THE ASTM C-33 CONCRETE SAND AND THE DRAINAGE AGGREGATE.
2. INSTALL A MINIMUM OF 4 X 1/8 IN. DIA. WEEP HOLES WITH PLUGS WHEN CASTING THE DOWNDRAIN OUTLET STRUCTURE. THE PLUGS SHALL REMAIN IN PLACE UNTIL CONSTRUCTION OF THE AGGREGATE COLLAR DURING FINAL CLOSURE.

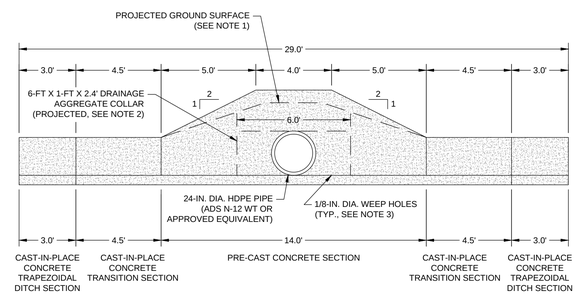
1 / D-3.1 DOWNDRAIN OUTLET

SCALE: 1" = 4'



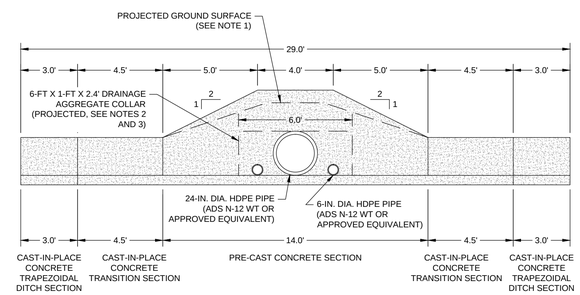
2 / D-3.1 DOWNDRAIN OUTLET SECTION 1

SCALE: 1" = 4'



NOTES:
1. PROJECTED GROUND SURFACE REFLECTS FINAL COVER SYSTEM CONDITION.
2. INSTALL NCDOT NO. 78M DRAINAGE AGGREGATE COLLAR WITH 8 OZ/SY NONWOVEN GEOTEXTILE WRAP AT THE DOWNDRAIN TERMINATION BEHIND THE DOWNDRAIN OUTLET STRUCTURE. THE DRAINAGE AGGREGATE COLLAR SHALL BE 6 FEET WIDE, 1 FOOT DEEP, AND 1 PIPE DIAMETER IN HEIGHT. IT IS NOT NECESSARY TO PLACE GEOTEXTILE BETWEEN THE ASTM C-33 CONCRETE SAND AND THE DRAINAGE AGGREGATE.
3. INSTALL A MINIMUM OF 4 X 1/8 IN. DIA. WEEP HOLES WITH PLUGS WHEN CASTING THE DOWNDRAIN OUTLET STRUCTURE. THE PLUGS SHALL REMAIN IN PLACE UNTIL CONSTRUCTION OF THE AGGREGATE COLLAR DURING FINAL CLOSURE.

OPTION 1 - TYPICAL COVER SYSTEM GEOCOMPOSITE OUTLET

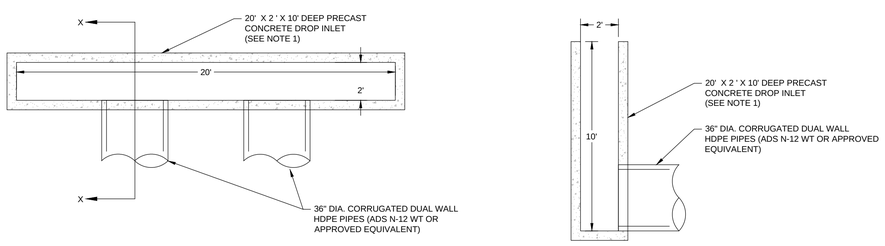


NOTES:
1. PROJECTED GROUND SURFACE REFLECTS FINAL COVER SYSTEM CONDITION.
2. INSTALL NCDOT NO. 78M DRAINAGE AGGREGATE COLLAR WITH 8 OZ/SY NONWOVEN GEOTEXTILE WRAP AT THE DOWNDRAIN TERMINATION BEHIND THE DOWNDRAIN OUTLET STRUCTURE. THE DRAINAGE AGGREGATE COLLAR SHALL BE 6 FEET WIDE, 1 FOOT DEEP, AND 1 PIPE DIAMETER IN HEIGHT. IT IS NOT NECESSARY TO PLACE GEOTEXTILE BETWEEN THE ASTM C-33 CONCRETE SAND AND THE DRAINAGE AGGREGATE.
3. INSTALL A MINIMUM OF 4 X 1/8 IN. DIA. WEEP HOLES WITH PLUGS WHEN CASTING THE DOWNDRAIN OUTLET STRUCTURE. THE PLUGS SHALL REMAIN IN PLACE UNTIL CONSTRUCTION OF THE AGGREGATE COLLAR DURING FINAL CLOSURE.

OPTION 2 - ALTERNATE COVER SYSTEM GEOCOMPOSITE OUTLET

3 / D-3.1 DOWNDRAIN OUTLET SECTION 2

SCALE: 1" = 4'



NOTES:
1. INSTALL PRECAST CONCRETE DROP INLET AND GRATES IN ACCORDANCE WITH NCDOT SPECIFICATIONS.
2. DROP INLET DIMENSIONS MAY BE OPTIMIZED FOR FIELD CONDITIONS.

4 / D-3.1 DROP INLET

SCALE: 1" = 4'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
- WASTE
- INTERIM SOIL COVER
- FINAL SOIL COVER
- VEGETATIVE SOIL COVER
- NCDOT 78M DRAINAGE AGGREGATE
- ASTM C-33 CONCRETE SAND
- RIPRAP
- CONCRETE
- COMPACTED ABC STONE
- GEOSYNTHETIC CLAY LINER (GCL)
- 60-MIL DOUBLE-SIDED TEXTURED HDPE GEOMEMBRANE
- GEOCOMPOSITE DRAINAGE LAYER
- GEOTEXTILE
- LINER SYSTEM
- PIPE (HIDDEN)
- PIPE (EXPOSED)

PRELIMINARY
NOT FOR CONSTRUCTION

NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUHL
AMEC LICENSE No. F-1253

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	ENG.	APPR.
0	26	08	2015	SUBMITTED FOR PERMIT REVIEW	CHR	KRD

CLIENT LOGO: DUKE ENERGY.

CLIENT: DUKE ENERGY CAROLINAS, LLC
EDEN, NORTH CAROLINA

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LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

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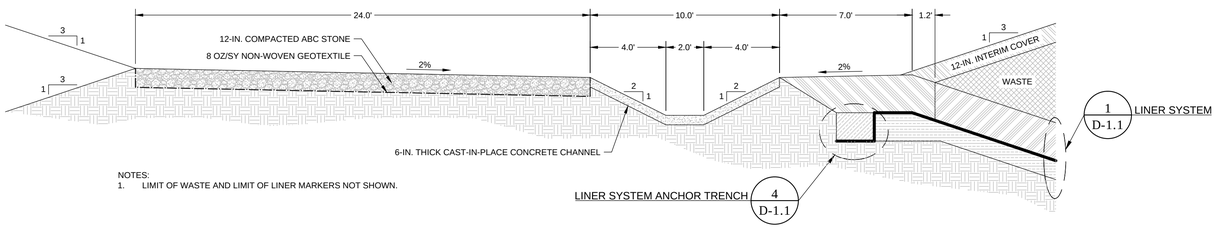
DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: STORMWATER DETAILS 1

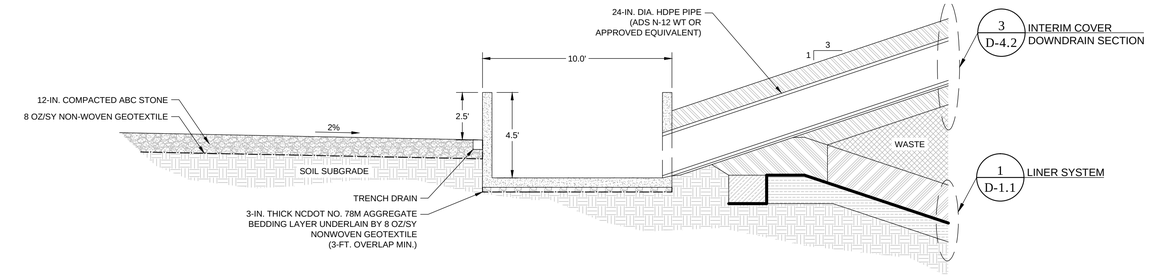
PROJECT NO.:	7810-14-0065
REVISION NO.	0
DATE:	8/26/2015
DRAWING NO.	D-3.1

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:D-3.1 STORMWATER DETAILS 1 August 26, 2015 10:05:36am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\D-3.1 STORMWATER DETAILS 1.dwg

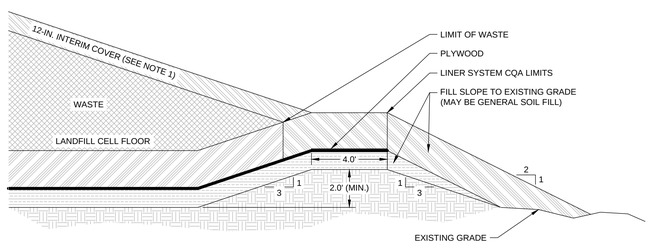


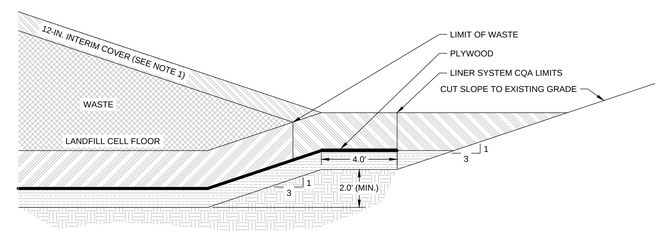
NOTES:
1. LIMIT OF WASTE AND LIMIT OF LINER MARKERS NOT SHOWN.

1 / D-4.1 LANDFILL PERIMETER BERM WITH INTERIM COVER
SCALE: 1" = 4'



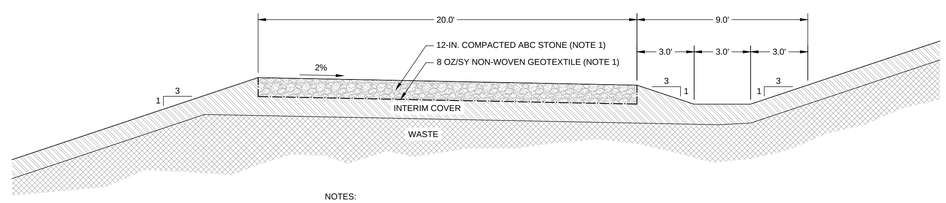
2 / D-4.1 DOWNDRAIN OUTLET SECTION WITH INTERIM COVER
SCALE: 1" = 4'





NOTES:
1. INTERIM COVER FOR INTERIOR SIDE SLOPES MAY NOT BE REQUIRED DEPENDING ON THE PHASING OF LANDFILL CONSTRUCTION AND OPERATIONS.

3 / D-4.1 INTERCELL BERM WITH INTERIM COVER
SCALE: 1" = 4'



NOTES:
1. TYPICAL ROAD SECTION MAY BE OPTIMIZED FOR ANTICIPATED TRAFFIC LOADING

4 / D-4.1 SLOPE ACCESS ROAD WITH INTERIM COVER
SCALE: 1" = 4'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
- WASTE
- INTERIM SOIL COVER
- FINAL SOIL COVER
- VEGETATIVE SOIL COVER
- NCDOT 78M DRAINAGE AGGREGATE
- ASTM C-33 CONCRETE SAND
- RIPRAP
- CONCRETE
- COMPACTED ABC STONE
- GEOSYNTHETIC CLAY LINER (GCL)
- 60-MIL DOUBLE-SIDED TEXTURED HDPE GEOMEMBRANE
- GEOCOMPOSITE DRAINAGE LAYER
- GEOTEXTILE
- LINER SYSTEM
- PIPE (HIDDEN)
- PIPE (EXPOSED)

PRELIMINARY
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NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. BUHL
AMEC LICENSE No. F-1253

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amec foster wheeler

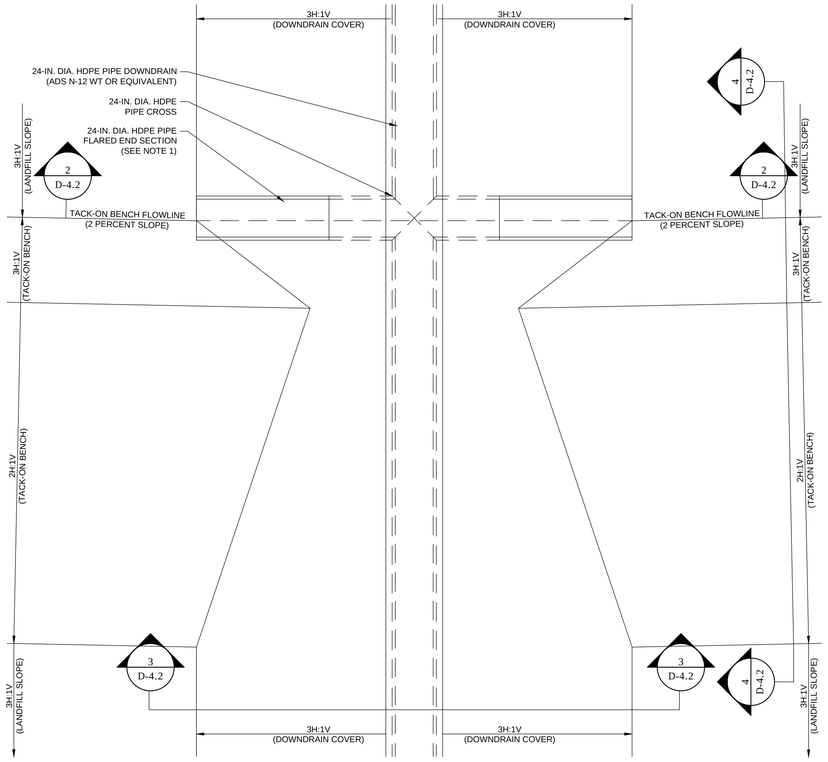
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: OPERATIONS DETAILS 1

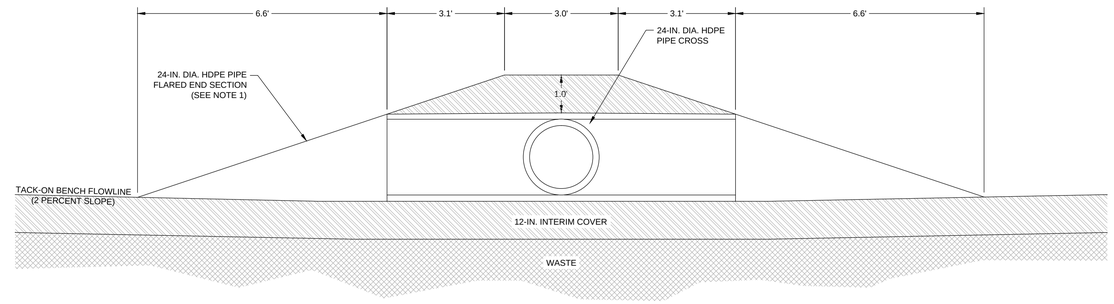
PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. D-4.1

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:D-4.1 OPERATIONS DETAILS 1 August 26, 2015 10:06:02am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\D-4.1 OPERATIONS DETAILS 1.dwg



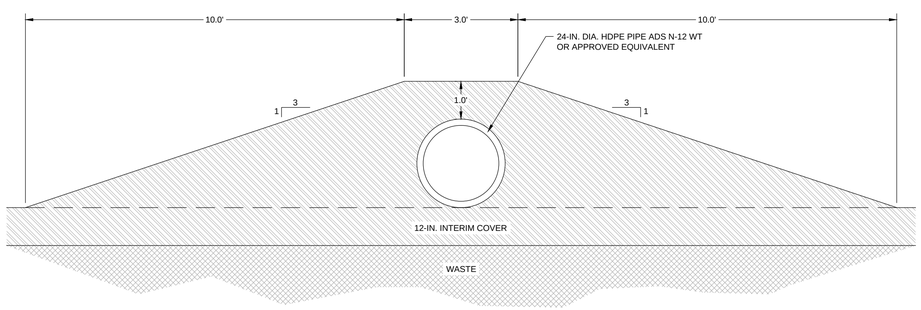
NOTES:
1. FIELD-FIT GRADES TO DRAIN TO FLARED END SECTION.

1 / D-4.2 INTERIM COVER TACK-ON BENCH TIE-IN TO DOWNDRAIN
SCALE: 1" = 4'



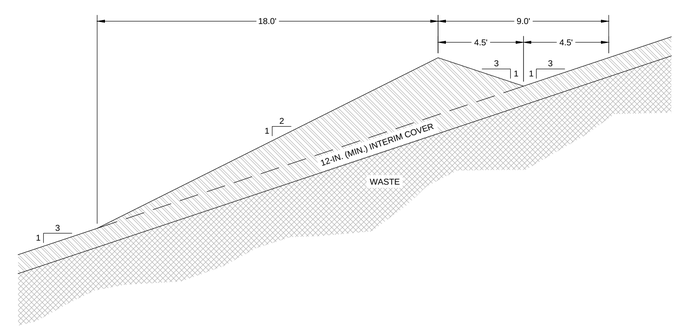
NOTES:
1. FIELD-FIT GRADES TO DRAIN TO FLARED END SECTION.

2 / D-4.2 INTERIM COVER TACK-ON BENCH TIE-IN TO DOWNDRAIN SECTION
SCALE: 1" = 2'



NOTES:
1. AT THE TIME OF FINAL CLOSURE, REMOVE EXISTING INTERIM COVER DOWNDRAINS FOR RE-USE. DOWNDRAINS SHALL BE ADS N-12 WT OR EQUIVALENT.

3 / D-4.2 INTERIM COVER DOWNDRAIN SECTION
SCALE: 1" = 2'



4 / D-4.2 INTERIM COVER TACK-ON BENCH SECTION
SCALE: 1" = 4'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
- WASTE
- INTERIM SOIL COVER
- FINAL SOIL COVER
- VEGETATIVE SOIL COVER
- NCDOT 78M DRAINAGE AGGREGATE
- ASTM C-33 CONCRETE SAND
- RIPRAP
- CONCRETE
- COMPACTED ABC STONE
- GEOSYNTHETIC CLAY LINER (GCL)
- 60-MIL DOUBLE-SIDED TEXTURED HDPE GEOMEMBRANE
- GEOCOMPOSITE DRAINAGE LAYER
- GEOTEXTILE
- LINER SYSTEM
- PIPE (HIDDEN)
- PIPE (EXPOSED)

PRELIMINARY
NOT FOR CONSTRUCTION

NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RIHL
AMEC LICENSE No. F-1253

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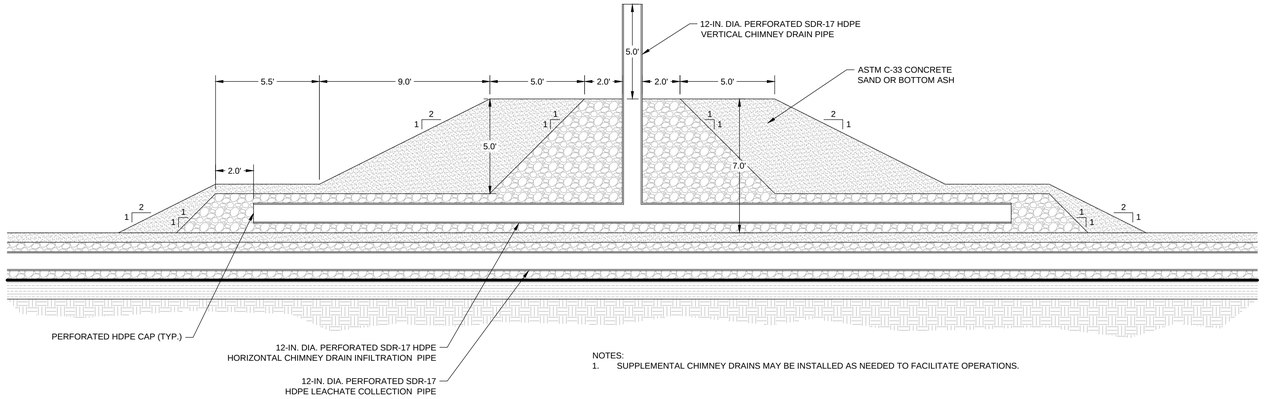
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: OPERATIONS DETAILS 2

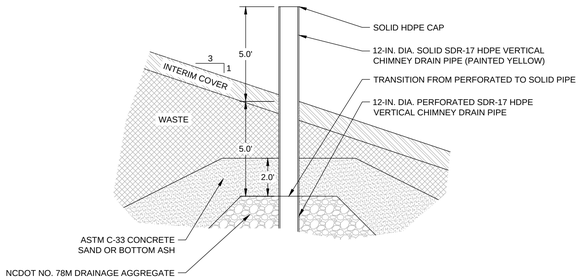
PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. D-4.2

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:D-4.2 OPERATIONS DETAILS 2 August 26, 2015 10:06:34am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\D-4.2 OPERATIONS DETAILS 2.dwg

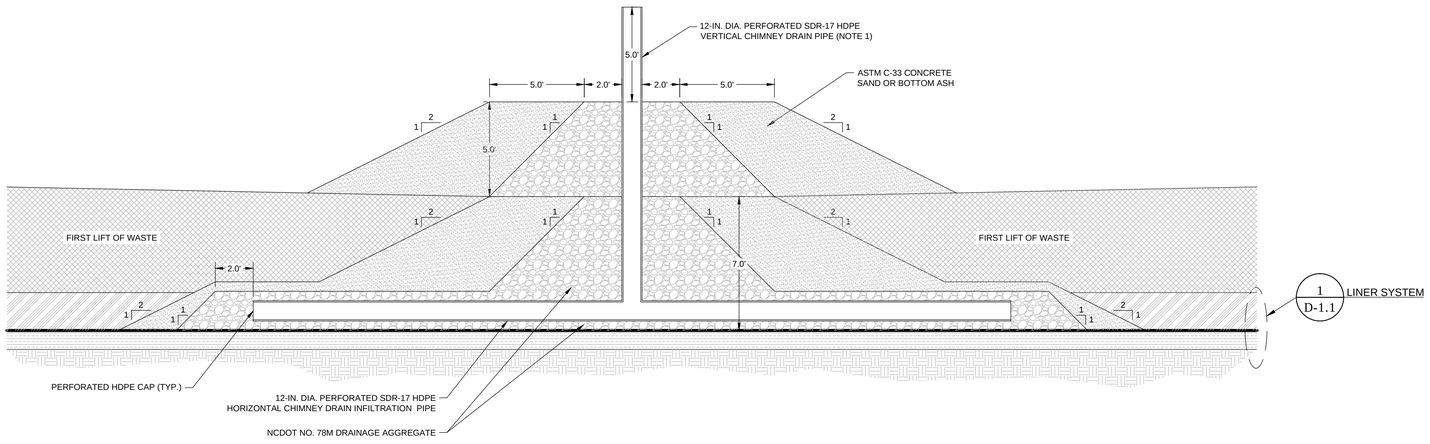


NOTES:
1. SUPPLEMENTAL CHIMNEY DRAINS MAY BE INSTALLED AS NEEDED TO FACILITATE OPERATIONS.

1 / D-4.3 SUPPLEMENTAL CHIMNEY DRAIN
SCALE: 1" = 4'



3 / D-4.3 CHIMNEY DRAIN INTERIM CLOSEOUT
SCALE: 1" = 4'



NOTES:
1. VERTICAL CHIMNEY DRAIN PIPE EXTENSIONS SHALL BE MECHANICALLY CONNECTED OR OTHERWISE SECURED TO THE EXISTING CHIMNEY DRAIN PIPE

2 / D-4.3 CHIMNEY DRAIN EXTENSION
SCALE: 1" = 4'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
- WASTE
- INTERIM SOIL COVER
- FINAL SOIL COVER
- VEGETATIVE SOIL COVER
- NCDOT 78M DRAINAGE AGGREGATE
- ASTM C-33 CONCRETE SAND
- RIPRAP
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- COMPACTED ABC STONE
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- GEOCOMPOSITE DRAINAGE LAYER
- GEOTEXTILE
- LINER SYSTEM
- PIPE (HIDDEN)
- PIPE (EXPOSED)

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NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUHL
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amec foster wheeler

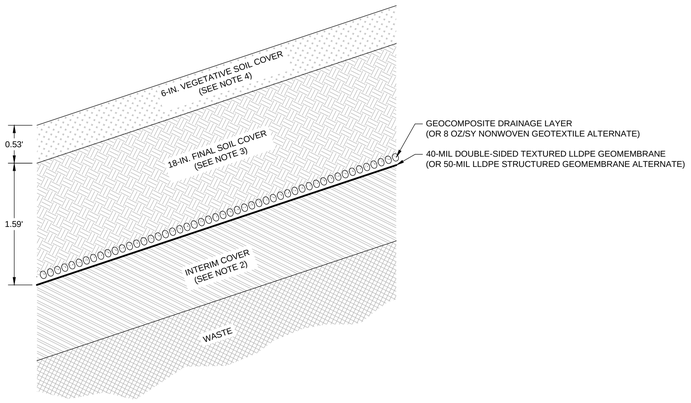
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: OPERATIONS DETAILS 3

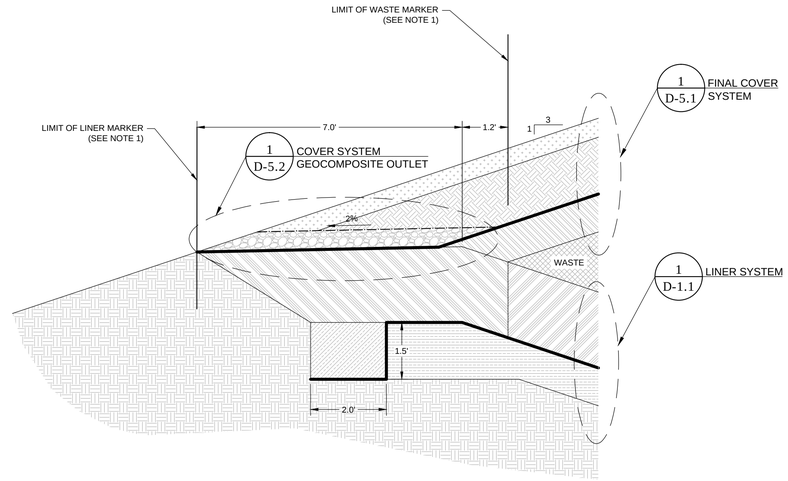
PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. D-4.3

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:D-4.3 OPERATIONS DETAILS 3 August 26, 2015 10:07:02am Q:\Duke\DanRiver\78101400 65_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\D-4.3 OPERATIONS DETAILS 3.dwg



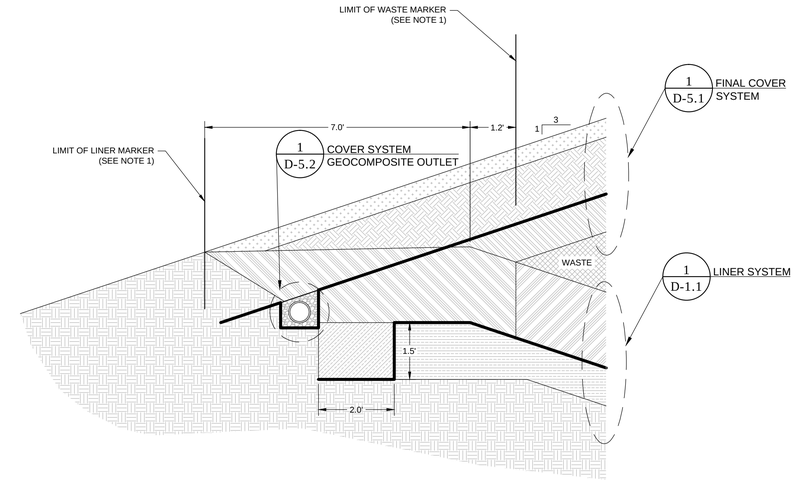
NOTES:
1. GEOSYNTHETIC COMPONENTS SHOWN AT EXAGGERATED SCALE.
2. THE THICKNESS OF THE INTERIM COVER SHALL BE AS NEEDED TO ACHIEVE GEOSYNTHETIC COVER SYSTEM SUBGRADE. INTERIM COVER AT THE TIME OF FINAL CLOSURE MAY CONSIST OF ASH.
3. THE THICKNESS OF FINAL SOIL COVER SHALL BE MEASURED FROM THE BOTTOM OF THE GEOMEMBRANE (LINER SYSTEM SUBGRADE) TO THE TOP OF THE FINAL SOIL COVER IN THE VERTICAL DIRECTION. ASSUMING A MAXIMUM SLOPE OF 3H:1V, THE CONVERSION FROM PERPENDICULAR THICKNESS TO VERTICAL THICKNESS IS A FACTOR OF 1.06.
4. THE THICKNESS OF VEGETATIVE SOIL COVER SHALL BE MEASURED FROM THE TOP OF THE FINAL SOIL COVER TO THE TOP OF THE VEGETATIVE SOIL COVER IN THE VERTICAL DIRECTION. ASSUMING A MAXIMUM SLOPE OF 3H:1V, THE CONVERSION FROM PERPENDICULAR THICKNESS TO VERTICAL THICKNESS IS A FACTOR OF 1.06.

1 / D-5.1 FINAL COVER SYSTEM
SCALE: 1" = 1'



NOTES:
1. REMOVE EXISTING MARKERS PRIOR TO INSTALLATION OF COVER SYSTEM FOR RE-USE. INSTALL MARKERS USING METHOD THAT WILL NOT DAMAGE LINER SYSTEM SUCH AS A HAND AUGER. SELECT MARKER LENGTH SUCH THAT VISIBLE PORTION ABOVE GROUND SHALL BE 3-FT. MINIMUM.

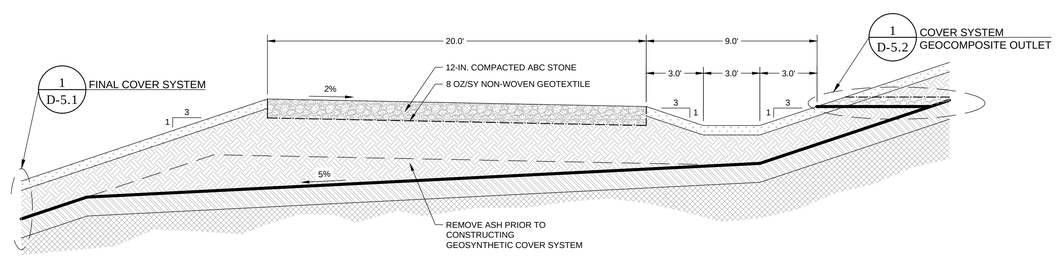
OPTION 1 - TYPICAL COVER SYSTEM GEOCOMPOSITE OUTLET



NOTES:
1. REMOVE EXISTING MARKERS PRIOR TO INSTALLATION OF COVER SYSTEM FOR RE-USE. INSTALL MARKERS USING METHOD THAT WILL NOT DAMAGE LINER SYSTEM SUCH AS A HAND AUGER. SELECT MARKER LENGTH SUCH THAT VISIBLE PORTION ABOVE GROUND SHALL BE 3-FT. MINIMUM.

OPTION 2 - ALTERNATE COVER SYSTEM GEOCOMPOSITE OUTLET

2 / D-5.1 FINAL COVER SYSTEM ANCHOR TRENCH
SCALE: 1" = 2'



3 / D-5.1 SLOPE ACCESS ROAD WITH FINAL COVER SYSTEM
SCALE: 1" = 4'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
- WASTE
- INTERIM SOIL COVER
- FINAL SOIL COVER
- VEGETATIVE SOIL COVER
- NCDOT 78M DRAINAGE AGGREGATE
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- RIPRAP
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- GEOCOMPOSITE DRAINAGE LAYER
- GEOTEXTILE
- LINER SYSTEM
- PIPE (HIDDEN)
- PIPE (EXPOSED)

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NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUHL
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amec foster wheeler

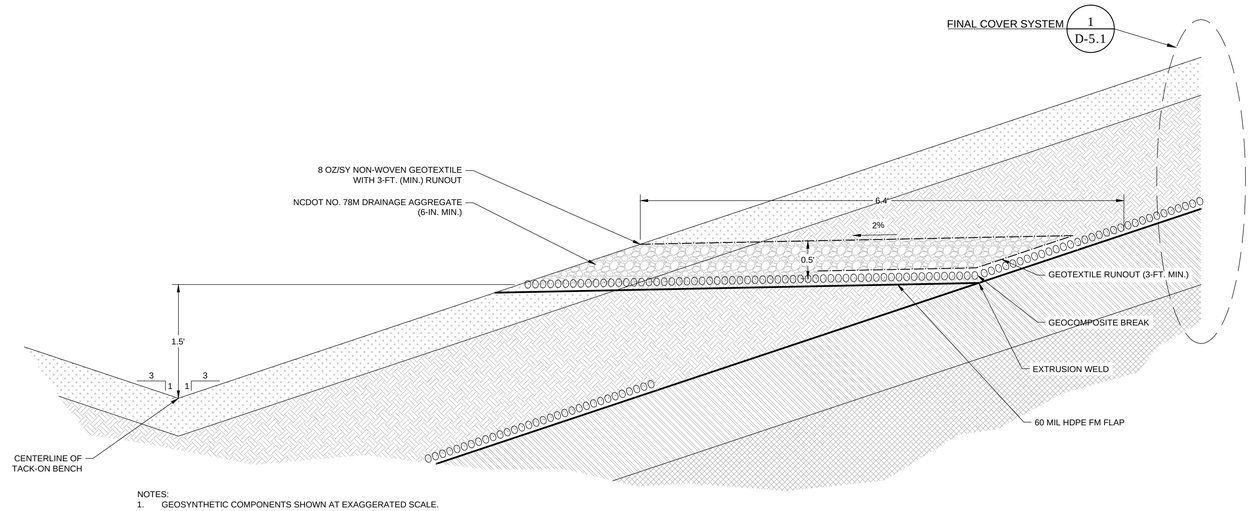
DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: CLOSURE DETAILS 1

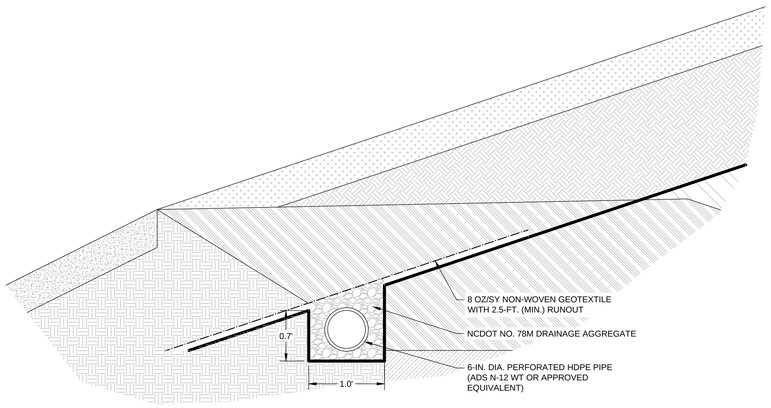
PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. D-5.1

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:D-5.1 CLOSURE DETAILS 1 August 26, 2015 10:07:33am Q:\Duke\DanRiver\7810140065_ARSAT Dan River Off Site LF\Plansheets\Landfill Design\D-5.1 CLOSURE DETAILS 1.dwg

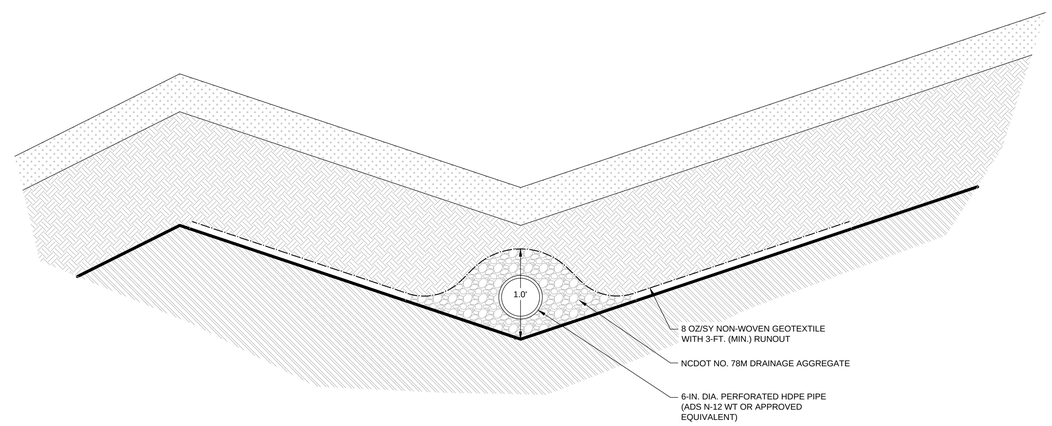


NOTES:
1. GEOSYNTHETIC COMPONENTS SHOWN AT EXAGGERATED SCALE.

OPTION 1 - TYPICAL COVER SYSTEM GEOCOMPOSITE OUTLET



OPTION 2 - ALTERNATE COVER SYSTEM GEOCOMPOSITE OUTLET
LANDFILL PERIMETER



OPTION 2 - ALTERNATE COVER SYSTEM GEOCOMPOSITE OUTLET
TACK-ON BENCH

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
- WASTE
- INTERIM SOIL COVER
- FINAL SOIL COVER
- VEGETATIVE SOIL COVER
- NCDOT 78M DRAINAGE AGGREGATE
- ASTM C-33 CONCRETE SAND
- RIPRAP
- CONCRETE
- COMPACTED ABC STONE
- GEOSYNTHETIC CLAY LINER (GCL)
- 60-MIL DOUBLE-SIDED TEXTURED HDPE GEOMEMBRANE
- GEOCOMPOSITE DRAINAGE LAYER
- GEOTEXTILE
- LINER SYSTEM
- PIPE (HIDDEN)
- PIPE (EXPOSED)

1 / D-5.2 COVER SYSTEM GEOCOMPOSITE OUTLET
SCALE: 1" = 1'

PRELIMINARY
NOT FOR CONSTRUCTION

NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUHL
AMEC LICENSE No. F-1253

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	ENG.	APPR.
0	26	08	2015	SUBMITTED FOR PERMIT REVIEW	CHR	KRD

CLIENT LOGO: DUKE ENERGY.

CLIENT:
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EDEN, NORTH CAROLINA

Amec Foster Wheeler Environment & Infrastructure, Inc.
2801 YORKMONT ROAD, SUITE 100
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TEL: (704) 357-8600 FAX: (704) 357-8638
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DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: CLOSURE DETAILS 2

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DRAWING NO. D-5.2

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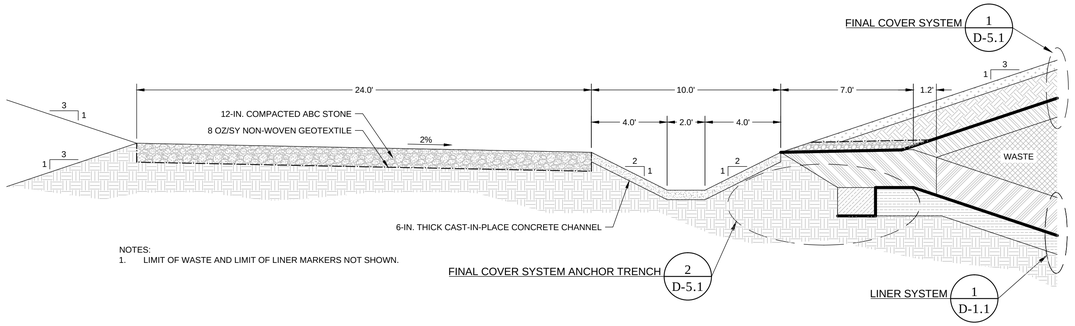
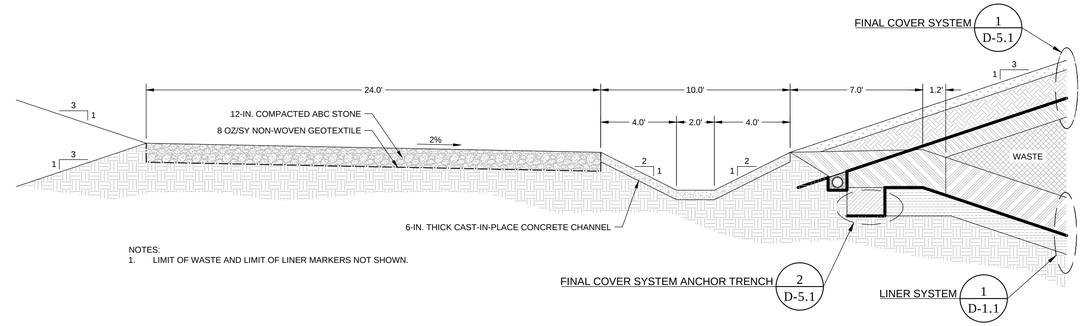


NOTES:
1. LIMIT OF WASTE AND LIMIT OF LINER MARKERS NOT SHOWN.

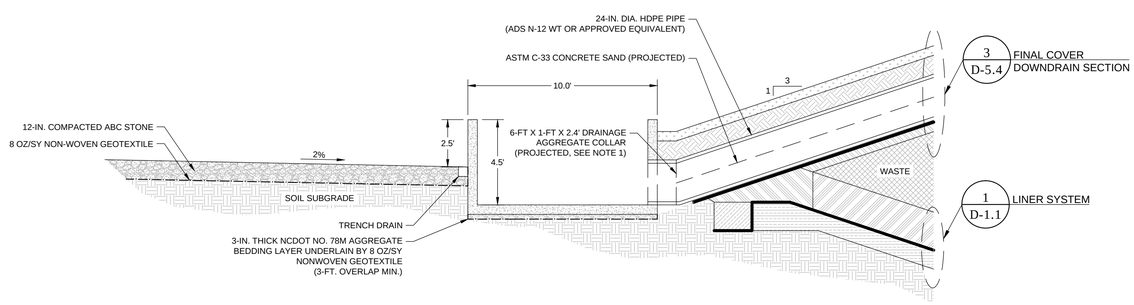
OPTION 1 - TYPICAL COVER SYSTEM GEOCOMPOSITE OUTLET



NOTES:
1. LIMIT OF WASTE AND LIMIT OF LINER MARKERS NOT SHOWN.

OPTION 2 - ALTERNATE COVER SYSTEM GEOCOMPOSITE OUTLET
LANDFILL PERIMETER

1 / D-5.3 PERIMETER WITH FINAL COVER SYSTEM
SCALE: 1" = 4'



NOTES:
1. INSTALL NCDOT NO. 78M DRAINAGE AGGREGATE COLLAR WITH 8 OZ/SY NONWOVEN GEOTEXTILE WRAP AT THE DOWNDRAIN TERMINATION BEHIND THE DOWNDRAIN OUTLET STRUCTURE. THE DRAINAGE AGGREGATE COLLAR SHALL BE 6 FEET WIDE, 1 FOOT DEEP, AND 1 PIPE DIAMETER IN HEIGHT. IT IS NOT NECESSARY TO PLACE GEOTEXTILE BETWEEN THE ASTM C-33 CONCRETE SAND AND THE DRAINAGE AGGREGATE.

2 / D-5.3 DOWNDRAIN OUTLET SECTION WITH FINAL COVER SYSTEM
SCALE: 1" = 4'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
- WASTE
- INTERIM SOIL COVER
- FINAL SOIL COVER
- VEGETATIVE SOIL COVER
- NCDOT 78M DRAINAGE AGGREGATE
- ASTM C-33 CONCRETE SAND
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- CONCRETE
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- GEOSYNTHETIC CLAY LINER (GCL)
- 60-MIL DOUBLE-SIDED TEXTURED HDPE GEOMEMBRANE
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DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: CLOSURE DETAILS 3

PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
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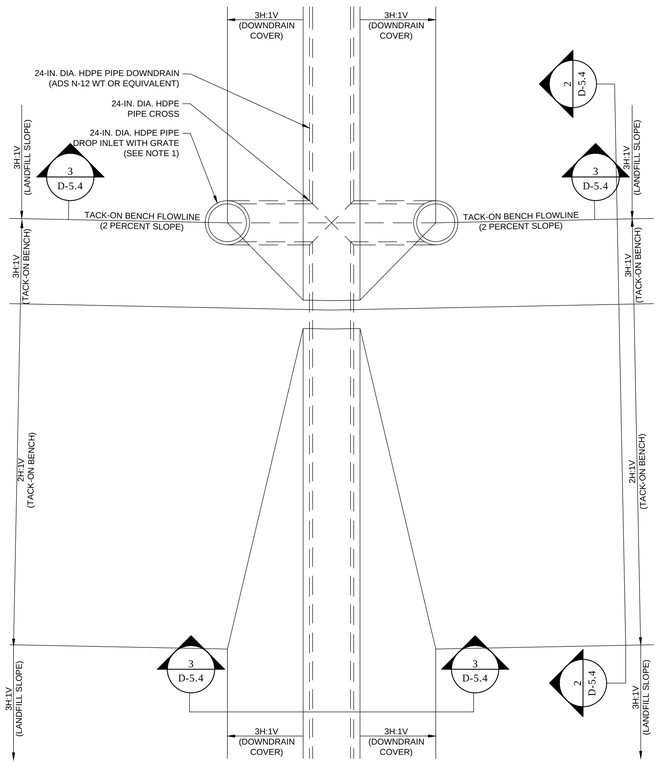
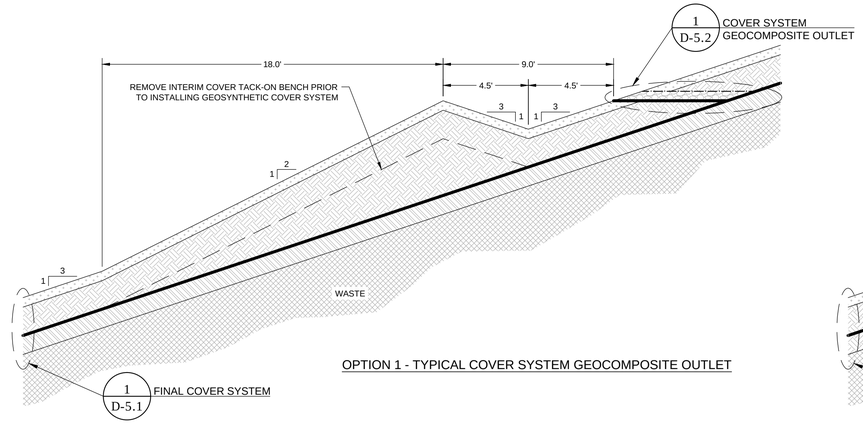
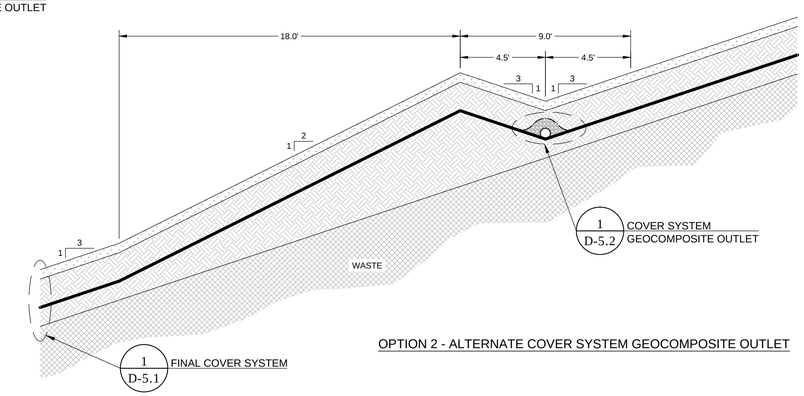


NOTES:
1. FIELD-FIT GRADES TO DRAIN TO GRATE.

1 D-5.4 FINAL COVER TACK-ON BENCH TIE-IN TO DOWNDRAIN
SCALE: 1" = 4'

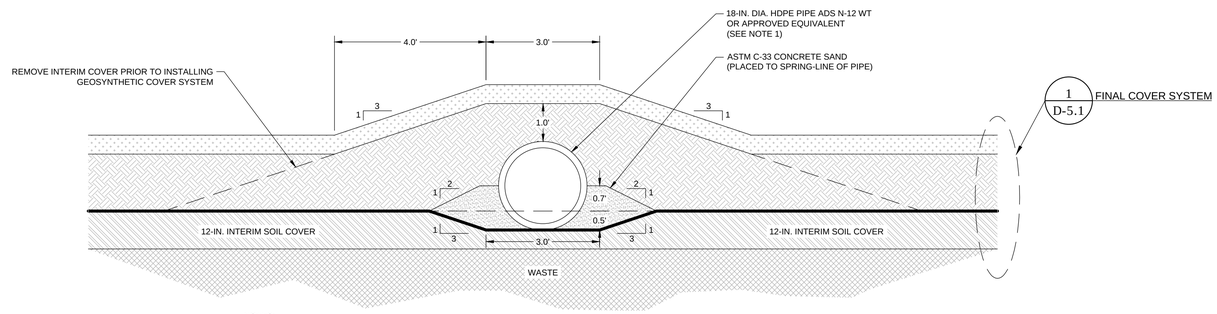


OPTION 1 - TYPICAL COVER SYSTEM GEOCOMPOSITE OUTLET



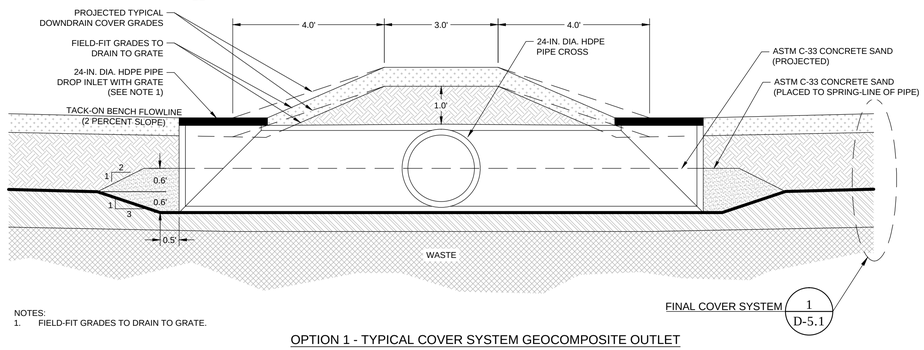
OPTION 2 - ALTERNATE COVER SYSTEM GEOCOMPOSITE OUTLET

2 D-5.4 FINAL COVER TACK-ON BENCH SECTION
SCALE: 1" = 4'



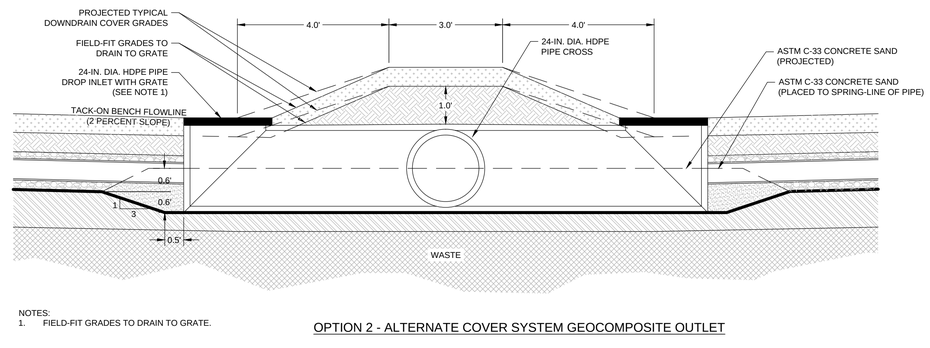
NOTES:
1. REMOVE EXISTING INTERIM COVER DOWNDRAINS FOR RE-USE DURING FINAL CLOSURE. DOWNDRAINS SHALL BE ADS N-12 WT OR EQUIVALENT.

3 D-5.4 FINAL COVER DOWNDRAIN SECTION
SCALE: 1" = 2'



NOTES:
1. FIELD-FIT GRADES TO DRAIN TO GRATE.

OPTION 1 - TYPICAL COVER SYSTEM GEOCOMPOSITE OUTLET



NOTES:
1. FIELD-FIT GRADES TO DRAIN TO GRATE.

OPTION 2 - ALTERNATE COVER SYSTEM GEOCOMPOSITE OUTLET

3 D-5.4 FINAL COVER TACK-ON BENCH TIE-IN TO DOWNDRAIN SECTION
SCALE: 1" = 2'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
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AMEC LICENSE No. F-1253

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DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CHR
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: CLOSURE DETAILS 4

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DATE: 8/26/2015
DRAWING NO. D-5.4

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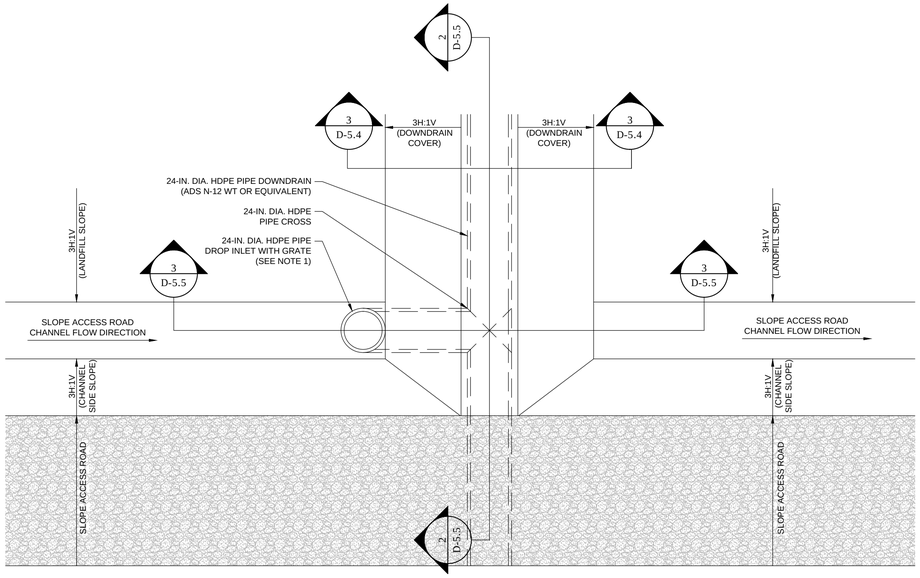
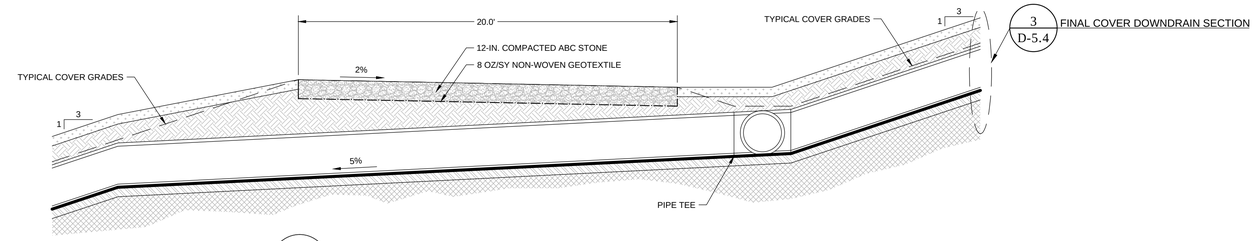


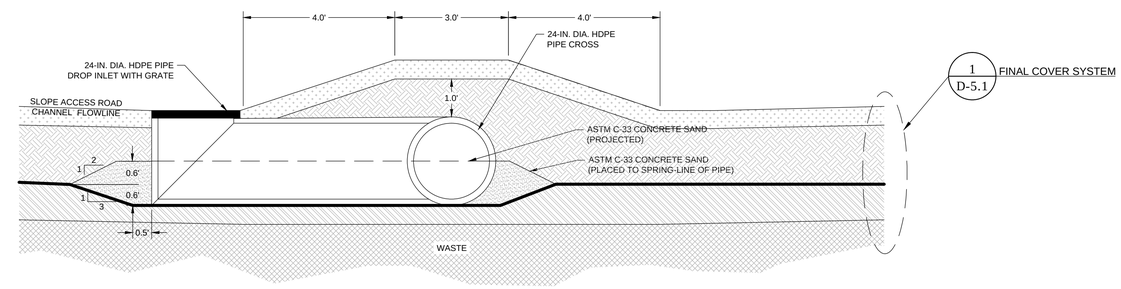
1 D-5.5 FINAL COVER SLOPE ACCESS ROAD TIE-IN TO DOWNDRAIN

SCALE: 1" = 4'



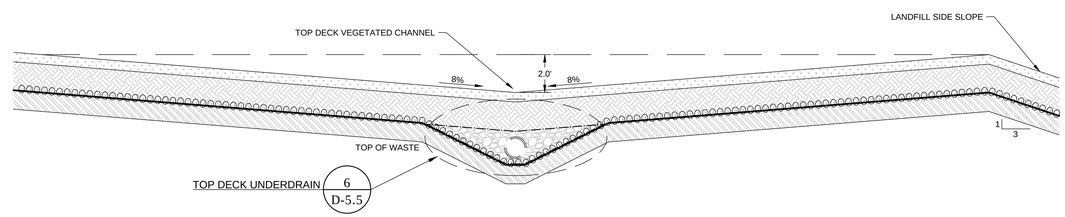
2 D-5.5 FINAL COVER SLOPE ACCESS ROAD TIE-IN TO DOWNDRAIN SECTION 1

SCALE: 1" = 4'



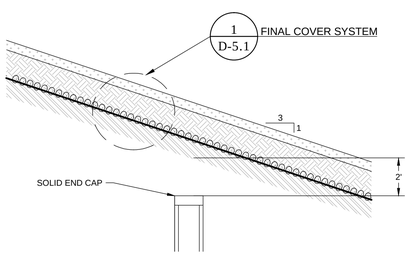
3 D-5.5 FINAL COVER SLOPE ACCESS ROAD TIE-IN TO DOWNDRAIN SECTION 2

SCALE: 1" = 2'



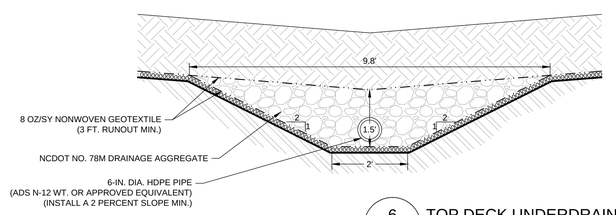
5 D-5.5 TOP DECK CHANNEL

SCALE: 1" = 4'



4 D-5.5 CHIMNEY DRAIN FINAL CLOSEOUT

SCALE: 1" = 4'



6 D-5.5 TOP DECK UNDERDRAIN

SCALE: 1" = 2'

DETAIL LEGEND

- SOIL SUBGRADE
- COMPACTED SOIL LINER
- RE-COMPACTED SOIL LINER (NO PERMEABILITY REQUIREMENT)
- PROTECTIVE COVER - CCR OR SOIL
- PROTECTIVE COVER - SOIL ONLY
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PRELIMINARY

NOT FOR CONSTRUCTION

NORTH CAROLINA PROFESSIONAL SEAL 036320 ENGINEER CEDRIC H. RUNK

AMEC LICENSE No. F-1253

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DRAWN BY:	CSJ
REVIEWED BY:	CHR
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL
CONSTRUCTION PLAN APPLICATION

TITLE: CLOSURE DETAILS 5

PROJECT NO.:	7810-14-0065
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DRAWING NO.	D-5.5

Plotted By:Jordan, Chris Sheet Set:DanRiver-Landfill Layout:D-5.5 CLOSURE DETAILS 5 August 26, 2015 10:09:44am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\Landfill Design\D-5.5 CLOSURE DETAILS 5.dwg

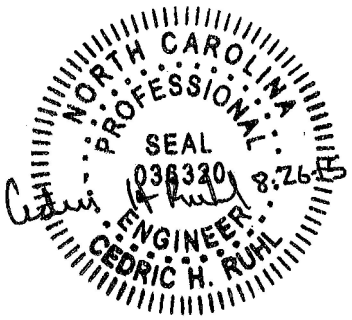
Operations Plan

Dan River Landfill

Duke Energy – Dan River Steam Station

Eden, North Carolina

Amec Foster Wheeler Project No. 7810140065



To:	Duke Energy Carolinas, LLC
Date	August 26, 2015
From:	Amec Foster Wheeler

DESCRIPTION OF REVISIONS

The following table provides a brief description of the revisions to the Operations Plan. The Operations Plan was originally submitted to the North Carolina Department of Environment and Natural Resources (NCDENR) on August 26, 2015 and modified as shown in the following table:

Revisions	***Date of Document***	***Description of Revisions***
Initial Issue	August 26, 2015	Initial issuance of document.

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1.3 Safety 1
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Appendix III	Closure and Post-Closure Plan

1 General Facility Operations

1.1 Overview

The purpose of this Operations Plan is to provide a plan for the safe and efficient operations of the Dan River Landfill at Duke Energy's Dan River Steam Station. This Operations Plan presents the operation requirements for: 1) General Facility Operations, 2) Operations Management, 3) Erosion and Sedimentation Control, and 4) Vegetation Management along with guidance for Landfill Closure and Required Regulatory Submittals. This Operations Plan was prepared consistent with 15A NCAC 13B .0505 Operational Requirements for Sanitary Landfill rules.

The Dan River Steam Station is located at 900 South Edgewood Road in Eden, Rockingham County, North Carolina. The proposed Dan River Landfill will be owned by Duke Energy Carolinas, LLC (Duke). The proposed landfill will be located largely within the footprint of existing Ash Fill 1 on the northeastern end of the property. The ash within Ash Fill 1 will be removed prior to construction of the proposed landfill. The proposed landfill will be bounded by existing overhead electrical lines to the west and north, rail lines to the east, and a natural gas pipeline to the south.

1.2 Contact Information

Correspondence and questions concerning the operation of the Dan River Landfill should be directed to the appropriate entity as follows:

Owner

Duke Energy Carolinas, LCC
Dan River Steam Station
900 South Edgewood Road
Eden, North Carolina 27288
(336) 635-3160
Facility Contact: Station Sponsor for Landfill Operations or Environmental Professional

State Regulatory Agency

North Carolina Department of Environment and Natural Resources
Division of Waste Management, Solid Waste Section
Asheville Regional Office
2090 US Highway 70
Swannanoa, North Carolina 28778
(828) 296-4500
Permitting Engineer: Mr. Larry Frost

1.3 Safety

The Dan River Landfill operations were developed with the consideration to the health and safety of the facility's operating staff. The operating staff will be provided with site-specific safety training prior to landfill operations, and on-site activities are to be conducted according to the applicable sections of Duke's Safe Work Practices.

1.4 Access and Security Requirements

The proposed Dan River Landfill is located entirely within Duke's property limits. Security for the site is currently in place, consisting of fencing, gates, wooded buffers and security check stations. Unauthorized vehicle access to the site is prevented around the landfill property by security check stations, woods, fencing, gates and stormwater conveyance features.

The access road to the site will be 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.

1.5 Operating Hours

The Dan River Landfill will be operated seven days a week, as needed.

1.6 Signs

A sign providing the landfill permit number and a statement reading, "NO HAZARDOUS OR LIQUID WASTE PERMITTED" will be posted at the site entrance, and shall be maintained in good condition.

Edge-of-waste markers will be installed and delineate the edge of waste. These markers shall be maintained in good condition and remain visible at all times.

1.7 Training

Due to the diversity and nature of job tasks required at the Dan River Landfill, personnel shall be adequately trained to handle facility operations and maintenance.

The Station Sponsor for Landfill Operations shall have a general understanding of all the tasks required for site operations. Individuals performing the various tasks shall have adequate training of the site-specific tasks they are assigned. Duke shall provide a site-specific training program for facility personnel.

Noteworthy operations and maintenance tasks to be addressed in training include:

- Maintaining accurate records of waste loading (quantitative and qualitative);
- Operating requirements for stormwater segregation from exposed waste areas; and
- Operating and maintaining the leachate collection system (LCS) and leakage detection system (LDS).

All training will be documented and training records will be kept on-site. The Station Sponsor for Landfill Operations will conduct Operations Plan training courses in accordance with the permit requirements.

1.8 Record Keeping

An operating record is to be maintained on-site and include the following records:

- Leachate Collection Systems (LCS) – Periodic Maintenance Documentation;
- Leak Detection System (LDS) Monitoring Information and Periodic Maintenance Documentation;
- Leachate Monitoring
- Erosion and Sedimentation Control Inspection Logs;
- Periodic Landfill Inspection Reports;
- Dust Control Plan Monitoring Worksheets (included in the Dust Control Plan);
- Groundwater Monitoring (and Sampling) Documentation; and
- Operations Plan.

The above records are to be kept in the operating record for the active life of the landfill and the post-closure care period. Information contained in the operating record must be furnished upon request to the North Carolina Department of Environment and Natural Resources Division of Waste Management, Solid Waste Section (Division) or be made available for inspection by the Division. Additional records kept on-site should include:

- Solid waste facility permits;
- Site Suitability Study;
- Permit to Construct Application;
- Landfill drawings and specifications;
- Record of the amount of solid waste received summarized on a monthly basis based on scale records;
- Vacuum truck waste logs;
- Regulatory agency inspection reports; and
- Employee training program and records.

1.9 Design Drawings

A list of landfill design drawings is provided in Table 1. The design drawings provide the location of landfill features, landfill construction details, and technical design and construction notes.

Table 1: Design Drawings

Drawing No.	Title	Drawing No.	Title
C-0.0	Cover Sheet	C-6.1	Landfill Closure Grades
C-1.1	Site Aerial	C-6.2	Landfill Closure Stormwater
C-1.2	Site Existing Conditions	C-7.1	Potential Stockpile Areas
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C-2.2	Ash Fill 1 Estimated Excavation Grades	C-8.2	Groundwater Surface Map
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C-3.4	Landfill Cell 1 Leak Detection System	D-2.1	LCRS Details 1
C-3.5	Landfill Cell 1 Leachate Collection System	D-2.2	LCRS Details 2
C-4.1	Landfill Cell 2 Compacted Soil Liner Subgrade	D-2.3	LCRS Details 3
C-4.2	LandfilL Cell 2 Geosynthetic Liner Subgrade	D-2.4	LCRS Details 4
C-4.3	Landfill Cell 2 Top of Protective Cover	D-3.1	Stormwater Details 1
C-4.4	Landfill Cell 2 Leak Detection System	D-4.1	Operations Details 1
C-4.5	Landfill Cell 2 Leachate Collection System	D-4.2	Operations Details 2
C-5.1	Landfill Cell 3 Compacted Soil Liner Subgrade	D-4.3	Operations Details 3
C-5.2	LandfilL Cell 3 Geosynthetic Liner Subgrade	D-5.1	Closure Details 1
C-5.3	Landfill Cell 3 Top of Protective Cover	D-5.2	Closure Details 2
C-5.4	Landfill Cell 3 Leak Detection System	D-5.3	Closure Details 3
C-5.5	Landfill Cell 3 Leachate Collection System	D-5.4	Closure Details 4
		D-5.5	Closure Details 5

2 Operations Management

The primary objective of operations management at the Dan River Landfill is to dispose of waste material in compliance with permit conditions while operating in a safe manner.

The Dan River Landfill will generally be operated from northwest to northeast to south as receipt of Permit to Operate for Landfill Cells 1, 2, and 3 are obtained in general accordance with the Landfill Sequencing Drawings in Appendix II. Waste will be placed in approximate 10-foot lifts. During operations, diversion berms and other features will be utilized to separate leachate from non-contact water.

The exterior side slopes of the landfill will be constructed to slopes of 3H:1V and will be periodically covered with approximately 12-inches of interim soil cover. Intermediate cover and dust control measures will be implemented as described in the Dust Control Plan. During operations, tack-on benches will be located along exterior side slopes at intervals of approximately 30 vertical feet (90 horizontal feet) to intercept surface water flows and decrease erosion potential. The tack-on benches will convey flow to downdrains which will consist of HDPE pipes installed perpendicular to the landfill side slope contours. The downdrains will convey flow to the concrete channel system located around the perimeter of the landfill and ultimately to the Dan River.

2.1 Waste Handling and Landfill Sequencing

2.1.1 Landfill Capacity

The proposed Dan River landfill will be constructed as one phase with three cells. The Dan River Landfill is anticipated to receive waste at a rate of approximately 10,000 cubic yards (cy) per day during closure of on-site coal combustion residual (CCR) units. Assuming an in-place dry density of CCR materials of 1 ton per cubic yard, the disposal rate is approximately 10,000 tons per day. The estimated capacity of the landfill is presented in the following table:

Table 2: Landfill Capacity

Phase	Cell	Area (ac)	Estimated Airspace Volume (cy)	Dry Density of CCR (tons/cy)	Estimated Disposal Rate (tons/day)	Estimated Lifetime (days)	Estimated Lifetime[1] (years)
1	1	5.1	170,153	1.0	10,000	17	0.07
	2	7.4	512,902	1.0	10,000	51	0.20
	3	10.8	1,444,042	1.0	10,000	144	0.56
	TOTALS	23.3	2,127,097	---	---	213	0.82

Notes:
1. Lifetime in years assumes operations occur 5 days per week.

The actual quantity of material disposed in the landfill may vary pending CCR unit closure requirements. Upon closure of the existing CCR units, the landfill may remain active for the benefit of Duke until the entire landfill waste capacity is realized.

2.1.2 Waste Acceptance, Disposal, and Screening Requirements

The Dan River Landfill is permitted for the acceptance of the following on-site waste types:

- Coal combustion residuals (CCRs) (including fly and bottom ash, pyrites, and coal mill rejects) generated at Duke facilities;
- Wastewater treatment sludge generated at Dan River Steam Station;
- Vacuum truck waste generated at Dan River Steam Station;
- Waste soils (i.e. from ash removal activities or soil that has contacted petroleum); and
- Small quantities of inert debris from CCR unit decommissioning activities.

The Dan River Landfill will not be open for public disposal.

The landfill owner or operator shall notify the Division within 24 hours of attempted disposal of any wastes the landfill is not permitted to receive.

At a minimum, hazardous waste, yard trash, liquid wastes, regulated medical waste, sharps not properly packaged, polychlorinated diphenyl (PCB) waste as defined in 40 Code of general regulations (CFR) 761, and wastes banned from disposal in North Carolina by General Statute 130A-309.10(f), must not be accepted at the landfill.

Asbestos waste will not be disposed of in the landfill.

The removal of waste from the landfill is prohibited without owner or operator approval. Waste will be hauled and disposed of by dedicated and consistent operators from the waste source to the landfill. Access to the interim waste storage location(s) (i.e. existing ash basins and ash fills), haul routes and landfill are restricted; therefore, no screening of waste is recommended.

2.1.3 Dust, Litter, Odor, and Vector Control

Litter, odors, and vectors are not anticipated to be concerns at the Dan River Landfill. The waste placed in the landfill does not attract vectors, and windblown material is not anticipated to be a problem. Odors are typically not a problem at CCR waste landfills.

Dust control is addressed in the Dust Control Plan included as Appendix I. Generally, dust control measures will be implemented when necessary, and will include at a minimum, watering of dusty roads and exposed work areas. Other measures include physical measures such as fencing and/or berms, temporary covers (like tarps), spraying dust suppressants, and modifying the active work area. Leachate may be used as a dust suppressant in areas that drain to the leachate collection system (i.e. active face of the landfill) in accordance with the Dust Control Plan. Additionally, interim cover will be vegetated as soon as practical in order to minimize the blowing of dust on-site.

2.1.4 Fire Control

No open burning shall be permitted at the Dan River Landfill. There are no explosive gas concerns with ash waste, waste soils, and inert debris from CCR unit decommissioning activities; therefore, the threat of fire is considered to be minimal.

Although it is unlikely, if a fire occurs at the landfill, the Station Control Room (phone number: 336-635-3160) shall be notified, and equipment and stockpiled soil shall be provided to control accidental fires. Dan River Steam Station will notify the local fire department, which will be immediately dispatched to assist with fire control. Any fire that occurs at the landfill shall be reported to the Division within 24 hours, and a written notification will be submitted within 15 days by the Station Sponsor for Landfill Operations.

2.1.5 Landfill Sequencing

The Dan River Landfill will be constructed as one phase with three cells as shown in the Landfill Sequencing Drawings in Appendix II. The landfill sequencing drawings illustrate possible sequences of landfill operations. The actual filling sequence, fill heights, and grades may be modified at the Owner's discretion.

2.1.6 Waste Placement

2.1.6.1 Bottom Ash and Fly Ash Material

Bottom ash and fly ash material at the Dan River Station is transported from the interim waste storage areas to the landfill by using on-road or off-road dump trucks. Upon reaching the active face of the landfill, the waste is dumped from the dump trucks onto the active face of the landfill. After the waste is dumped, the dump trucks exit the landfill and return to the interim waste storage areas. The interim waste storage areas, haul roads, and landfill are located within the secured Dan River Steam Station facility.

No truck washes are proposed at this time because the haul paths and ash units drain to the existing ash basin. Upon completion of disposal of on-site CCR materials, the haul roads will be remediated by removing the top several inches of road material or as necessary and disposing in a lined facility permitted to receive CCR materials.

The landfill surface shall be graded to promote surface water drainage to the leachate collection system (i.e. chimney drains). No waste shall be placed in standing water.

2.1.6.2 Wastewater Sludge, Pyrites, and Coal Mill Rejects

Wastewater sludge, pyrites, and coal mill rejects will be spread in 6-inch lifts in the center of the operational area and shall not be placed within 25 feet of the exterior slopes. Wastewater sludge shall be blended with the other waste (i.e. ash) prior to placement of the next fill lift. Wastewater sludge, pyrites, and coal mill rejects shall be compacted as densely as practical and specific monitoring. In-place density testing of these materials is not required.

2.1.6.3 Vacuum Truck Waste

Vacuum trucks are used to remove waste materials from the plant areas that consist of various permitted CCRs. The origin of the vacuum truck waste materials is typically from various sumps, catch basins, wheel wash stations, and coal pile sumps located within the plant.

The moisture contents of the vacuum truck waste materials may vary considerably with the waste varying in consistency from a relatively dry state to a wet, fluid-like state depending on the amount of liquid present in the sumps or vacuumed areas.

CCR material transported via vacuum truck will occur in a vacuum truck dedicated to Duke Energy operations or documentation will be obtained to ensure that the vacuum truck contains no human or other non-permitted waste streams. Vacuum truck waste could also mean similar waste material transported in smaller water tight units.

Vacuum truck waste shall consist of permitted waste materials. Non-permitted waste materials inadvertently included with the vacuum truck waste including but not limited to yard trash (paper, plastic, wood, aluminum, Styrofoam, etc.) shall be visually screened and immediately removed from the vacuum truck waste after the waste material is dumped in the operational area by vacuum contractor.

The consistency of the vacuum truck waste may vary from a relatively dry state to a relatively wet, fluid-like state. Vacuum truck waste material shall be moisture conditioned by initial decanting excess moisture from the waste or by mixing the waste with fly ash, bottom ash, or gypsum materials depending on its consistency. The vacuum truck waste shall be placed and spread in maximum 6-inch lifts near the center of the operational area. The vacuum truck waste shall not be placed within 50 feet horizontally from exterior landfill slopes or within 50 feet of chimney drain structure locations. The vacuum truck waste material shall be thoroughly mixed with fly ash, bottom ash, or gypsum material during waste placement using a dozer or other similar grading equipment to provide additional moisture conditioning prior to compaction. In-place density testing of the vacuum truck waste materials is not required.

The vacuum contractor shall coordinate vacuum truck waste placement with landfill operator personnel and the vacuum truck waste disposal will be documented.

Dust control measures shall be provided for the vacuum truck waste in accordance with the Dust Control Plan outlined in Appendix I.

2.1.7 Compaction Requirements and Testing

After the waste is dumped from the trucks and placed on the active face, the waste will be placed in consecutive, approximate 1-foot thick lifts that do not exceed a 10-foot operational lift. Prior to compaction of an existing lift, the existing and new material should be adequately blended.

2.1.7.1 In-Place Density and Moisture Content Testing

In-place density and moisture content testing shall be performed at a minimum frequency of one test per 8,000 cubic yards (or one test per 216,000 square feet per 12-inch thick lift). Waste shall be compacted to a minimum 95 percent of its Standard Proctor (ASTM D698) maximum dry density. Compacted moisture content shall be within 5 percent of the material's optimum moisture content as determined by ASTM D698.

In-place density tests shall be performed using the Sand Cone Method (ASTM D1556), Drive-Cylinder Method (ASTM D2937), or Nuclear Method (ASTM D6938). If the nuclear method is selected, a minimum

of one comparison density test using the Sand Cone or Drive Cylinder method shall be performed for every five nuclear density tests, and correlations between the test methods shall be developed and reviewed by the Engineer. A sample of ash material shall be collected from each density test location and placed in a sealed container for subsequent field and laboratory moisture testing.

A family of Proctor curves shall be developed for the on-site ash material as standard Proctor moisture-density tests are performed as a reference for the field density testing. A minimum of one (1) one-point field Proctor test shall be performed for every five field density tests. Additional one-point field Proctors shall be performed if the dry density between successive density tests varies by more than 2 pounds per cubic foot (pcf). If the estimated standard Proctor maximum dry density based on the results of one-point Proctor testing indicates that the maximum dry density varies by more than 5 pcf from the nearest representative standard Proctor moisture-density relationship, an additional bulk sample of ash material shall be obtained and standard Proctor testing shall be performed for the sample as a reference for the field density testing.

Field moisture content testing shall be performed for each density test using the Direct Heating Method (ASTM D4959). The Nuclear Method (ASTM D6938) shall not be used for moisture content testing on the ash material. Comparison laboratory moisture content testing shall be performed using the Oven Method (ASTM D2216), at an oven temperature of 60 degrees Celsius. The laboratory moisture content shall control in the event of a discrepancy between laboratory moisture content and in-place moisture content.

2.1.7.2 Laboratory Testing

Laboratory moisture content testing shall be performed in conjunction with the field density testing as described above. The laboratory moisture content testing shall be performed using the Oven Method (ASTM D2216), at an oven temperature of 60 degrees Celsius.

Standard Proctor moisture-density relationship (ASTM D698) testing shall be performed at a minimum frequency of one test for every 50,000 cubic yards of material placed. As previously mentioned, additional standard Proctor samples shall be obtained and tested if one-point Proctor testing indicates that the estimated maximum dry density of the material varies by more than 5 pcf from the nearest representative standard Proctor moisture-density relationship.

2.1.8 Cover Requirements

2.1.8.1 Operational Cover

Operational cover should be applied, as needed, for dust control and stormwater management. If needed, operational cover should be applied at a thickness suited for its purpose. For example, operational cover may be applied thinner to provide dust control and it may be applied thicker to tolerate erosion. Operational covers to provide dust control shall be as described in the Dust Control Plan in Appendix I.

Downdrains, tack-on benches, and chimney drains will be installed and extended as appropriate. Soil Diversion berms will be used to direct water as appropriate.

Waste will be covered with interim and final cover as applicable, in accordance with the following sections in this plan. Operational cover consisting of soil is not required, provided the Dust Control Plan included as Appendix I is followed.

2.1.8.2 Interim Cover

An interim cover layer shall be placed at a thickness of approximately 1-foot on exterior slopes and areas where final waste grades have been reached. For areas where waste placement will be inactive for 12 months or more, interim soil cover is not required, provided the Dust Control Plan included as Appendix I is followed.

2.1.8.3 Final Cover

The final cover system for the Dan River Landfill will be completed within 180 days following the beginning of closure activities unless otherwise approved by the Division.

The proposed cover system will consist of the following components, from top to bottom:

- 6-inch thick vegetative soil cover;
- 18-inch thick final cover soil;
- Geocomposite drainage layer (or 8 oz/sy non-woven geotextile alternate); and
- 40-mil thick double-sided textured linear low density polyethylene (LLDPE) geomembrane (or 50-mil LLDPE structured geomembrane alternate);
- Interim cover.

The soil components will provide a surface suitable to sustain vegetative growth while protecting the underlying geosynthetic components of the cover system. Infiltration through the cover soils will be collected by the geocomposite drainage layer, while the geomembrane will function as a hydraulic barrier to reduce infiltration into the waste mass. Interim cover shall be as needed to achieve geosynthetic cover system subgrade. The interim cover at the time of final closure may consist of ash. The cover system stormwater management structures will collect both infiltration and surface water runoff. The final cover will be vegetated with grasses within six months following closure.

Refer to the Closure and Post-Closure Plan in Appendix III for final cover specifications and maintenance and operations requirements.

2.2 Leachate and Stormwater Management

As previously described, the landfill has been designed to provide separation of leachate from stormwater. Leachate includes water that has percolated through the waste as well as surface water flows from the active face of the landfill that are intercepted by chimney drains. The leachate collection system and leak detection system consists of a geocomposite drainage layer and pipe network to convey leachate to sumps located in each landfill cell. Leachate will be pumped from the landfill sumps to a leachate tank storage facility and ultimately to the City of Eden publically owned treatment works (POTW) for treatment or alternative leachate treatment approach as approved by the Division.

Stormwater runoff from the proposed landfill will be conveyed to the perimeter channel network via a series of tack-on benches and downdrains.

No truck washes are proposed at this time. Transport of existing on-site CCR materials to the Dan River Landfill will occur on Dan River Station property and within areas that currently drain to the existing Primary and Secondary Ash Basins. Loading and unloading of CCR material will be conducted using methods to prevent excessive spillage and tracking of CCR material during transport. Upon completion of hauling on-site CCR materials, haul road surfaces will be remediated as necessary to protect the environment.

2.3 Leachate Collection System (LCS)

The leachate collection system has been designed to meet the performance criteria of providing less than 1 foot of leachate head on the liner system under normal operating conditions and conveying leachate generated by the 25-year, 24-hour storm event. The leachate collection system generally consists of the following components:

- Leachate collection system pipes within the landfill;
- Sumps at the low points of each cell of the landfill; and
- Force main and appurtenant structures (pumps, valves, etc.).

Each landfill cell is equipped with leachate collection system (LCS) pipes located directly above the geocomposite drainage layer that collect infiltration and chimney drain flows. The LCS pipes convey leachate flows by gravity to collection sumps for removal. Clean-outs have been provided at the ends of the leachate header pipes in the event that the leachate collection and removal pipes become clogged.

Chimney drains have been installed in each cell and shall be extended vertically along with the placement of each lift. Each chimney drain comprises a vertical, perforated HDPE riser pipe surrounded by filter aggregate. At the base of the chimney drains, the riser pipe connects to a distribution pipe which conveys the flow from the riser pipe into the LCS, via infiltration through a constructed layer of drainage material. During operations, chimney drains may be modified with pipe fittings to allow the chimney drain pipe to drain leachate from the active face.

Sumps are located at the low point of the landfill cells. From the sumps, leachate is conveyed to the leachate force main via side slope risers and pumps and ultimately to the City of Eden POTW or alternative leachate treatment approach as approved by the Division.

The LCS sump shall be equipped with a dedicated pump system. The LCS pump system contains one low-flow pump and one high-flow pump. The pump system shall operate automatically based on level switches with a low level cutoff and high level run-start activations. Additionally, a high level alarm shall be in place which will also have a high level activation. The LCS system control panels will be equipped with visual and audible alarms programmed to activate at the programmed sump liquid level. The alarms will be equipped with a test function.

It is anticipated that leachate generated at the Dan River Landfill will ultimately discharge to the City of Eden POTW for treatment or alternative leachate treatment approach as approved by the Division. Modifications to the permit documents will be submitted with the Permit to Operate application.

2.3.1 LCS Maintenance

The maintenance of the leachate management system's physical facilities (consisting of high-density polyethylene (HDPE) piping) and records will be performed by or under the direct supervision of Duke. Visual observations of the LCS system performance will be made monthly by Duke staff to verify that the LCS is performing properly.

Clean-out pipes will be located on the LCS leachate lateral and header pipes. LCS pipes will be cleaned out by the use of a clean-out snake or high-pressure water flushing at least once a year, and the LCS piping will be remote-camera monitored at least once every 5 years. The frequency of clean-out and camera inspections may be modified based on consecutive inspection results and observed operating conditions.

2.3.2 LCS Record Keeping and Sampling

Records will be maintained documenting the leachate line cleanout and camera monitoring. Untreated leachate shall be sampled and analyzed at least semi-annually concurrently with the groundwater water sampling as discussed in the approved Water Quality Monitoring Plan.

2.3.3 Leak Detection System (LDS)

A leak detection system (LDS) has been incorporated into the design of the landfill. The LDS consists of a secondary 60 mil HDPE liner system overlain by a secondary geocomposite drainage layer connected to an LDS sump. Flow collected in the sump will be transferred to the active ash basin via the leachate force main.

The LDS sump shall be equipped with a dedicated pump system. The LDS pump system contains one low-flow pump. The LDS pump system shall operate automatically based on level switches with a low level cutoff and a high level run-start activation. Additionally, a high level alarm shall be in place which will also have a high level activation. The LDS system control panels will be equipped with visual and

audible alarms programmed to identify sump liquid levels. The alarms will be equipped with a test function.

The LDS has been designed with an Initial Response Leakage Rate (IRLR) of 300 gallons per acre per day and an Action Leakage Rate (ALR) of 500 gallons per acre per day. Should fluid collected in the LDS exceed the IRLR or ALR based on routine flow meter readings, the owner or operator shall take steps as indicated in the facility's leachate Response Action Plan presented in Section 2.3.6.

The management of the leak detection system's physical facilities (consisting of piping and flow meters) and monitoring records will be performed by or under the direct supervision of Duke.

2.3.4 Leak Detection System Maintenance

The maintenance of the leachate management system's physical facilities (consisting of high-density polyethylene (HDPE) piping, sumps, and pumps) and records will be performed by or under the direct supervision of Duke. Visual observations of the LDS system performance will be made monthly by Duke staff to verify that the LDS is performing properly.

Clean-out pipes are located on the LDS leachate lateral and header pipes. LDS pipes will be cleaned out by the use of a clean-out snake or high-pressure water flushing at least once a year, and the LDS piping will be remote-camera monitored at least once every 5 years. The frequency of clean-out and camera inspections may be modified based on consecutive inspection results and observed operating conditions.

2.3.5 Record Keeping and Monitoring

Flow will be measured at the discharge of the LDS sump by a totalizing flow meter. The facility shall maintain records of monthly flow rate data from the LDS sump from the activation of the cell drainage system and until the waste height reaches approximately 40 feet. From that point, flow rate data shall be collected on a quarterly basis until landfill closure.

During the post-closure care period, semi-annual monitoring is required. If the liquid level in the sump stays below the pump high level run-start (no pump flow) for more than 1 year, then flow rates can be recorded annually. However, if at any time during post-closure care the pump high level run-start level is exceeded on the semi-annual or annual schedules, the facility must return to monthly monitoring, until such time as the liquid level remains below the pump high-level run start activation level for two consecutive months.

The purpose of LDS monitoring is to monitor if the leakage rates have been exceeded. Specific leakage rates are identified in Section 2.3.6. To determine if exceedances of the leakage rates have occurred, the facility must convert monitored data to an average daily flow rate for the cell (in gallons per acre per day, gpad). For example, the average daily flow rate in gpad is equal to the total monthly flow rate divided by the number of days in the month, divided by the area of the cell in acres.

Table 3: Cell Area

Cell	Area (ac)
1	5.1
2	7.4
3	10.8

If a leakage rate is exceeded, then the Division must be notified as set forth in the Response Action Plan presented in Section 2.3.6.

2.3.6 Response Action Plan

The purpose of the Response Action Plan is to describe the necessary course of action in the event the Initial Response Leakage Rate (IRLR) and/or the Action Leakage Rate (ALR) are exceeded. If the IRLR

is exceeded, steps 1 through 4 will be followed. Should the ALR also be exceeded steps 1 through 6 will be followed. The IRLR and ALR are referenced collectively as "leakage rates" in the following Response Action Plan steps.

The IRLR is 300 gallons per acre per day.

The ALR is 500 gallons per acre per day.

The estimated monthly volume of leakage triggering an IRLR or ALR response is provided in the following table:

Table 4: Leakage Rate Monitoring

		Initial Response Leakage Rate (IRLR)		Action Leakage Rate (ALR)	
Cell	Area (ac)	Initial Response Leakage Rate {IRLR} (gpad)	Monthly Volume[1] (gal)	Action Leakage Rate {ALR} (gpad)	Monthly Volume[1] (gal)
1	5.1	300	45,900	500	76,500
2	7.4	300	66,600	500	111,000
3	10.8	300	97,200	500	162,000

Notes:
1. Assumes a 30-day month

If the monthly volumes exceed those for the IRLR and the ALR listed in the table above, the response action steps will include:

1. (IRLR and ALR) - Review physical equipment (pump and flow meter) function and data to confirm flow readings. Review operations to evaluate where operating equipment may have contacted the landfill liner or how landfill operations may have influenced the exceedance.

   If the exceedance is confirmed, the cell LDS flow shall be recorded daily. Should the daily monitored LDS flow exceed the IRLR or ALR after the initial exceedance, operational responses may include: the reduction of active face area; grading to provide improved drainage; and/or, the addition of interim soil cover.

2. (IRLR and ALR) - Within 14 days of identifying that a leakage rate has been exceeded, the facility shall contact the Division in writing. Daily LDS flow recording shall continue. Should none of the daily measured LDS flow rates exceed the leakage rate within 14 days of initial identification of the exceedance, monthly LDS flow averaging shall resume.

3. (IRLR and ALR) - Within 30 days of identifying that a leakage rate has been exceeded, the facility shall submit to the Division a written preliminary assessment which shall include at a minimum:

   - the amount of the liquid exceedance including initial measurement and daily measurements, if necessary, to date;
   - likely sources of the liquids;
   - the possible leak location;
   - the possible leak size;
   - the probable cause of the leak; and
   - an outline of the short-term actions being taken and planned.

4. (IRLR and ALR) - To the extent practicable, evaluate the location, size and cause of the leak; and assess the potential for leakage escaping into the environment and its mobility. Leachate quality

shall be sampled, including a chemical analysis of LDS fluids, to evaluate potential hazards (pH and RCRA metals).

5. (ALR only) - When the ALR is exceeded, establish whether or not the unit should be closed or receipt of waste should be curtailed; and conclude whether waste should be removed from the unit for inspection, engineered controls, or repair of the liner and drainage system. Evaluate and prepare to implement what other short-term or long-term measures shall be taken to mitigate or stop any leaks according to the stage (early operations, middle operations, or closed) of landfill development.

6. (ALR only) - Within 60 days of identifying that the ALR has been exceeded, submit to the Division the results of the evaluation performed in Step 4, any actions taken according to Step 5, and any further measures planned. For as long as there is an exceedance of the action leakage rate, the owner or operator shall submit monthly reports to the Division summarizing the results of the remedial actions taken and further actions planned.

2.4 Stormwater Collection and Conveyance

Stormwater that does not come in contact with waste will be treated as non-contact water. Non-contact water will be managed separately from leachate and may be used for dust control or other operational purposes. The stormwater collection system has been designed to pass the 50-year, 24-hour storm event, and generally consists of the following components:

- Tack-on benches;
- Downdrains; and
- Perimeter ditches.

Interim cover will be placed over waste at the exterior side slopes. Tack-on benches will be placed to convey non-contact surface water from the exterior side slopes to downdrains. The tack-on benches and downdrains will be constructed and extended as operations progress. The downdrains discharge to perimeter ditches, which in turn ultimately discharge to the Dan River via a system of culverts and channels.

2.4.1 Stormwater Discharge

The stormwater system at the landfill was designed to assist in prevention of the discharge of pollutants. Landfill operation shall not cause a discharge of pollutants into waters of the United States, including wetlands, that violates any requirement of the Clean Water Act, including but not limited to NPDES requirements, pursuant of Section 402. In addition, under the requirements of Section 404 of the Clean Water Act, the discharge of dredge or fill material into waters of the state would be a violation of the requirements and shall not be allowed by landfill operations.

Operations of the landfill shall not cause the discharge of a non-point source of pollution to waters of the United States, including wetlands, that violates any requirements of an area-wide or statewide water quality management plan that has been approved under Section 208 or 319 of the Clean Water Act, as amended.

2.5 Stormwater Maintenance Requirements

All drainage features (i.e., diversion ditches, berms, risers, discharge pipes, chimney drains, etc.) will be inspected every 7 days and within 24 hours of rainfall events of 0.5 inches or greater, and documented for signs of damage, settlement, clogging, silt buildup, or washouts. If necessary, repairs to drainage control features will be made as early as possible.

2.6 Groundwater Monitoring Well Access Requirements

Groundwater monitoring wells will be located around the landfill perimeter. A readily accessible, unobstructed path shall be maintained so that monitoring wells may be accessed using four-wheel drive vehicles. Care must be taken around the wells to prevent any damage to the wells.

2.7 Landfill Gas Management

Because the nature of the waste to be placed in the Dan River Landfill, the Owner does not anticipate that methane or hydrogen sulfide gas will be generated or that odor will be an issue during operations. Therefore, landfill gas monitoring and management is not proposed.

3 Erosion and Sediment Control

Erosion and sedimentation control (E&SC) during landfill operations will consist of monitoring and repairing E&SC stormwater conveyance features and surface erosion as defined in this Operations Plan and the active Erosion and Sediment Control Plan.

3.1 E&SC Measures Monitoring and Maintenance

Erosion control principles include:

- Disturbing as little area as possible at any one time for landfilling operations.
- Seeding/mulching of disturbed areas commencing as soon as practically possible. Employing erosion control matting or seeding and mulch on steep slopes and other erosion prone areas;
- Use of earthen berms, wattles, silt fences, riprap, or equivalent devices down gradient of disturbed areas, stockpiles, drainage pipe inlets and outlets, and at intervals along grassed waterways, until such time as permanent vegetation is established.
- Placement of riprap at the inlets and outlets of stormwater piping.

Erosion and sedimentation control structures include stormwater best management practice (BMP) systems, settling basins, and channels. Stormwater BMP's shall be inspected every 7 days and within 24 hours of rainfall events 0.5 inches or greater. Sediment shall be removed from each structure when sediment accumulates to one half of the design depth. Sediment removal shall bring BMP's to their original design depth. The BMP's, embankments, spillways and outlets shall also be observed for erosion damage. Necessary repairs shall be made immediately. Trash or debris within the riser structures or outfalls shall be removed.

Channels shall be observed for damage every 7 days and within 24 hours of rainfall events 0.5 inches or greater. Riprap-lined channels and outlet protection aprons used to prevent damage to channel vegetation shall be observed for washouts. Riprap shall be added to those areas, as needed, to maintain the integrity of the structure.

Embankment slopes shall be inspected for erosion every 7 days and within 24 hours of rainfall events 0.5 inches or greater. The embankment slopes shall be mowed at least three times a year. The embankment slopes shall be fertilized in the second year unless vegetation growth is fully adequate. Damaged areas shall be reseeded, fertilized and mulched immediately. Seeding, fertilizing, and mulching shall be in accordance with the North Carolina Erosion and Sedimentation Control Guidelines and in accordance with the active Erosion and Sediment Control Plan.

Ground stabilization shall be performed within 7 calendar days on perimeter areas and slopes greater than 3H:1V. Ground stabilization shall be performed within 14 calendar days in other areas. Seedbed preparation, seeding, soil amendments, and mulching for the establishment of vegetative ground cover will be applied in accordance with North Carolina Erosion and Sedimentation Control Guidelines.

3.2 Surface Erosion Monitoring

Adequate erosion control measures shall be practiced to prevent sediment from leaving the site. Channels will be observed once every seven days and within 24 hours after any rainfall event of 0.5 inches or greater.

Slopes will be periodically checked for erosion and vegetative quality, fertilized, and mowed. A slope or portion thereof shall be identified as needing maintenance if it meets any one of the following conditions:

- Exposed waste on exterior slopes;
- Areas of cracking, sliding, or sloughing; and
- Areas of seepage

Slopes identified as needing maintenance shall be repaired as soon as practical and as appropriate to correct deficiencies. Repair activities may include re-dressing the slope, filling in low areas, and/or seeding.

4 Vegetation Management

Within six months after final termination of disposal operations at the site, the area shall be stabilized with vegetation as required by design drawings and the Closure and Post-Closure Plan included in Appendix III. Temporary seeding will be applied as required.

Temporary methods of erosion control may be required until permanent cover is established. Mulching, until a vegetative cover is established, can stabilize areas where final grade has been reached. Soil mulching can be achieved using wood chips, straw, hay, asphalt emulsion, jute matting, and synthetic fibers. Mulches allow for greater water retention; reduce the amount of runoff; retain seeds, fertilizer, and lime in place; and improve soil moisture and temperature conditions.

4.1 Temporary Seeding

Temporary seeding shall be applied as specified in the current Duke *Vegetation Maintenance Implementation Plan (VMIP)*. Alternatively, temporary seeding will be applied as follows (source: *NC Erosion and Sediment Control Planning and Design Manual* [June 2006, Revised March 2009]):

Table 5A: Temporary Seeding	
Late Winter to Early Spring - January through April	
Species	*Pounds per Acre*
Rye Grain *(Secale cereale)*	125
Annual Rye	50
Summer - May through August	
Species	*Pounds per Acre*
German Millet *(Setaria italica)*	50
Fall - September through December	
Species	*Pounds per Acre*
Rye Grain *(Secale cereale)*	125

Table 5B: Temporary Seeding Soil Amendments	
Soil Amendment	**Pounds per Acre**
Agricultural limestone	2,000
Fertilizer (10-10-10)	1,000
Mulch (straw)	4,000

Note: Soil amendments are for all-season temporary seeding applications.

4.2 Permanent Seeding

Permanent seeding shall be applied as specified in the current Duke *Vegetation Maintenance Implementation Plan (VMIP)*. Alternatively, permanent seeding will be applied as follows (source: *NC Erosion and Sediment Control Planning and Design Manual* [June 2006, Revised March 2009]):

Table 6A: Permanent Seeding	
Fall to Early Spring - September through April	
Species	*Pounds per Acre*
Kentucky 31 Tall Fescue *(Festuca arundinacea)*	100
Rye Grain *(Secale cereale)*	50
Spring to Summer - May through August	
Species	*Pounds per Acre*
German Millet *(Setaria italica)*	50

Table 6B: Permanent Seeding Soil Amendments	
Soil Amendment	**Pounds per Acre**
Agricultural limestone	4,000
Fertilizer (10-10-10)	1,000
Mulch (straw)	4,000

Note: Conduct North Carolina Department of Agriculture Soil Test(s). Apply fertilizer and lime pursuant to soil sampling and testing results. Apply minimum 4,000 pounds per acre of straw mulch. Protect steeper slopes (3:1 horizontal to vertical or steeper with erosion control matting. Water (if available), monitor, and maintain.

4.3 Over-Seeding

Over seeding will be applied as follows (source: NC *Erosion and Sediment Control Planning and Design Manual* [June 2006, Revised March 2009] and the current Duke *Vegetation Maintenance Implementation Plan (VMIP)*:

Table 7: Over-Seeding	
Late Winter to Early Spring - January through April	
Species	*Pounds per Acre*
Kentucky 31 Tall Fescue *(Festuca arundinacea)*	50
Rye Grain *(Secale cereale)*	25
Summer - May through August	
Species	*Pounds per Acre*
German Millet *(Setaria italica)*	25
Fall - September through December	
Species	*Pounds per Acre*
Tall Fescue *(Festuca arundinacea)*	50
Rye Grain *(Secale cereale)*	25

Note: Cut the existing turf to be over-seeded to an approximate 1-inch height. Aerate the soil and turf area to be over-seeded. Apply soil amendments pursuant to prior soil sampling and nutrient testing.

5 Landfill Closure

The Dan River Landfill will be closed in accordance with the design drawings and Closure and Post-Closure Plan included in Appendix III. The Closure and Post-Closure Plan outlines the sequence for closing the landfill and the post-closure maintenance activities. Closure is designed to minimize the need for long-term maintenance and control the post-closure release of contaminants. Closure activities may be revised as appropriate for materials, specifications, technology advancements, or changes in regulations at the time the landfill is closed or in post-closure. In general, the landfill development is designed so that final cover can be established as soon as practical.

6 Required Regulatory Submittals

Table 8: Required Regulatory Submittals		
Submittal	**Requirement**	**Reporting/Action Frequency**
Groundwater Monitoring Reports	Maintain a record of all monitoring events and analytical data in accordance with the Water Quality Monitoring Plan. Reports of the analytical data for each water quality monitoring sampling event shall be submitted to DENR Division of Waste Management (DWM) within 60 days of sampling event.	Semiannually
Annual Tonnage Reports	Tons of waste received and disposed of in the landfill shall be reported to the DWM and to all counties from which waste was accepted on forms prescribed by the DWM. Refer to the Permit to Operate for annual reporting requirement information.	Annually Must submit no later than August 1 each year
10-Year Waste Management Plan	Per North Carolina G.S. 130A-309.09D (c): ► A 10-year waste management plan shall be developed for this landfill and submitted to DWM. ► The plan shall be updated and submitted to DWM at least every three years. ► A report on the implementation of the plan is required to be submitted to DWM by August 1 of each year.	10-year plan prepared every 10 years 10-year plan updated every 3 years Implementation report annually

APPENDIX I

Dust Control Plan

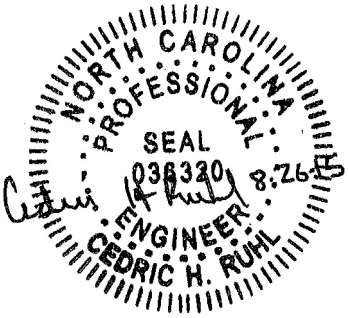
Dust Control Plan

Dan River Landfill

Duke Energy – Dan River Steam Station

Eden, North Carolina

Amec Foster Wheeler Project No. 7810140065



To:	Duke Energy Carolinas, LLC
Date	August 26, 2015
From:	Amec Foster Wheeler

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2 DUST CONTROL METHODS 1
3 MONITORING AND CORRECTIVE ACTION RESPONSE 2
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3.2 Corrective Action Response 2

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Figure 1 Dust Control Monitoring Grid

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Dust Control Monitoring Worksheet

1 Introduction and Site Description

This Dust Control Plan is for the Dan River Landfill at Duke Energy's Dan River Steam Station. This Plan provides dust control methods for managing dust emissions at the landfill. The Plan also provides a monitoring program and corrective action responses to contain coal combustion residuals (CCR's) on site and to prevent dust nuisances to employees and the public. The monitoring program will aid Duke Energy and the landfill operator in evaluating the dust control methods, or combination of dust control methods, that prove effective with site specific conditions.

The Dan River Landfill is principally used for CCR management. CCR's disposed of in the Dan River Landfill will predominantly consist of fly and bottom ash and is defined in Section 2.1.2 of the Operations Plan.

This Plan is included as an Appendix to the Dan River Landfill Operations Plan. Please refer to the Operations Plan for a description of revisions as necessary.

2 Dust Control Methods

The primary potential source of dust emissions in the landfill is the top deck area and active area of waste placement. These areas are at a higher risk for producing dust due to vehicular and equipment traffic and earthworks like construction. Exterior landfill slopes are less of a dust control concern, as they have intermediate or operational soil covers which are vegetated as required in the Operations Plan.

Dust emissions from the landfill can be controlled through a variety of dust control methods. Possible dust control methods are identified herein. Dust control methods may be characterized as products and/or applications, structural wind breaks and/or covers, and operational methods.

Dust control methods for the landfill area include:

- Watering;
  - Potable or non-potable water (all areas);
  - Leachate (areas within the limit of waste footprint that drain to the leachate collection system only i.e. active face);
- Establishing vegetative cover;
- Mulching;
- Structural controls consisting of:
  - Wind breaks (i.e. fencing and/or berms); and
  - Temporary coverings (i.e. tarps);
- Spray applied dust suppressants consisting of, and not limited to:
  - Anionic asphalt emulsion;
  - Latex emulsion;
  - Resin in water;
  - Polymer based emulsion; and
  - Mineral mortar coatings (i.e. posi-shell);
- Calcium chloride;
- Soil stabilizers (i.e. soil cements);
- Operational soil cover;
- Modifying the active working area; and
- 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 Plan, operational soil cover 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 a dust monitoring program outlined in Section 3.

Operational equipment generally consists of dump trucks, vibratory smooth drum rollers, sheepsfoot compactors, bulldozers, water trucks, spray trailers, track hoes, and service trucks. Operational equipment will be used to construct, install, apply, and/or repair dust control methods. The operator will make provisions to alleviate any on-site issues that arise when primary equipment is being maintained or is inoperable. In the event that the landfill site contains multiple facilities in the future, the landfill operator will make provisions to have the necessary equipment to control multiple fugitive CCR dust emission events.

3 Monitoring and Corrective Action Response

This section describes the dust monitoring program and suggests corrective action responses should fugitive emissions be observed.

3.1 Monitoring

During landfill operations, a dust monitoring program will be implemented to evaluate the dust control measure performance and observe the areas for dust emissions. The dust monitoring program will consist of performing visual observations of dust prone areas, dust control measures, and monitoring existing and forecasted weather conditions.

Dust emissions can occur under many conditions. For the purposes of this Plan, dust emissions are characterized as fugitive emissions, where CCR dust may be transported outside the limit of landfill waste. This is most likely to occur during windy, dry, and hot weather conditions. Therefore, the operator will monitor both existing and forecasted weather conditions and use dust control measures accordingly. The dust control measures shall be implemented prior to the forecasted weather conditions.

Equipment operators shall continuously observe the active face and other areas within the landfill limit for dust emissions. In addition, preventative dust control measures should be observed and documented at least twice daily (morning and afternoon) when the landfill is in operation, to evaluate the dust control measure performance. Additional observations may be necessary as site and weather conditions dictate.

Observations will be documented on the attached "*Monitoring Worksheet*," or online database/worksheet, etc. Due to the continual maintenance necessary on moisture conditioned and spray-applied areas, the operator shall pay particular attention to these areas. Structural controls shall be observed to monitor that they are achieving their intended purpose. Observations in the landfill area may be made with reference to the Operations Grid system shown in the attached Figure 1.

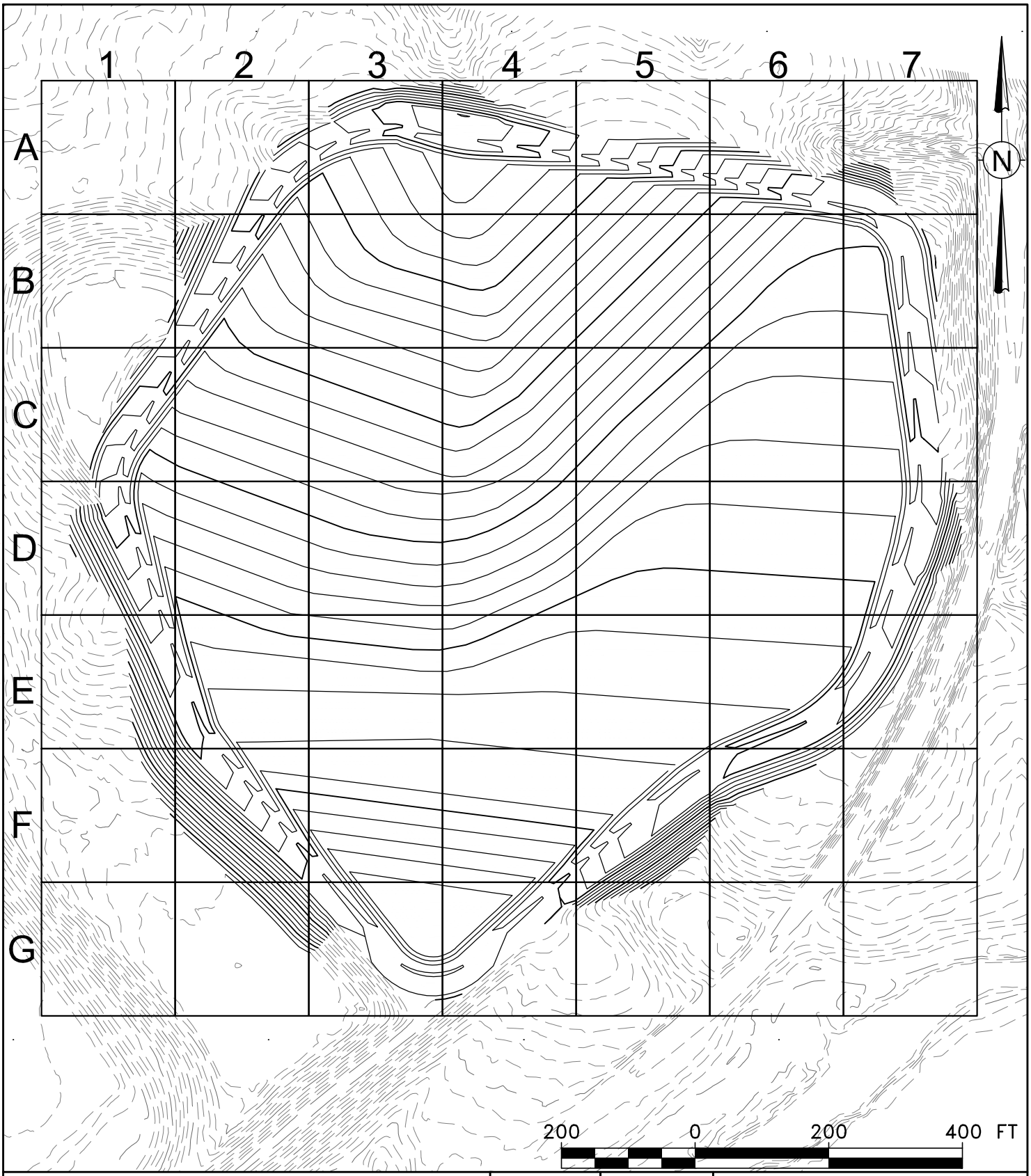
Monitoring will be conducted during times when the landfill is in operation. The operator shall continue to provide necessary dust control measures during periods when operations are inactive (i.e. outages, weekends, and holidays). Operators are to establish appropriate measures so that dust emissions are not reasonably likely to occur during inactive operation periods when monitoring is not being conducted.

3.2 Corrective Action Response

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 will implement dust control measures as preventative controls rather than in response to fugitive dust emissions.

FIGURES



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CLIENT LOGO

CLIENT
DUKE ENERGY CAROLINAS
ROCKINGHAM COUNTY, NC

PROJECT: DAN RIVER LANDFILL	DWN BY: RFK	DATUM: NAD99	DATE: 08/26/2015
TITLE: DUST CONTROL MONITORING GRID LANDFILL SUBGRADE	CHK'D BY: CHR	REV. NO.: 0	PROJECT NO: 7810-14-0065
	PROJECTION: UTM Zone 0	SCALE: AS SHOWN	FIGURE No. 1

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ATTACHMENTS

Dan River Landfill
Permit No. TBD

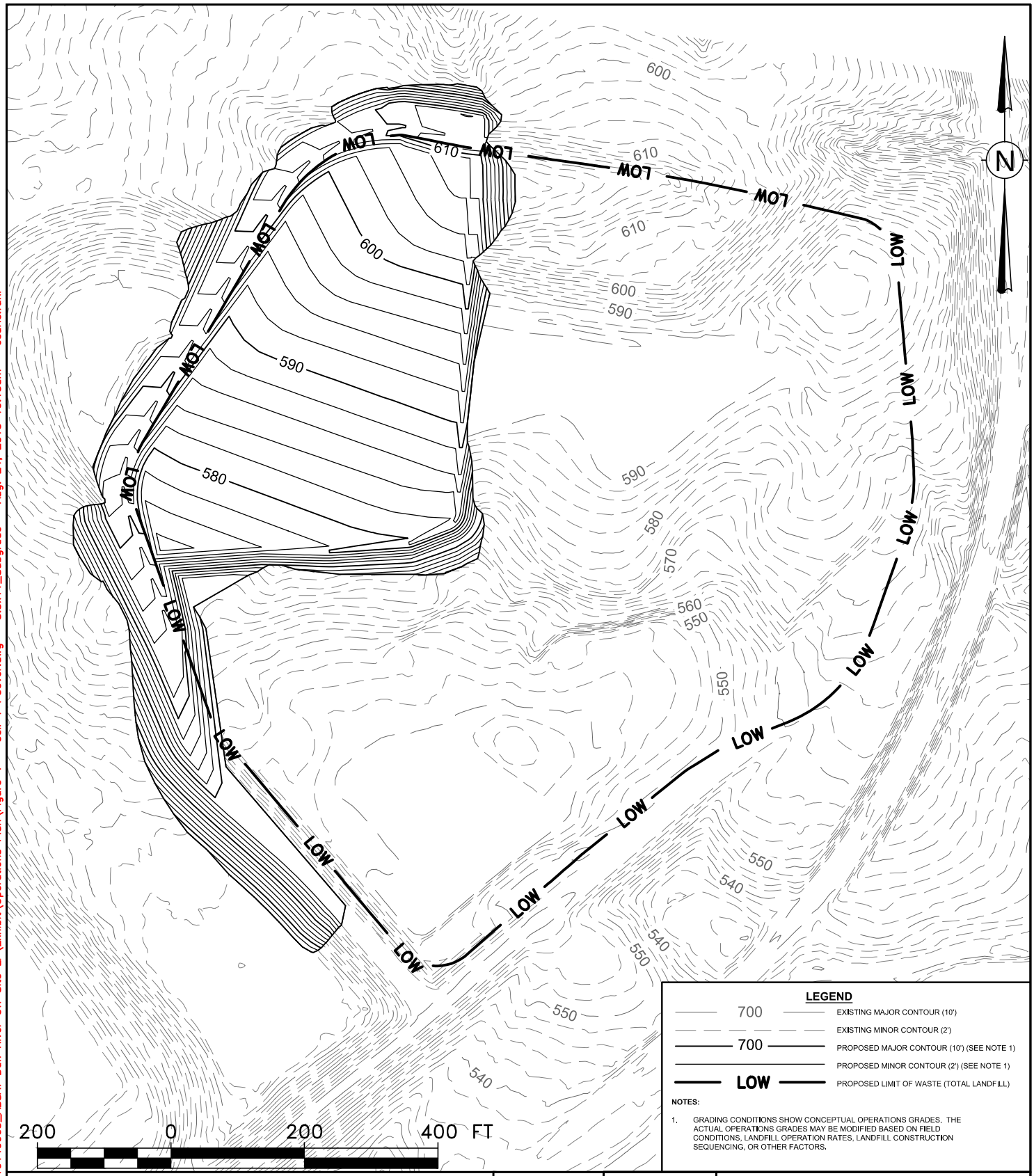
Dust Control Monitoring Worksheet

Dan River Steam Station
Eden, North Carolina

Date/Time	Dust Control Method in Use	Effective Yes/No	Observation Location	Preventative or Corrective Action Taken Yes/No	Observations/comments including: weather conditions, wind speeds, precipitation, forecast, preventative or corrective actions taken (if needed), additional operational notes	Name of Observer

APPENDIX II

Landfill Sequencing Drawings



LEGEND

700	EXISTING MAJOR CONTOUR (10')
	EXISTING MINOR CONTOUR (2')
700	PROPOSED MAJOR CONTOUR (10') (SEE NOTE 1)
	PROPOSED MINOR CONTOUR (2') (SEE NOTE 1)
LOW	PROPOSED LIMIT OF WASTE (TOTAL LANDFILL)

NOTES:

1. GRADING CONDITIONS SHOW CONCEPTUAL OPERATIONS GRADES. THE ACTUAL OPERATIONS GRADES MAY BE MODIFIED BASED ON FIELD CONDITIONS, LANDFILL OPERATION RATES, LANDFILL CONSTRUCTION SEQUENCING, OR OTHER FACTORS.

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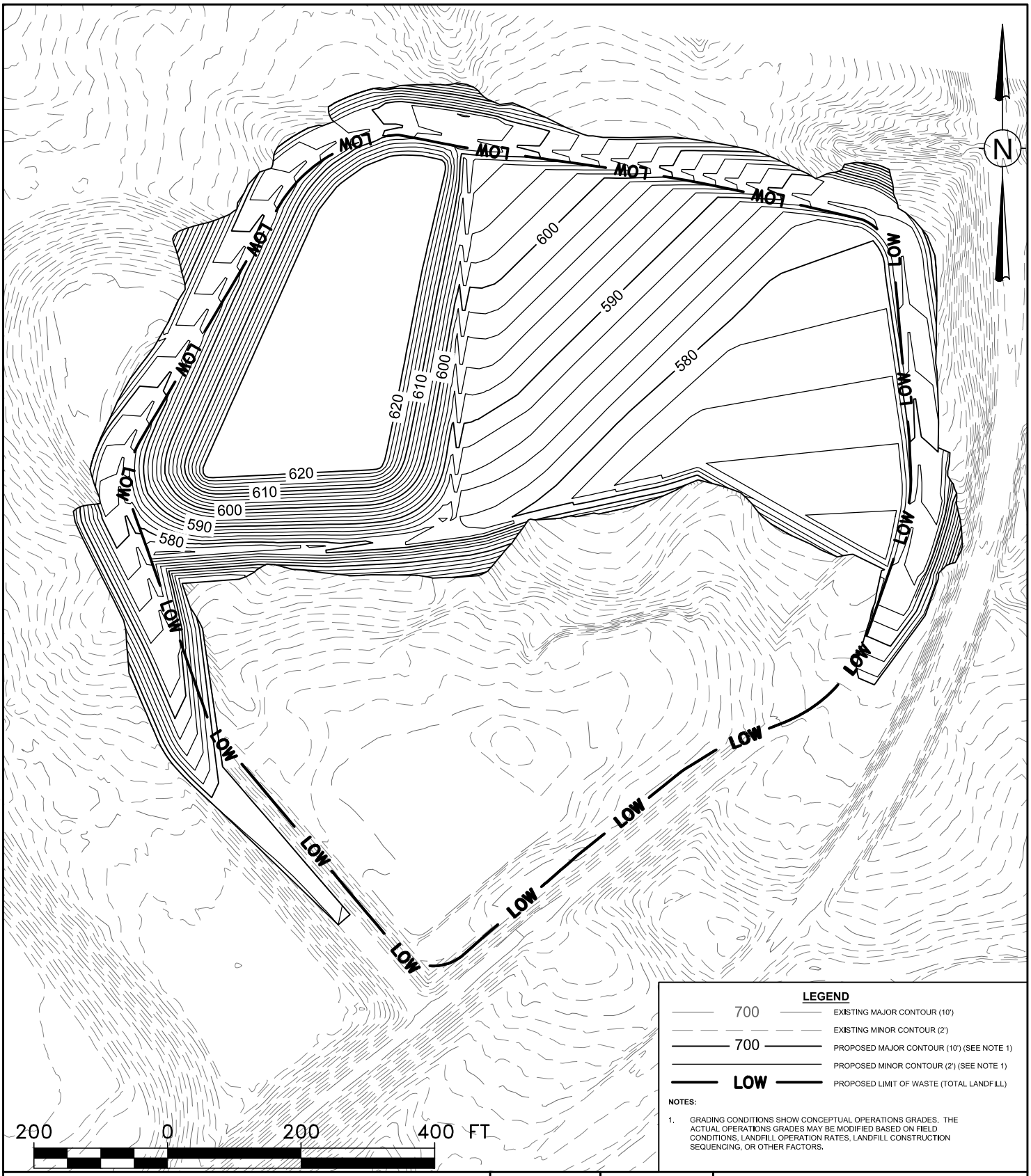
CLIENT: DUKE ENERGY CAROLINAS
ROCKINGHAM COUNTY, NC

PROJECT: DAN RIVER LANDFILL	DWN BY: CSJ	DATUM: NAD99	DATE: 08/26/2015
TITLE: LANDFILL OPERATIONS SEQUENCE 1 CELL 1 PROTECTIVE COVER GRADES	CHK'D BY: CHR	REV. NO.: 0	PROJECT NO: 7810-14-0065
	PROJECTION: UTM Zone 0	SCALE: AS SHOWN	FIGURE No. 1

\\Clt1-fs1\cad\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Exhibit\Operations Plan\Figure 1 - Cell 1 PCover.dwg - 8.5x11_Subgrade - Aug. 24, 2015 10:13am - cedric.ruhl



LEGEND

700	EXISTING MAJOR CONTOUR (10')
	EXISTING MINOR CONTOUR (2')
700	PROPOSED MAJOR CONTOUR (10') (SEE NOTE 1)
	PROPOSED MINOR CONTOUR (2') (SEE NOTE 1)
LOW	PROPOSED LIMIT OF WASTE (TOTAL LANDFILL)

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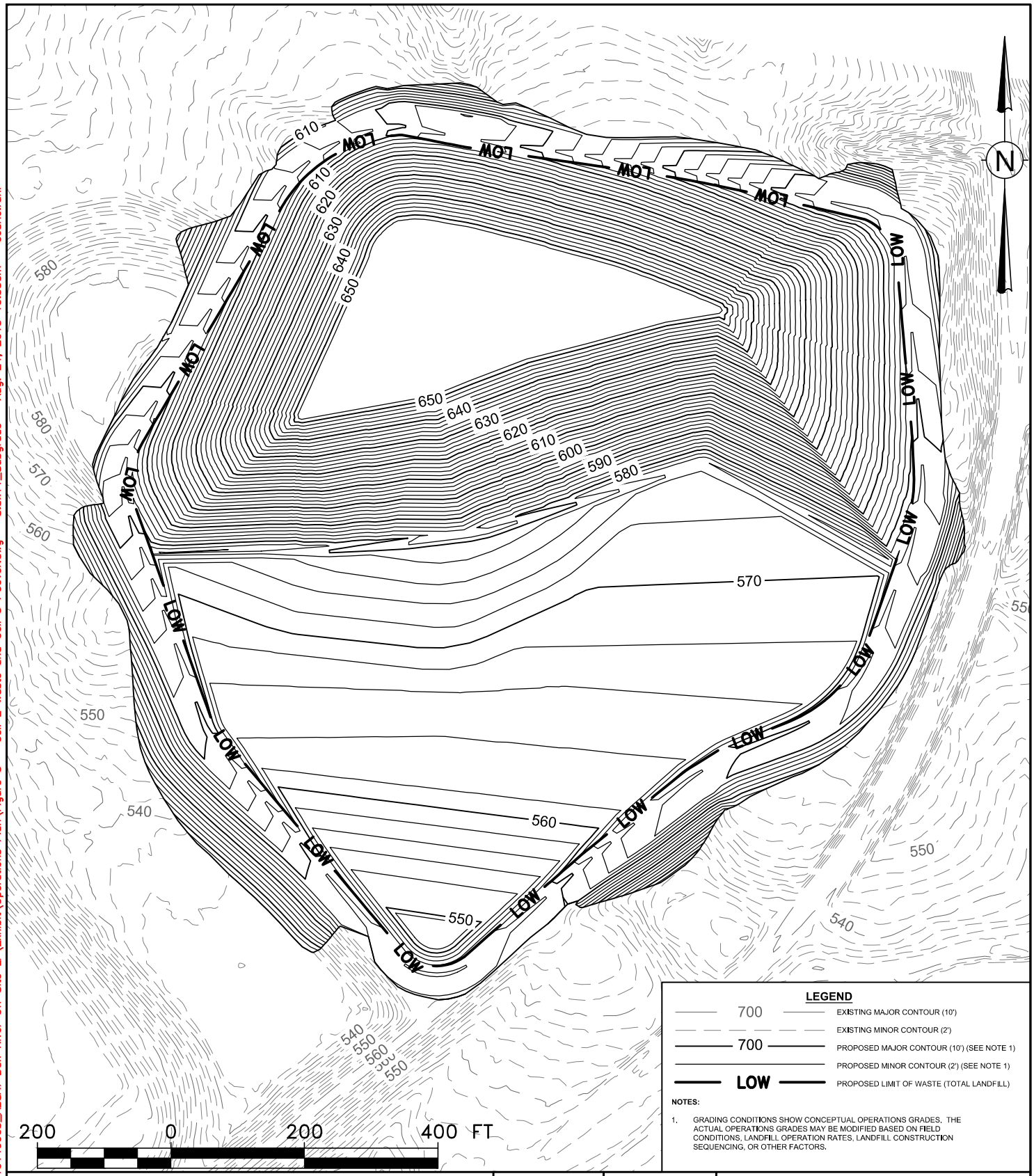
ROCKINGHAM COUNTY, NC

PROJECT: DAN RIVER LANDFILL	DWN BY: CSJ	DATUM: NAD99	DATE: 08/26/2015
TITLE: LANDFILL OPERATIONS SEQUENCE 2 CELL 1 INTERIM WASTE, CELL 2 INITIAL CONDITIONS	CHK'D BY: CHR	REV. NO.: 0	PROJECT NO: 7810-14-0065
	PROJECTION: UTM Zone 0	SCALE: AS SHOWN	FIGURE No. 2

\\Clt1-fs1\cad\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Exhibit\Operations Plan\Figure 2 - Cell 1 Waste and Cell 2 PCover.dwg - 8.5x11_TopCover - Aug. 24, 2015 10:17am - cedric.ruhl



LEGEND

700	EXISTING MAJOR CONTOUR (10')
	EXISTING MINOR CONTOUR (2')
700	PROPOSED MAJOR CONTOUR (10') (SEE NOTE 1)
	PROPOSED MINOR CONTOUR (2') (SEE NOTE 1)
LOW	PROPOSED LIMIT OF WASTE (TOTAL LANDFILL)

NOTES:

1. GRADING CONDITIONS SHOW CONCEPTUAL OPERATIONS GRADES. THE ACTUAL OPERATIONS GRADES MAY BE MODIFIED BASED ON FIELD CONDITIONS, LANDFILL OPERATION RATES, LANDFILL CONSTRUCTION SEQUENCING, OR OTHER FACTORS.

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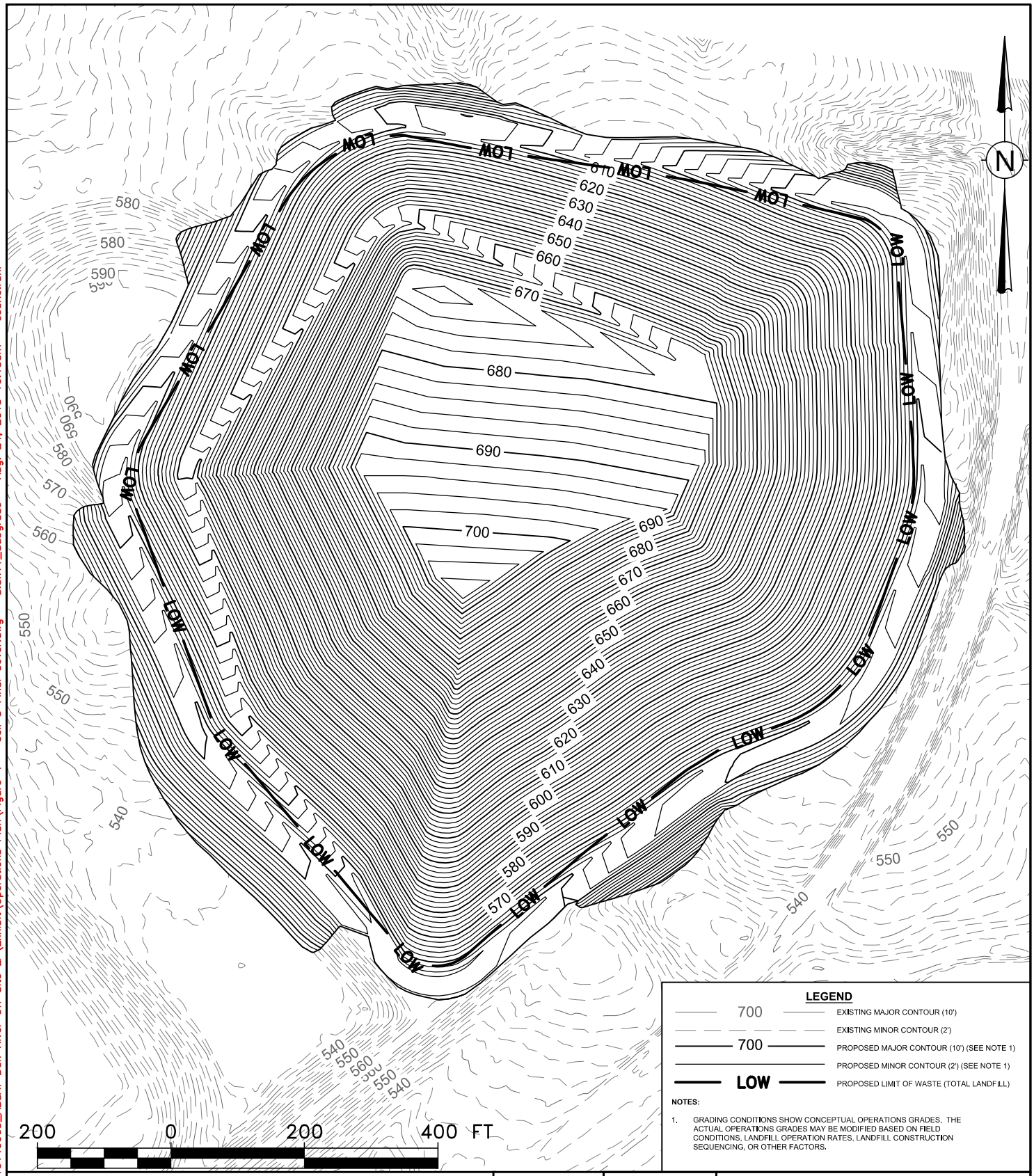
ROCKINGHAM COUNTY, NC

PROJECT: DAN RIVER LANDFILL	DWN BY: CSJ	DATUM: NAD99	DATE: 08/26/2015
TITLE: LANDFILL OPERATIONS SEQUENCE 3 CELLS 1 AND 2 INTERIM WASTE, CELL 3 INITIAL CONDITIONS	CHK'D BY: CHR	REV. NO.: 0	PROJECT NO: 7810-14-0065
	PROJECTION: UTM Zone 0	SCALE: AS SHOWN	FIGURE No. 3

\\Clt1-fs1\cad\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Exhibit\Operations Plan\Figure 3 - Cell 2 Waste and Cell 3 PCover.dwg - 8.5x11_Subgrade - Aug. 24, 2015 10:33am - cedric.ruhl



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ROCKINGHAM COUNTY, NC

PROJECT: DAN RIVER LANDFILL	DWN BY: CSJ	DATUM: NAD99	DATE: 08/26/2015
TITLE: LANDFILL OPERATIONS SEQUENCE 4 FINAL COVER GRADES	CHK'D BY: CHR	REV. NO.: 0	PROJECT NO: 7810-14-0065
	PROJECTION: UTM Zone 0	SCALE: AS SHOWN	FIGURE No. 4

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APPENDIX III

Closure and Post-Closure Plan

Closure and Post-Closure Plan

Dan River Landfill

Duke Energy – Dan River Steam Station

Eden, North Carolina

Amec Foster Wheeler Project No. 7810140065

NORTH CAROLINA PROFESSIONAL SEAL 038320 ENGINEER CEDRIC H. RUHL 8-26-15

To:	Duke Energy Carolinas, LLC
Date	August 26, 2015
From:	Amec Foster Wheeler

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Appendix I Example Post-Closure Monitoring Form

Appendix II Cost Estimate for Closure and Post-Closure Activities

1 Introduction

This Closure and Post-Closure Plan is being submitted as part of the Construction Plan Application and was prepared for the proposed Dan River Landfill in accordance with Title 15A Subchapter 13B of the North Carolina Administrative Code (NCAC) to meet the requirements of .0503(2), .0504(2), and .0505 for industrial landfills; and substantive requirements of Rules .1627-.1629 for municipal solid waste (MSW) landfills. The proposed Dan River Landfill is an industrial landfill and therefore some of the requirements of Rules .1627-.1629 do not apply. The information contained in this plan will be used to assist Duke Energy Carolinas, LLC (Duke) in the closure of active waste units and the maintenance and monitoring required during the post-closure care period.

1.1 Project Information

Duke Energy intends to construct an industrial landfill on Dan River Steam Station property. The proposed landfill will be located largely within the footprint of existing Ash Fill 1 on the northeastern end of the property. The ash within Ash Fill 1 will be removed prior to construction of the proposed landfill. The proposed landfill will be bounded by existing overhead electrical lines to the west and north, rail lines to the east, and a natural gas pipeline to the south.

2 Closure Plan

The landfill cover system has been designed to reduce infiltration into the landfill and to resist erosion. The proposed landfill cover system components, size, and closure schedule are described in the following sections of this report.

2.1 Description of Cover System

The proposed cover system will consist of the following components, from top to bottom:

- 6-inch thick vegetative soil cover;
- 18-inch thick final cover soil;
- Geocomposite drainage layer (or 8 oz/sy non-woven geotextile alternate);
- 40-mil thick double-sided textured linear low density polyethylene (LLDPE) geomembrane (or 50-mil LLDPE structured geomembrane alternate); and
- Interim cover layer.

The soil components will provide a surface suitable to sustain vegetative growth while protecting the underlying geosynthetic components of the cover system. Infiltration through the cover soils will be collected by the geocomposite drainage layer, while the geomembrane will function as a hydraulic barrier to reduce infiltration into the waste mass. Interim cover shall be as needed to achieve geosynthetic cover system subgrade. The interim cover at the time of final closure may consist of ash. The cover system stormwater management structures will collect both infiltration and surface water runoff. The final cover will be vegetated with grasses within six months following closure.

2.1.1 Vegetative Soil Cover

The vegetative soil layer will consist of 6 inches of soil materials capable of sustaining vegetation, which will preserve the integrity of the cover system by preventing erosion. The vegetative cover layer will not be subjected to compaction requirements.

2.1.2 Final Cover Soil

The final cover soil layer will consist of 18 inches of soil materials which will be compacted as specified in the Specifications. The final cover soil layer will protect the geosynthetic components of the cover system and reduce infiltration.

2.1.3 Geocomposite Drainage Layer

A geocomposite drainage layer will be located beneath the final cover soil layer. The geocomposite will promote veneer stability and reduce infiltration through the closed landfill by conveying infiltration to regularly spaced geocomposite outlets.

The alternate cover system option includes an 8 oz/sy non-woven geotextile which will provide soil separation and allow infiltration into the underlying 50-mil LLDPE structured geomembrane.

2.1.4 Geomembrane

A 40-mil thick double-sided textured LLDPE geomembrane barrier will be installed between the geocomposite drainage layer and the interim cover to prevent infiltration through the closed landfill. The geomembrane will have texturing on both sides to improve veneer stability.

The alternate cover system option includes a 50-mil LLDPE structured geomembrane to prevent infiltration through the closed landfill. The structured component allows drainage and is an integral component of the geomembrane.

2.1.5 Interim Cover

Interim cover will be placed during landfill operations prior to cover system construction as necessary to control fugitive dust. Interim cover will consist of soil or an approved alternative.

2.2 Gas Management System

The majority of waste disposed in the Dan River Landfill will consist of CCR materials, predominantly fly ash and bottom ash. Based on the nature of CCR materials and our experience it is not anticipated that landfill gases such as methane or hydrogen sulfide gas will be generated or that nuisance odors will be an issue. Therefore, Duke does not propose monitoring for landfill gas or landfill gas management measures.

In the event that methane or hydrogen sulfide gases are detected during landfill operations, appropriate actions will be taken. In the event that gases are regularly detected during active landfill operations, the final closure and post-closure plan will be modified to address gas. It is anticipated that a minimum response would be to provide a passive gas venting system with the final closure.

2.3 Stormwater Management System

The proposed Dan River Landfill is designed with a network of stormwater conveyances accounting for active landfill operations, interim closure, and final closure conditions. Upon final closure, stormwater will be collected by tack-on benches and conveyed to a series of down-drain pipes which will discharge to the perimeter channel system. Plans and details illustrating the stormwater management system are provided in the Engineering Plan drawings.

2.4 Largest Area Requiring Cover System

The proposed Dan River Landfill will be operated until closure, and future expansions are not anticipated at this time. The largest area requiring cover system construction is the entire footprint of the proposed landfill which is approximately 23.3 acres.

2.5 Estimated Maximum Waste Inventory

The proposed landfill design provides approximately 2,120,000 cubic yards of airspace as measured from the top of the protective cover soil following subgrade construction to the bottom of the interim cover following completion of CCR placement. Assuming a compacted CCR dry density of 1.0 tons per cubic yard, the available dry tonnage capacity of the proposed landfill is approximately 2,120,000 tons.

2.6 Closure Schedule

Following the completion of waste placement, a final cover system will be constructed. The primary purpose of a final cover system is to minimize infiltration into the waste. The proposed final cover system cross section is presented in the Engineering Plan Drawings.

Final closure of the landfill will commence when final design grades are achieved, Duke declares that no more waste will be accepted, or as directed by the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Waste Management – Solid Waste Section (the Division). Duke may elect to close the landfill incrementally during landfill operations once an area large enough to warrant cover system construction has reached final grades. Prior to beginning closure of the proposed landfill, the Owner or Operator shall notify the Division that a notice of intent to close the landfill has been placed in the operating record.

Closure activities for the landfill shall begin no later than 30 days after final receipt of waste unless otherwise approved by the Division or, if the landfill has remaining capacity and there is a reasonable likelihood that the landfill will receive additional wastes, no later than one year after the most recent receipt of wastes. Extensions beyond the one-year deadline for beginning closure may be granted by the Division if the Owner or Operator demonstrates that the landfill has the capacity to receive additional wastes and the Owner or Operator has taken and will continue to take the steps necessary to prevent threats to human health and the environment from the unclosed landfill.

The final cover system will be finished within 180 days following the beginning of closure activities unless otherwise approved by the Division. Extensions of the closure period may be granted by the Division if the Owner or Operator demonstrates that closure will, of necessity, take longer than 180 days and they have taken and will continue to take the necessary steps to prevent threats to human health and the environment from the unclosed landfill unit. The final cover system for the closed phase will be certified by a professional engineer as being completed. Duke Energy shall record a notation on the deed to the landfill property stating that the property has been used as a landfill and its use is restricted under the Closure/Post-Closure Plan approved by the Division. The Division will be notified by Duke Energy of the closure completion, certification, deed notation, and placement of these records into the landfill's operating record.

Following cover system construction, the landfill will be vegetated with grass and maintained. If the landfill must be closed prior to reaching the final contours, the surface of the landfill will be sloped to a minimum grade of 5 percent and maximum grade of 33.33 percent (3H:1V). A final cover will be established over the landfill unit being closed.

3 Post-Closure Plan

The Post-Closure Plan outlines the monitoring and maintenance activities intended to maintain cover system integrity during the post-closure care period. During the post-closure period, the landfill cover system and related facilities must be monitored and maintained.

3.1 Maintenance Activities

Maintenance activities will be conducted as soon as practical to address items of concern identified during monitoring events. Mowing will occur at a minimum twice per year, other maintenance activities will be performed as needed and are anticipated to include the following:

- Filling in animal burrows and re-locating the animal;
- Localized placement of fill to prevent ponding of water caused by differential settlement;
- Removal of trees or brushy vegetation within the cover system limits;
- Vegetative cover shall be amended and fertilized as needed to maintain healthy vegetation; and
- Repair of stormwater conveyance measures.

Any disturbed areas will be seeded and soil amendments applied as necessary to establish a healthy vegetative cover.

3.2 Monitoring Activities

Post-closure monitoring events will be conducted quarterly for the first two years and semi-annually thereafter during the post-closure care period. Post-closure monitoring will include a review of the following:

- The condition of site security features such as gates and/or fencing;

- Evidence of erosion, settlement, and/or animal burrows within the cover system;
- Type and quality of vegetation within the cover system;
- Evidence of erosion and integrity of stormwater conveyance features; and
- Integrity of the leachate collection and removal system (LCRS).

Example forms that may be used to document the monitoring events are included in Appendix I. The post-closure grades, stormwater features, and grid are shown on Figure 3 which may be used to assist with post-closure monitoring. Completed post-closure forms will be maintained in the facility operating record.

3.2.1 Groundwater and Surface Water Monitoring

Groundwater and surface water monitoring requirements are described in the Groundwater Monitoring Plan, submitted under separate cover.

3.3 Facility Contact Information

Duke will be responsible for post-closure maintenance and monitoring. Correspondence regarding the Dan River Landfill should be directed to:

Duke Energy Carolinas, LCC
Dan River Steam Station
900 South Edgewood Road
Eden, North Carolina 27288
(336) 635-3160
Station Sponsor for Landfill Operations or Environmental Professional

The physical address of the proposed Dan River Landfill is the same as above.

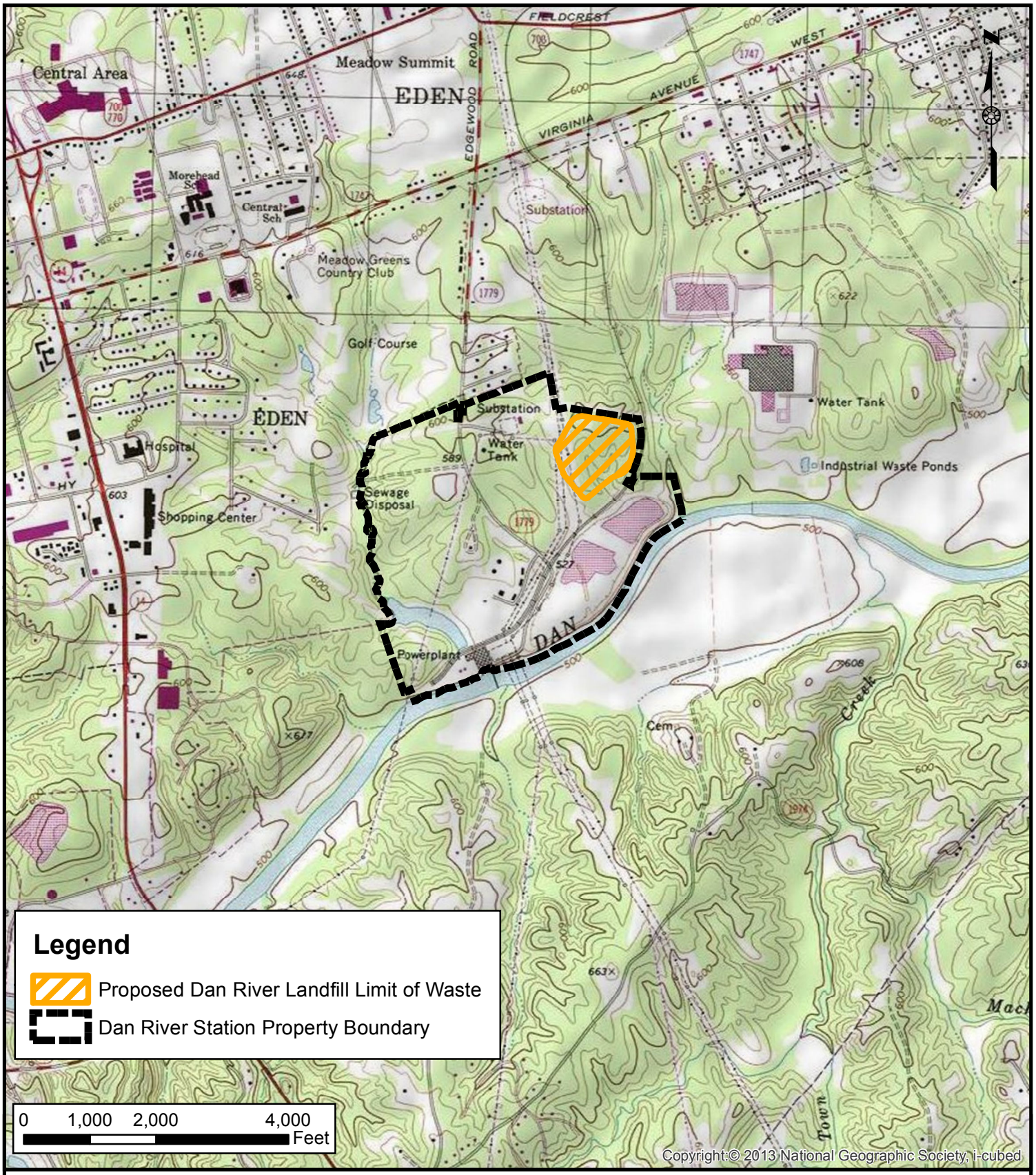
3.4 Post-Closure Planned Use

The Dan River Landfill will be vegetated following closure. Site access to the public will remain restricted through landfill closure and the post-closure care period. There are no current anticipated post-closure uses for the proposed Dan River Landfill. Duke Energy will obtain approval from NCDENR if a proposed post-closure use is identified.

3.5 Certification

Consistent with regulations, the end of the closure/post-closure care period must be certified by a registered professional engineer. To accomplish certification over the required 30-year duration, a registered professional engineer will prepare annual certifications. The annual certifications will document that the cover system has been monitored and maintained in accordance with the Post-Closure Plan. The annual certifications shall be based on observations and results documented on regular post-closure monitoring reports, maintenance records, and compliance monitoring reports maintained in the Operating Record.

FIGURES

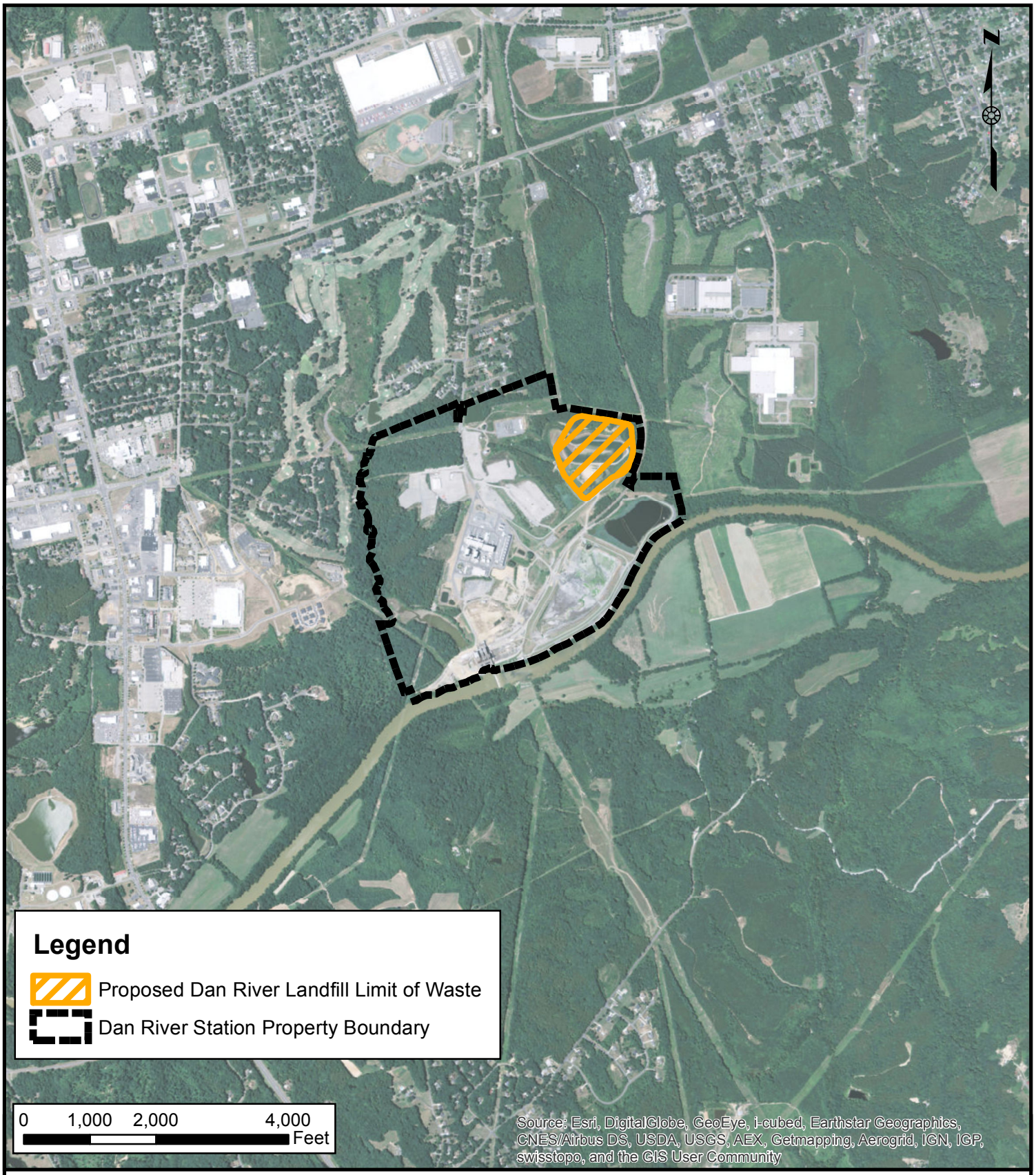


Source: Rockingham County GIS

amec foster wheeler

SITE VICINITY MAP - USGS
DAN RIVER LANDFILL
DUKE ENERGY
ROCKINGHAM COUNTY, NORTH CAROLINA

PREPARED BY	DATE	CHECKED BY	DATE	JOB NUMBER	FIGURE
CHR	7/20/2015	CJ	7/20/2015	7810-14-0065	1



Source: Rockingham County GIS

amec foster wheeler

SITE VICINITY MAP - AERIAL
DAN RIVER LANDFILL
DUKE ENERGY
ROCKINGHAM COUNTY, NORTH CAROLINA

PREPARED BY	DATE	CHECKED BY	DATE	JOB NUMBER	FIGURE
CHR	7/20/2015	CJ	7/20/2015	7810-14-0065	2

APPENDIX I

Example Post-Closure Monitoring Form

Duke Energy - Dan River Landfill
Post-Closure Monitoring Form

Date/Time: _____
Observation Personnel: _____
Weather/Temperature: _____

Question	No	Yes	If yes, location	Description	Corrective Actions Recommended	Date Corrected
Is there evidence of erosion, settlement, rutting, or potholes?						
Is there evidence of cover system intrusion (ruts, burrows, excavation)?						
Is there evidence of stressed vegetation or bare spots, or evidence of woody vegetation (small trees and/or shrubs)?						
Is there evidence of erosion or sedimentation in storm water channels, down drain pipes, or other stormwater features?						

Duke Energy - Dan River Landfill
Post-Closure Monitoring Form

Date/Time: _____
Observation Personnel: _____
Weather/Temperature: _____

Question	No	Yes	If yes, location	Description	Corrective Actions Recommended	Date Corrected
Is there evidence of penetrations (poles, posts, stakes)?						
Is there evidence of human encroachment (trash, fire pits, tire/footprints)?						
General Notes:						

APPENDIX II

Cost Estimate for Closure and Post-Closure Activities

Cost Estimate for Closure and Post-Closure Activities
Table 1 - Estimate of Closure Costs
Duke Energy - Dan River Landfill
Rockingham County, North Carolina
August 26, 2015

Item No.	Description	Estimated Quantity	Units	Unit Cost	Total Cost
General					
1	Mobilization / demobilization	1	EA	$443,069.47	$443,069.47
2	Surveying	1	EA	$147,689.82	$147,689.82
				Subtotal - General	**$590,759.29**
Erosion and Sediment Control					
3	Silt fence	4,274	LF	$3.50	$14,959.81
4	Wattles	43	EA	$110.00	$4,730.00
5	Sediment basins	2	EA	$15,000.00	$30,000.00
6	Temporary seeding (2d quantity)	11.65	AC	$1,400.00	$16,310.00
7	Permanent seeding (2d quantity)	23.3	AC	$1,400.00	$32,620.00
				Subtotal - Erosion and Sediment Control / Stormwater Management	**$98,619.81**
Earthwork					
8	Demolition/disposal of interim stormwater measures	23.3	AC	$1,000.00	$23,300.00
9	Subgrade preparation	23.3	AC	$1,500.00	$34,950.00
10	Final cover soil layer (18-inch thick compacted fill)	56,386	CY	$5.50	$310,123.00
11	Vegetative soil layer (6-inch thick un-compacted fill)	18,795	CY	$11.00	$206,748.67
12	Slope access road surfacing	60,000	SF	$0.85	$51,000.00
				Subtotal - Earthwork	**$626,121.67**
Geosynthetics					
13	Anchor trench (includes markers)	4,274	LF	$6.00	$25,645.40
14	40-mil textured LLDPE geomembrane (2d quantity)	1,014,948	SF	$1.11	$1,126,592.28
15	Geocomposite drainage layer (2d quantity)	1,014,948	SF	$0.54	$548,071.92
				Subtotal - Geosynthetics	**$1,700,309.60**
Stormwater Management					
16	Tack-on benches	11,616	LF	$25.00	$290,400.00
17	Downdrains	1,080	LF	$190.00	$205,200.00
18	Downdrain outlet structures	3	EA	$2,500.00	$7,500.00
19	Geocomposite outlet at perimeter	4,274	LF	$6.00	$25,645.40
				Subtotal - Stormwater Management	**$528,745.40**

Subtotal - Final Cover System Construction Costs	**$3,544,555.77**

Additional Costs					
20	Design, permitting, and CQA	23.3	AC	$15,500.00	$361,150.00
21	Contingency (assumed 15% of construction costs)	1	EA	$531,683.36	$531,683.36
				Subtotal - Additional Costs	**$892,833.36**

TOTAL ESTIMATE OF CLOSURE COSTS	**$4,437,389.13**
ESTIMATE OF CLOSURE COSTS PER ACRE	**$190,445.89**

Cost Estimate for Closure and Post-Closure Activities
Table 2 - Estimate of Post-Closure Maintenance Costs
Duke Energy - Dan River Landfill
Rockingham County, North Carolina
August 26, 2015

Item No.	Description	Estimated Quantity	Units	Unit Cost	Total Cost
Administration/Inspection/Recordkeeping[1]					
1	Senior Professional (80 hours/year @ $100/hr)	30	YR	$8,000.00	$240,000.00
2	Technician (40 hours/year @ $70/hour)	30	YR	$2,800.00	$84,000.00
3	Clerical (8 hours/year @ $45/hour)	30	YR	$360.00	$10,800.00
				Subtotal - Administration/Inspection/Recordkeeping	**$334,800.00**
Maintenance					
4	Fencing, Gates, Signs, Etc.	30	YR	$500.00	$15,000.00
5	Access Roads	30	YR	$1,000.00	$30,000.00
6	Mowing ($100/acre per quarter over 23.3 acres)	30	YR	$9,320.00	$279,600.00
7	Stormwater Structures	30	YR	$2,500.00	$75,000.00
8	Leachate Collection and Disposal	30	YR	$1,000.00	$30,000.00
9	Final Cover System ($1,500/acre over 5.8 acres)[2]	30	YR	$8,700.00	$261,000.00
				Subtotal - Maintenance	**$690,600.00**

Subtotal - Closure and Post-Closure Activities	**$1,025,400.00**

Additional Costs		
10	Contingency (assumed 15% of subtotal)	$153,810.00

30 Year Total	**$1,179,210.00**
30 Year Total per Acre (for 23.3 acres)	**$50,609.87**
Cost Per Year (Includes 15% Contingency)	**$39,307.00**
Cost Per Acre Per Year (for 23.3 acres)	**$1,687.00**

Notes:
1. Assumes quarterly monitoring and reporting, preparation of annual report, and managing site activities.
2. Assumes erosion repair and seeding for 25 percent of the cover annually.

Cost Estimate for Closure and Post-Closure Activities
Table 3 - Estimate of Post-Closure Corrective Action Costs
Duke Energy - Dan River Landfill
Rockingham County, North Carolina
August 26, 2015

Item No.	Description	Estimated Quantity	Units	Unit Cost	Total Cost
Compliance Monitoring and Reporting					
1	Senior Professional (24 hours/year @ $100/hr)	30	YR	$2,400.00	$72,000.00
2	Technician (16 hours/year @ $70/hour)	30	YR	$1,120.00	$33,600.00
3	Clerical (4 hours/year @ $45/hour)	30	YR	$180.00	$5,400.00
				Subtotal - Compliance Monitoring and Reporting	**$111,000.00**
Sampling and Analysis					
4	Approx. 10 Well Pairs (20 Wells) and 4 Surface Water Samples Tested Semi-Annually for 30 Years	60	EVENT	$42,000.00	$2,520,000.00
5	Leachate Sampling Semi-Annually for 30 Years	60	EVENT	$500.00	$30,000.00
				Subtotal - Sampling and Analysis	**$2,550,000.00**

Subtotal - Post-Closure Corrective Action Costs	**$2,661,000.00**

Additional Costs		
6	Contingency (assumed 15% of subtotal)	$399,150.00

30 Year Total	**$3,060,150.00**
30 Year Total per Acre (for 23.3 acres)	**$131,336.91**
Cost Per Year (Includes 15% Contingency)	**$102,005.00**
Cost Per Acre Per Year (for 23.3 acres)	**$4,377.90**

Construction Quality Assurance Plan

Dan River Landfill

Duke Energy – Dan River Steam Station

Eden, North Carolina

Amec Foster Wheeler Project No. 7810140065

NORTH CAROLINA PROFESSIONAL SEAL 036330 ENGINEER CEDRIC H. RUHL 8.26.15

To:	Duke Energy Carolinas, LLC
Date	August 26, 2015
From:	Amec Foster Wheeler

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1 Introduction

This Construction Quality Assurance (CQA) Plan is being submitted as part of the Construction Plan Application and was prepared for the proposed Dan River Landfill in accordance with Title 15A Subchapter 13B of the North Carolina Administrative Code (NCAC) to meet the requirements of 0.0503(2) and 0.0504(2) and 0.0505 for industrial landfills; and substantive requirements of Rules 0.1627-0.1629 for municipal solid waste (MSW) landfills. The proposed Dan River Landfill is an industrial landfill and therefore some of the requirements of the .1600 Rules do not apply.

This CQA Plan covers the construction of the proposed Dan River Landfill, which includes site preparation; grading for the proposed landfill; installing a liner system and leachate collection system (LCS) and a leachate detection system (LDS); and constructing perimeter berms.

2 Project Background

The project consists of permitting, designing, constructing, and operating an industrial landfill to accept coal combustion residual (CCR) materials at Dan River Steam Station. The objective of this CQA Plan is to outline the construction monitoring and testing program that will document that the facility was constructed in general accordance with the permitted design.

Landfill construction includes a combination of earthworks and geosynthetics construction. Landfill construction will begin by excavation and placement of compacted fill and subgrade fill to meet landfill liner system grades. The proposed landfill will include a liner system installed on the landfill subgrade. The liner system will consist of the following components (from top to bottom):

- 24-inch thick protective cover;
- Geocomposite drainage layer;
- Primary 60-mil HDPE geomembrane;
- Geocomposite leak detection layer;
- Secondary 60-mil HDPE geomembrane;
- Geosynthetic clay liner; and
- 12-inch thick compacted soil liner.

Once final waste grades have been achieved, the final cover system will be constructed. The final cover system will include the following components (from top to bottom):

- 6-inch thick vegetative soil cover;
- 18-inch thick final cover soil;
- Geocomposite drainage layer (or 8 oz/sy non-woven geotextile alternate);
- 40-mil thick double-sided textured linear low density polyethylene (LLDPE) geomembrane (or 50-mil LLDPE structured geomembrane alternate); and
- Interim soil cover layer.

The following CQA plan defines the roles and responsibilities of the CQA project team, as well as the CQA requirements for construction elements.

3 Project Team and Responsibilities

3.1 Owner

Duke Energy Carolinas, LLC (Duke Energy) is the project Owner. The Owner has overall responsibility for the project and will maintain the contractual relationships with the Design Engineer of Record (Engineer) and the Contractor(s).

3.2 CQA Project Team

The CQA Project Team will oversee construction of the landfill and will provide certification of landfill construction.

3.2.1 Design Engineer of Record (Engineer)

The Engineer is responsible for defining quality assurance requirements compatible with the project objectives, reviewing and approving shop drawings, reviewing and approving submittals, outlining procedures for the analysis of test data, and preparing quality assurance memorandums and quality assurance reports. The Engineer is responsible for design changes (as approved by the State Solid Waste Section), clarifications, and specification addenda. The Engineer also has the ultimate responsibility for approving or disapproving elements of the project. The responsibility to stop work is held by the Owner. CQA documents will be prepared, signed and sealed by the Engineer assuming the CQA firm is the same as the design firm. The Engineer will review field and laboratory test data on a regular basis. The Engineer will be a registered Professional Engineer in the State of North Carolina and will report to Duke Energy.

3.2.2 Construction Quality Assurance Agency

The Construction Quality Assurance Engineer (CQA Engineer)will be experienced in quality assurance testing and monitoring. The CQA Engineer will report to the Engineer and can be one in the same entity. The CQA Engineer serves as the on-site representative of the Owner and is responsible for the field implementation of the approved quality assurance program as follows:

- Monitor the quality assurance activities of the field testing and document conformance with test procedures and the Technical Specifications;
- Inform the Engineer of quality assurance activities and non-conformance to the approved CQA program, if any;
- Logging of geosynthetic samples and establishing laboratory conformance testing lots;
- Observe that sample handling procedures are in accordance with the appropriate guidelines for the testing to be conducted;
- Organize, assign, and direct engineering technicians; and
- Maintain an awareness of the overall field testing operations to identify conditions that may jeopardize the quality of testing.

3.2.3 Engineering Technicians

The engineering technicians (technicians) are responsible for field observations and testing at the direction of the CQA Engineer. Technicians will be assigned to the project as deemed necessary by the CQA Engineer. The CQA Engineer may perform and conduct field observations and testing himself. Technicians will be under the direct supervision of the CQA Engineer.

3.3 Contractor

The Contractor is the organization who the Owner has entered into a contractual agreement to complete the project construction. The Contractor and his subcontractors will be responsible for providing materials, labor, and equipment to complete the scope of work as defined in the contract documents. Often times, the Contractor is responsible for earthworks and general overall construction activities. It is anticipated that the Contractor may subcontract the liner system geosynthetics work to a specialized contractor referred to herein as the Geosynthetic Installer.

3.4 Pre-Construction Meeting

A pre-construction meeting shall be conducted prior to the start of construction. The meeting shall include, but not be limited to, discussion of:

- Health and safety;
- Construction management organization;
- Respective duties of the construction management organization and the Contractors;
- Proposed construction schedule;
- Testing requirements and procedures; and

- Periodic reporting requirements for test results and construction activities.

3.5 Progress Meetings

Progress meetings will be held on a regular basis, and as needed, between the Owner, Engineer, CQA Engineer, Contractor, and representatives of other involved parties. The status of the project, scheduled activities, and construction related subjects will be discussed.

3.6 Pre-Installation Meeting

A pre-installation meeting will be scheduled prior to geosynthetics installation. The Contractor, the Geosynthetics Installer, and the CQA Engineer shall attend the meeting. The meeting shall be held a minimum of two weeks prior to the Geosynthetics Installer's mobilization.

3.7 Troubleshooting Meetings

If problems develop or should deficiencies arise during construction, troubleshooting meetings shall be held between the Owner, Engineer, the CQA Engineer, the Contractor, and representatives of other involved parties. The problem(s) shall be defined and a resolution shall be discussed.

4 Compacted Fill

4.1 Material

Compacted fill is soil material placed to achieve proposed liner system subgrade elevations, establish berms, and access roads. Subgrade fill may consist of off-site and on-site soils that meet the project specifications and that are free of organic material, refuse, or debris. Fill located within 1-foot of geosynthetics shall have a maximum particle size of 3 inches with a maximum protrusion of ¼ inch above surrounding grades. The subgrade fill shall be constructed and compacted to meet the requirements outlined in Section 312000 of the Technical Specifications.

4.2 Construction

Subgrade fill will be compacted in lifts not exceeding 12 inches in compacted thickness. The Engineer may modify maximum allowable lift thickness depending on soil type used, construction equipment, and methods employed.

4.3 Observations

Prior to fill placement, the base surface or surface of the previous lift shall be observed. Soils shall be monitored to evaluate that the materials are free of deleterious materials and meet the specification requirements. During fill placement, observations of lift thickness and uniform mixing of soils will be performed.

4.4 Testing

Testing of subgrade fill will consist of both in-place and laboratory testing described as follows.

4.4.1 In-Place Testing

In-place field density and moisture content tests shall be performed as shown in Table 4.4.1. Where multiple test methods are listed, only one test method need be used.

Table 4.4.1 - In-Place Field Density Testing Requirements of Subgrade Fill

TEST	METHOD	FREQUENCY
Field Density	Sand Cone (ASTM D1556)	One (1) test per one (1) acre per lift
	Drive Cylinder (ASTM D2937)	
	Nuclear Gauge (ASTM D6938)	
Moisture Content	Field Moisture (ASTM D2216)	

Required field density and moisture content tests will be completed before the overlying lift of soil is placed. The surface preparation (e.g. wetting, drying, scarification, etc.) will be completed prior to placement of subsequent fill lifts.

4.4.2 Laboratory Testing

Bulk samples of the subgrade fill soils will be retained for each 10,000 cubic yards of soil placed. The Engineer may modify the number of bulk samples needed depending on the variability of the soils being placed. Laboratory testing will include, but not be limited, to the following tests:

Table 4.4.2 - Laboratory Testing Requirements of Subgrade Fill

TEST	METHOD	FREQUENCY
Water (Moisture) Content	ASTM D2216	One (1) test per 10,000 cubic yards
Particle Size	ASTM D422	
Liquid Limit, Plastic Limit, and Plasticity Index	ASTM D4318	
Standard Proctor Compaction Characteristics	ASTM D698	

5 Compacted Soil Liner

The compacted soil liner (CSL) shall be installed on the inspected prepared subgrade and will be overlain with a geosynthetic clay liner. The CSL will consist of on-site or off-site soils meeting the requirements outlined in the Section 312010 of the Technical Specifications.

5.1 Material

The CSL shall have a permeability on the order of 1.0×10^{-5} cm/sec. The CSL shall be composed of material void of debris, clods and any other contamination by foreign matter. The CSL shall be delivered on truck and preprocessed using pulverizing, harrow disking and other mechanical equipment used to condition the soil material in preparation for obtaining in-place moisture, density and permeability specifications.

5.2 Stockpiling, Borrow Area and Material Approval

Material to be used as compacted soil liner will be approved in advance by the Engineer. Final acceptance is based on upon successful completion of CQA testing outlined herein and in the Technical Specifications. Such testing can be performed either during excavation and stockpiling or from existing stockpiles prior to use.

The procedure for testing during excavation and stockpiling is outlined below:

- Each load of soil will be examined either at the borrow source or the stockpile area. Unsuitable material will be routed to separate stockpiles consistent with its end use.
- During stockpiling operations, one bulk sample will be collected for every 3,000 cubic yards of material stockpiled and tested in accordance with Section 5.7.

Approval reports of the material to be used as compacted soil liner will be prepared by the Engineer and will include a summary of laboratory test data; a drawing showing sample and test locations and limits of stockpile or borrow area investigated; and a summary of construction, sampling and testing methods, and recommendations.

5.3 Atterberg Limits

Atterberg Limits will be monitored and only material meeting the criteria for plasticity index stated in section 312010 of the Technical Specifications will be considered acceptable. Atterberg Limits will help to classify the various soils encountered and, in correlation with other soil properties, will assist in defining soil behavior such as permeability and compactability.

5.4 Test Pad

A test pad 35 ft x 100 ft in area shall be constructed inside or outside the landfill footprint using the same construction methods, equipment and material to be used for the compacted soil liner. Prior to compacted soil liner placement, the prepared subgrade shall be proof rolled with a loaded dump truck (minimum 20 tons) or similar rubber tired pneumatic vehicle, a minimum of two passes in each direction. Proofrolling shall be conducted at the discretion of the Engineer or his representative.

Compacted soil liner material shall be placed six-inch thick compacted lifts for the total minimize design thickness of the compacted soil liner. A minimum of 4 undisturbed samples will be obtained in the test pad by the CQA Engineer at a frequency of two samples per lift. The following laboratory tests will be performed on the undisturbed samples to document the soil's characteristics and to verify that the material, construction methods, and equipment can achieve a permeability of no greater than 1.0×10^{-5} cm/sec:

Table 5.4A - Laboratory Testing Requirements of Compacted Soil Liner Test Pad

TEST	METHOD	FREQUENCY
Liquid Limit, Plastic Limit, and Plasticity Index	ASTM D4318	One (1) test per lift
Particle Size with Hydrometer	ASTM D422	
Remolded Permeability	ASTM D5084	
Undisturbed Permeability	ASTM D5084	
Standard Proctor Compaction Characteristics	ASTM D698	

Field moisture and field density tests will also be performed by the CQA Engineer during soil placing and compaction to document the conditions obtained by the construction method, equipment and material to correlate with the required permeability of 1.0×10^{-5} cm/sec for the compacted soil liner test pad in accordance with the following table:

Table 5.4B – Field Density Testing Requirements of Compacted Soil Liner Test Pad

TEST	METHOD	FREQUENCY
Field Density	Sand Cone (ASTM D1556)	Three (3) tests per lift
	Drive Cylinder (ASTM D2937)	
	Nuclear Gauge (ASTM D6938)	
Moisture Content	Field Moisture (ASTM D2216)	

The Contractor shall coordinate with the Engineer and CQA Engineer to allow sufficient time for construction, testing, and evaluation of the test pad prior to placement of the compacted soil liner. If the initial test pad does not meet the required permeability (1.0×10^{-5} cm/sec), a second test pad shall be constructed prior to placement of the compacted soil liner. Based on the classification, density, moisture, and permeability testing performed on the test pad, the Engineer will determine the specified range of acceptable densities and moisture contents required to achieve a permeability of less than or equal to 1.0×10^{-5} cm/sec for the compacted soil liner material. If the compacted soil liner material differs in consistency to the material used in the test pad, the Engineer will require construction of another test pad with additional laboratory classification and permeability testing prior to placement. Test pads constructed inside the landfill footprint shall be removed prior to construction of the compacted soil liner unless the Engineer approves to remain in place.

5.5 Moisture Density-Permeability Relationships

The moisture-density relationships determined during materials evaluation testing will be used as a basis for determining the optimal moisture content and compaction to achieve the required permeability. The CQA Engineer will program the nuclear densitometer with the maximum dry density representative for the soil being placed in order to measure the in-place density and moisture content. This will enable the CQA Engineer to compare in-place density and moisture content to the moisture- density-permeability comparison test and approximate the in-situ permeability at that location. The CQA Engineer will also be

able to determine the percent compaction by comparing the in-place density to the maximum dry density and calculating the percent compaction.

5.6 Compaction

The Contractor shall make all required efforts to obtain the required compaction. The number of compactor passes required shall be evaluated based on the results of the test fill. One pass is defined as a compactor drum passing over a location one time. The first lift of the primary compacted soil layer shall be compacted with a smooth drum roller or a tamping foot compactor with feet no more than 3 to 4 inches in length and all equipment shall avoid sharp turns, sudden starts, and sudden stops. These measures are to protect the subgrade from damage. All subsequent lifts should be constructed in accordance with the previously mentioned techniques.

5.7 Construction Quality

Construction of the 12-inch compacted soil layer requires placement of low permeability soil on a maximum side slope of 3H: 1V (3 horizontal to 1 vertical). This slope may be too steep to construct the low permeability soil layers by normal practices. The construction of the low permeability soil layer on these side slopes may require construction equipment to be towed or winched up and down the side slopes. An alternative method of placement of the CSL on the side slopes may be suggested by the Contractor and the CQA Engineer shall evaluate the suggested technique based on the dynamic loadings. Due to the limited space and the location of the geosynthetics, a smaller tamping foot compactor with feet no longer than 3 to 4 inches may be required. A smaller compactor may require the placement of thinner lifts and/or additional passes to achieve compaction goals.

The loose lifts shall have a moisture content wet of the average optimum water content. The optimum practicable moisture content range will be determined for each source of CSL by the CQA Engineer, from the results of the materials evaluation testing and the test fill. In no case shall this range be less than the optimum moisture content from the Standard Proctor Curve of that material. The CQA Engineer will select the optimum practicable moisture content range to fall within the range of moisture contents encountered in the test fill which produced low permeability soil with a permeability of 1.0×10^{-5} cm/sec or less. When necessary, moisture will be added using approved sprinkling equipment, to provide an even distribution of moisture. The Contractor shall add sufficient water during rolling and tamping to assure complete compaction. If, in the judgment of the CQA Engineer, the material is too wet for satisfactory compaction, construction personnel shall temporarily stop work and allow the material to dry. To hasten the drying process, the material may be aerated by blading, disking, harrowing, or other methods and mixed thoroughly within the loose lift to ensure an even distribution of moisture prior to compaction.

The placement or compaction of low permeability soil will not be permitted during or immediately following rainfall. When rainfall is anticipated, the fill surface shall be sealed with a smooth drum roller. The surface of the fill shall be scarified prior to any subsequent placement of lifts. During compaction, the moisture content of the CSL soil shall be maintained in the optimum practicable moisture content range described above and shall be maintained uniformly throughout the lift. During hot and dry weather this may require the contractor to periodically wet the CSL surface to prevent the drying of the lift that could cause detrimental shrinkage cracking.

If desiccation cracks occur and they are 2 inches in depth or less, then powdered free flowing, high swelling, sodium bentonite may be used for filling the cracks. If the desiccation cracks are greater than 2 inches, but less than the depth of the disking blade (measured from the axle to the edge of the blade) are observed, bentonite use will not be acceptable and the surface will be rewetted, disked, recompacted and retested. If cracks greater than the depth of the disking blades are observed, then the entire lift will be removed, replaced and retested.

If the moisture content of the CSL at the borrow source is lower than the optimum practicable moisture content range, water shall be added and distributed within the CSL before final placement. If final adjustment is necessary, the CSL soil moisture content can be adjusted upward by disking, watering, and disking again. The method used should ensure an even distribution of moisture within the lift.

The CSL shall not be overworked. If any area requires more than twice the predicted number of passes to reach the required density then a one point check of the Proctor curve shall be performed. If this check indicates that the material properties have changed substantially, then a new Proctor curve shall be developed. In no case shall an overcompacted crust be formed on the top of a lift.

Compacted zones shall be constructed by placing CSL in horizontal lifts no less than 50 feet wide and compacted full width with the exception of the lifts placed on the side slope. The surface of each lift shall be scarified just prior to the placement of the next lift of CSL to ensure that the existing lift does not dry out and no construction seepage path or scars remain. Piles deposited by haul vehicles shall not exceed one rank beyond the spreading face. Each lift shall not be placed in excess of 500 linear feet without being compacted. Intermediate lifts shall also be rolled to seal the surface when subsequent lifts will not be placed until one calendar day later. Prior to the placement of subsequent CSL material, the sealed surface of the intermediate lifts will be scarified, moistened if required, and prepared to receive the next lift. Complete bonding of one placed lift to another shall take place along all contact surfaces.

One such contact surface occurs when a new lift of fill is being placed adjacent to an existing lift of fill; the existing lift of fill should be cut back at a maximum slope of 4H: IV to tie the two lifts together. A second important contact surface occurs when fresh CSL is placed over any area that was placed more than a few hours earlier. A third important contact surface occurs when CSLs from one borrow source comes in contact with compacted soil from a different source. The Quality Assurance Engineer shall determine other contact surface situations. At a minimum, the previously placed low permeability soil at any contact surface should be scarified and adjusted to the proper moisture content prior to placement of subsequent layers.

The measured in-place dry density immediately after low permeability soil compaction shall equal or exceed 95 percent of the Maximum Standard Proctor dry density from the most recent representative Standard Proctor curve developed for that CSL from the borrow source. The measured in-place dry density and moisture content shall then be compared to the most representative moisture-density-permeability comparison test to approximate the in-situ permeability at that location.

Nuclear density methods are preferred for all density testing. Nuclear density test locations will be determined by the on-site monitor with consideration given to evenly distributing the test locations over the constructed lift and as directed by the Engineer or CQA Engineer. Questions concerning the accuracy of any single test shall be addressed by retesting in that or another location. Nuclear density methods shall be used as the primary testing method due to its ease of operation and quick output of results. The calibration of each nuclear densitometer shall be checked daily by comparison to the standard block for that specific instrument. The Quality Assurance Engineer will program the nuclear densitometer with the maximum dry density of the soil actually being placed. The testing for in-situ hydraulic conductivity from undisturbed soil samples (Shelby tubes) will not be permitted until the in-place soil moisture and density measurements have been completed and approved by the Quality Assurance Engineer. All areas disturbed by the test methods mentioned in this section will be backfilled with granular free flowing, high swelling sodium bentonite.

The top surface of each completed CSL barrier shall be smooth and the upper 6 inches adjacent to the geosynthetic clay liner shall have a maximum protrusion size of ¼ inch.

Lift thicknesses, water content, compactor weight (compactive effort) and the number of passes of the compacting equipment will be adjusted as required to obtain the specified density and permeability. Construction monitoring evaluation of the construction work will include the following:

- Observations and recording of the water content and other physical properties of the soil during processing, placement and compaction
- Observations and recording of the thickness of lifts as loosely placed and compacted
- Observation and recording of the use of proper equipment for the construction (e.g., sheepsfoot vs. smooth drum compaction, discs for scarifying and drying, if necessary) and effective use of same to properly prepare materials

- Observations and recording of the action of the compaction and heavy hauling equipment on the construction surface (sheepsfoot penetration, pumping, cracking, etc.)
- Observation and recording of the average number of passes used for compaction of each lift.

5.8 Testing

The CQA Engineer or his technician will monitor the construction of the compacted soil liner and perform field and laboratory tests to verify that the soils and construction methods are capable of meeting the specification performance criteria.

5.8.1 In-Place Testing

In-place Sampling and testing of the compacted soil liner shall be as follows:

Table 5.7.1 - Conformance Field Testing Requirements of the CSL

TEST	METHOD	FREQUENCY
Field Density	ASTM D2937	Every other lift in each 100 foot by 100 foot grid. Adjacent grids shall have alternate lifts tested.
Natural Moisture Content	ASTM D2216	At every density test location and at least once per every 800 cubic yards placed.

5.8.2 Laboratory Testing

Laboratory testing will be conducted on samples including:

Table 5.7.2 - Conformance Laboratory Testing Requirements of the CSL.

TEST	METHOD	FREQUENCY
Standard Proctor	ASTM D-698	Once per every 3000 cubic yards at stockpile or borrow area.
Atterberg Limits	ASTM D-4318	Once per every 3,000 cubic yards at stockpile or borrow area.
Grain Size with Hydrometer	ASTM D-422	Once per every 3,000 cubic yards at stockpile or borrow area.
Remolded Permeability	ASTM D-5084	Once per every 3,000 cubic yards at stockpile or borrow area.

6 Geosynthetic Clay Liner

The geosynthetic clay liner (GCL) shall be installed on the prepared compacted soil liner and overlain with a HDPE geomembrane.

6.1 Material

The GCL shall have a permeability on the order of 2.48×10^{-9} cm/sec. The GCL shall be dry and free of holes or any sign of contamination by foreign matter. The GCL shall be shipped rolled with a protective wrap around each roll, and shall be labeled with a unique roll number. The GCL shall be tested, handled, and installed in accordance with the requirements of the Technical Specifications and the following Sections.

6.2 Geosynthetic Manufacturer and Contractor

The Geosynthetic Installer is the party responsible for the installation of the GCL. The manufacturer is the party that supplies the geosynthetic products.

6.2.1 Manufacturer Submittals

The Geosynthetic Installer will submit the following as obtained from the geosynthetic manufacturer to the Engineer:

- Manufacturer (MQC) material certification for the GCL and materials used in manufacturing them;
- MQC Test data for GCL material. The results of these tests must meet the minimum required physical properties for GCL specified in Table 312015-A of the Technical Specifications; and manufacturers recommended installation instructions.

6.2.2 Contractor Submittals

The Geosynthetic Installer shall submit representative samples of the GCL material to the Engineer or a designated laboratory. The Engineer shall perform interface friction testing on representative samples to evaluate that the proposed materials are in compliance with Section 312015 of the Technical Specifications.

6.3 GCL Material Testing

Testing of GCL will consist of both MQC and conformance testing, described as follows.

6.3.1 Manufacturer Quality Control Testing

The manufacturer shall sample and test the GCL material prior to shipment to the site at the minimum frequencies specified in Table 6.3.2 of the Technical Specifications.

Any sample that does not comply with the requirements of Section 312015 of the Technical Specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no additional cost to the Owner. The Contractor shall require the manufacturer to sample and test each roll manufactured in the same lot or batch, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until acceptable results are established.

6.3.2 Conformance Testing

The CQA Engineer shall obtain samples for conformance testing. Samples may be obtained prior to shipment at the manufacturing facility by the Engineer or the geosynthetic laboratory. The minimum number of samples shall be one per 100,000 ft^2. The samples must be representative of the materials supplied and exclude the outer wrap of material if evidence of scuffing or other damage is observed. Samples should extend across the full roll width and shall not include the first 3 feet and be at least 3 feet wide.

Representative samples will be sent to a geosynthetics laboratory approved by the Engineer for conformance testing. The laboratory testing program will be directed by the CQA Engineer and include but not be limited to the following tests:

Table 6.3.2 - Conformance Testing Requirements of GCL

TEST	METHOD	FREQUENCY
Bentonite Mass per Unit Area	ASTM D5993	One (1) test per 100,000 square feet
Hydraulic Conductivity	ASTM D5887	
Peel Strength	ASTM D6496	
Tensile Strength	ASTM D6768	
Internal Shear Strength	ASTM D6243	One (1) test per 400,000 square feet

If samples do not comply with the requirements of Section 312015 of the Technical Specifications, the roll of GCL that is in nonconformance shall be replaced at no additional cost to the Owner. The Geosynthetic Installer shall perform additional conformance testing on the closest numerical roll on both sides of the failed roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.

The CQA Engineer shall monitor the rolls upon delivery to the site and report observed deviations from the requirements found in Section 312015 of the Technical Specifications to the Contractor. At the

Engineer's discretion, the CQA Engineer or his representative will sample rolls from each shipment of GCL delivered to the site.

6.4 GCL Installation

Ensure acceptance of underlying layers before installing overlying layers. The Geomembrane Installer, Contractor, Engineer, and CQA Engineer shall provide written acceptance daily for the surface to be covered by geosynthetic clay liner in that day's operations. The surface shall be maintained as acceptable during GCL installation. A single form shall be used and signed by all parties to document acceptance each day.

Unroll only those sections that are to be overlain by a geomembrane in one day. Panels should be positioned with the overlap recommended by the manufacturer, but not less than 6 inches for panel sides and 24 inches for panel ends.

Granular bentonite of the same type as the bentonite used for the GCL shall be placed along the entire overlap width at a minimum rate of 0.25 lbs/linear foot or as recommended by the Manufacturer. If using a GCL product with self-seaming edges, this qualification may be omitted if approved by the Engineer.

After panels are initially placed, remove wrinkles as directed by the Engineer. Unroll several panels and allow the GCL to "relax" before proceeding with adjacent panels so that the edges to be overlapped are smooth. The panels shall be placed so that the up gradient edge is overlying the down gradient edge so that potential silt run-off does not accumulate under a lapped seam. Once panels are in place and smooth, commence placement of the overlying geomembrane.

If exposed GCL panels cannot be covered by a geomembrane prior to the end of a working day, exposed panels or sections of panels shall be temporarily covered with plastic or other Engineer approved water proof material and ballasted to prevent hydration until geomembrane placement can commence.

If GCL panels become saturated from rainfall or other surface water run-on and exhibit bentonite swelling prior to placement of the geomembrane, the saturated sections of GCL shall be immediately removed and replaced at the Contractor's expense.

Any damaged areas exhibiting rips or tears shall be patched with a minimum 12-inch overlap and fastened with construction adhesive.

6.5 Acceptance and Closeout Procedures

The Geosynthetic Installer shall observe and check all phases of the GCL installation. Upon completion of liner system construction, the Geosynthetic Installer shall submit a Letter of Acceptance to the Owner that the installation conforms to the requirements of the Manufacturer.

7 Geomembrane

Geomembranes are incorporated as part of the bottom liner system (both primary and secondary geomembranes) and the cover cap system as described in the following sections

7.1 Material

The geomembrane for the landfill liner system will be a primary and secondary 60-mil textured on both sides high density polyethylene (HDPE) geomembrane as defined in Technical Specification Section 313200.

The geomembrane for the landfill cover system will consist of a 40-mil double-sided textured liner low density polyethylene (LLDPE) geomembrane as defined in the Technical Specification Section 313205.

7.2 Geosynthetic Manufacturer and Construction

The Geosynthetic Installer is the party responsible for installation of the geomembrane. The manufacturer is the party that supplies the geosynthetic products.

7.2.1 Manufacturer Submittals

The Geosynthetic Installer will submit the following as obtained from the geosynthetic manufacturer to the CQA Engineer:

- Test data for material and resin for each liner type. The results of these tests must meet the minimum required physical properties for HDPE geomembrane specified in tables 313200-A, and 313205-B of the Technical Specifications
- MQC Material Certification for liner rolls and resin used in manufacturing them
- Description of spark testing and Manufacturer Quality Control (MQC) Program for testing the geomembrane material and resin. These tests are discussed in the Technical Specification 313200 and 313205.
- Manufacturer's installation instructions
- Proposed geomembrane panel layout

7.2.2 Contractor Submittals

The Geosynthetic Installer will submit the following to the Engineer prior to installation for review:

- A materials properties sheet for each geomembrane product, including at a minimum all properties, test methods, and test values as required by Specifications 313200 and 313205.
- Example material warranty and liner installation guarantee as required by Specifications 313200 and 313205.
- The "Geosynthetic Contractor Qualifications Questionnaire" included in the contract bid documents.

The Geosynthetic Installer will submit representative samples of the proposed geomembrane to the Engineer or a geosynthetic testing laboratory as directed by the Engineer. The CQA Engineer or his representative shall perform interface friction testing to evaluate the interface shear strength between the geomembrane and the overlying and underlying materials, as specified in Section 313200, and 313205 of the Technical Specifications.

7.3 Geomembrane Material Testing

Testing of geomembrane will consist of both MQC and conformance testing, described as follows.

7.3.1 Manufacturer Quality Control Testing

The manufacturer shall sample and test the geomembrane material prior to shipment to the site, at minimum frequencies specified in 313200-A and 313205-A of the Technical Specifications.

Any geomembrane sample that does not comply with the requirements of Technical Specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no additional cost to the Owner. The Contractor shall require the manufacturer to sample and test each roll manufactured in the same lot or batch, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until acceptable results are established.

7.3.2 Conformance Testing

The CQA Engineer shall obtain samples for conformance testing. Samples may be obtained prior to shipment at the manufacturing facility by the Engineer or the geosynthetics laboratory. The minimum number of samples shall be one per 100,000 ft^2. The samples must be representative of the materials supplied and exclude the outer wrap of geomembrane if evidence of scuffing or other damage is observed. Samples should extend across the full roll width and be at least 3 feet wide.

Representative samples will be sent to a geosynthetics laboratory approved by the Engineer for conformance testing. The laboratory testing program will be directed by the Engineer and include, but not be limited, to the following tests:

Table 7.3.2 - Conformance Testing Requirements of Geomembrane.

TEST	METHOD	FREQUENCY
Thickness	ASTM D5199 and/or ASTM D5994	One (1) test per 100,000 square feet
Asperity height	ASTM D7466	
Density	ASTM D1505 and/or ASTM D792	
Carbon black content	ASTM D1603	
Tensile Properties	ASTM D6693	
Tear Resistance	ASTM D1004	

If a representative sample does not comply with the requirements of Section 313200, and 313205 of the Technical Specifications, the roll of geomembrane that is in non-conformance shall be replaced at no additional cost to the Owner. The Geosynthetic Installer shall perform additional conformance testing on the closest numerical roll on both sides of the failed roll. Sampling and testing of rolls shall continue until acceptable results are established.

The CQA Engineer or his representative shall monitor the rolls upon delivery to the site and report observed deviations from the requirements of the Technical Specifications to the Contractor. At the Engineer's discretion, the CQA Engineer or his representative may sample rolls from each shipment of geomembrane delivered to the site.

7.4 Geomembrane Installation

7.4.1 Meetings

A geosynthetics pre-installation meeting will be held prior to beginning geosynthetic installation. At a minimum, the Contractor, Geosynthetic Installer, Engineer or his representative, and a representative of the Owner will be in attendance. The Technical Specifications, quality assurance, and quality control procedures will be reviewed and discussed.

7.4.2 Field Panel Identification

The Geosynthetic Installer shall number each panel with an identification code using the format P1, P2, etc. Panels in the field must be numbered in the order in which the panels are actually laid regardless of pre-construction numbering. The CQA Engineer or his representative will record the location and date of installation of each panel using the identification code.

7.4.3 Field Seaming

Field seaming shall be in accordance with the US EPA. Technical Guidance document: "The Fabrication of Polyethylene FML Field Seams" EPA/530/SW-89/069 and/or according to the Technical Specifications. Seaming may be extrusion or fusion welding or a combination of these methods. The Engineer reserves the right to reject any proposed seaming method believed to be unacceptable. Additional concepts and requirements of proper field seaming are found in the Technical Specifications.

Adjoining liner panels shall be overlapped as recommended by the manufacturer, but not less than 4 inches, by adequately lapping the edges of the sheets. The overlap shall not exceed 6 inches for double-wedge fusion welds.

Section 313200, and 313205 of the Technical Specifications provides more in depth details on the general requirements for liner handling, placement, field seaming, and installation.

7.4.4 Test Seams

The Geosynthetic Installer will perform test seams at the beginning of each seaming period, after any interruption in power, after any prolonged idle period during the day, when changes in storing equipment occur, and at the request of the Engineer at any other time during the day. A test seam shall be made for

each texture contact type to be seamed by that welder during the working increment (i.e. smooth/smooth for edge seams, texture/texture for butt seams, etc.)

The CQA Engineer or his representative may request additional test seams according the Technical Specifications. The test seam should be approximately 6 feet long. The CQA Engineer or his representative will sample the test seam from the center 3 feet of the test sample.

The welder, date, time and equipment, as well as liner temperature, welding temperature, and seaming parameters will be recorded in the Geomembrane Trial Seam Log by the CQA Engineer or his representative for each test seam.

A minimum of six specimens from each sample will be tested with three in peel and three in shear. Film Tear Bond (FTB) type failures will be the criterion for qualification of the test seam. Testing will be performed in the field by the Geosynthetic Installer under full-time observation by the CQA Engineer or his representative.

Untested portions of the test seam will be retained by the CQA Engineer at his or her discretion for the project records and future testing, as required.

All test seams must pass the field testing requirements presented in Tables 313200-B, and 313205-B of the Technical Specifications before production seaming is performed by the Geosynthetic Installer.

7.4.5 Seam Monitoring

During seaming, the CQA Engineer or his representative will observe the seams for the proper preparation, grinding technique and for evidence of overheating. Where observations indicate that repairs are needed, the method of repair will be evaluated in the field by the CQA Engineer or his representative. The repairs will be logged in the Geomembrane Repair Testing Log CQA Engineer or his representative.

At the discretion of the CQA Engineer, coupons may be cut from the end of the extrusion seams and the bottom side of the seam will be observed for visible warping or deformation.

The CQA Engineer or his representative will observe the geomembrane during the cooler parts of the day to check for slack. Any areas where "trampolining" occurs will be marked and logged in the Geomembrane Defect Log by the Engineer for repair by the Geosynthetic Installer.

All repair locations shall be patched and tested in accordance with Sections 313200, and 313205 of the Technical Specifications prior to acceptance. All patches shall extend a minimum of 6 inches beyond the repair location. All repairs will be logged in the Geomembrane Repair Testing Log by the CQA Engineer or his representative.

7.4.6 Non-Destructive Testing

The Geosynthetic Installer is responsible for non-destructive testing of the entire length of field seams. The testing will be vacuum, air pressure and/or spark testing as outlined in the Technical Specifications.

Non-destructive testing will be monitored by the CQA Engineer or his representative on a full-time basis.

7.4.7 Field Destructive Testing

Field destructive testing (FDT) shall be conducted periodically at the discretion of the CQA Engineer or Engineer. The Geosynthetic Installer will obtain 12-inch wide by 42-inch long samples of field seams for testing. The name of the sample (e.g. FDT-1), date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer or his representative in the Geomembrane Defect Log.

Samples retained will be tested in the field by the Geosynthetic Installer. A minimum of three specimens with dimensions of 12 inches wide by 1 inch long from each sample will be tested in peel (ASTM D6392). FTB type failures will be the criterion for qualification of the production seam.

7.4.8 Laboratory Destructive Testing

Destructive seam samples will be tested by the CQA Engineer or his representative. Testing frequency is at least one sample per 500 cumulative linear feet of field seam at locations specified by the CQA Engineer or his representative. The name of the sample (e.g. LDT-1), date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer or his representative in the Geomembrane Defect Log. Test samples will be at least 54 inches long and 12 inches wide.

A minimum of five peel specimens will be tested for each sample in accordance with ASTM D6392. At least five specimens from each sample will be tested for bonded shear strength in accordance with ASTM D6392. Peel tests will be performed on both sides of a double-wedge fusion seam. The preference is for the CQA Engineer to establish an on-site laboratory to the satisfaction of the Engineer for performing laboratory destructive tests.

7.4.9 Repair Procedures and Verification

The Geosynthetic Installer shall visually inspect the geomembrane surface for defects. Portions of the geomembrane exhibiting defects, or failing a destructive or nondestructive test, must be repaired by the Geosynthetic Installer. Repairs shall be made in accordance with the Technical Specifications.

Each liner repair shall be recorded by the CQA Engineer or his representative in the Geomembrane Repair Testing Log including the date of repair, liner panel identification number, repair location, type of defect, cause of defect, and details of repairs made. Each repaired area shall be required to pass non-destructive testing. Large repair areas may require destructive test sampling.

7.4.10 Acceptance and Closeout Procedures

The Contractor is responsible for providing a record drawing of the geomembrane installation. The record drawings shall include panel corners, transitions in panel geometry, repair locations, the outside bottom corner of the anchor trench, and other significant features. Survey timing should be coordinated with the Geosynthetics Installer and the CQA Engineer so as not to impact the geosynthetics construction schedule.

The Geosynthetic Installer's supervisor shall observe and check all phases of the geomembrane installation. Upon completion of liner system construction, the Geosynthetic Installer shall submit a Letter of Acceptance to the Owner that the installation conforms to the requirements of the Manufacturer.

8 Geocomposite Drainage Layer

Geocomposite drainage layers are incorporated as part of the LCL, liner (bottom) drainage layer and drainage cover (cap) system.

8.1 Materials

The geocomposite drainage layer shall consist of an HDPE geonet drainage core with nonwoven geotextiles heat bonded to each side.

8.2 Geocomposite Manufacturer and Contractor

The Geosynthetic Installer is the party responsible for installation of the geocomposite. The manufacturer is the party that supplies the geosynthetic products.

8.2.1 Manufacturer Submittals

The Geosynthetic Installer will submit the following as obtained from the geosynthetic manufacturer to the CQA Engineer:

- Manufacturer's product information and manufacturer quality control test results. The results of these tests must meet the minimum required physical properties for geocomposite specified in Table 313220-B of the Technical Specifications
- Manufacturer's installation instructions

8.2.2 Contractor Submittals

The Geosynthetic Installer shall submit a materials property sheet for each geocomposite product, including at a minimum all properties, test methods and test values as required by Section 313220 in the Technical Specifications.

8.3 Geocomposite Material Testing

Testing of geocomposite will consist of both MQC and conformance testing, described as follows.

8.3.1 Manufacturer Quality Control Testing

The manufacturer shall sample and test the geocomposite material prior to shipment to the site, at minimum frequencies specified in table 313220-A of the Technical Specifications.

Any geocomposite sample that does not comply with the requirements of Section 313220 of the Technical Specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no additional cost to the Owner. The Contractor shall require the manufacturer to sample and test each roll manufactured in the same lot or batch, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until acceptable results are established.

8.3.2 Conformance Testing

The CQA Engineer shall obtain samples for conformance testing. Samples may be obtained prior to shipment at the manufacturing facility by the Engineer or the geosynthetic laboratory. The minimum number of samples shall be one per 100,000 ft^2 or 1 per lot, whichever provides the larger number of tests. Samples should extend across the full roll width and be at least 3 feet wide.

The CQA Engineer shall obtain representative samples of protective cover material for liner system construction or final cover soil for cover system construction to perform conformance testing of the soil/geotextile system.

Representative samples of the geocomposite and protective cover material will be sent to a geosynthetics laboratory approved by the Engineer for conformance testing. The laboratory testing program will be directed by the Engineer and include but not be limited to the following tests:

Table 8.3.2 - Conformance Testing Requirements of Geocomposite

TEST	METHOD	FREQUENCY
Thickness	ASTM D5199	One (1) test per 100,000 square feet
Density	ASTM D1505	
Ply Adhesion	ASTM D7005	
Transmissivity	ASTM D4716	
Hydraulic Conductivity Ratio (HCR) Testing of Soil/Geotextile Systems	ASTM D5567	Minimum of three (3) tests

If a representative sample does not comply with the requirements of Section 313220 of the Technical Specifications, the roll of geocomposite material that is in nonconformance shall be replaced at no additional cost to the Owner. The Geosynthetic Installer shall perform additional conformance testing on the closest numerical roll on both sides of the failed roll. Sampling and testing of rolls shall continue until a pattern of acceptable results is established.

The CQA Engineer shall monitor the geocomposite rolls upon delivery to the site and report observed deviations from the requirements found in Section 313220 of the Technical Specifications to the Contractor. At the CQA Engineer's discretion, the CQA Engineer or his representative will sample rolls from each shipment of geocomposite delivered to the site.

8.4 Geocomposite Installation

Each component of the geocomposite shall be secured or seamed to the like component at overlaps. The geocomposite shall be joined and repaired according to Section 313220 of the Technical Specifications. The CQA Engineer will observe geocomposite installation and repairs.

8.5 Acceptance and Closeout Procedures

The Geosynthetic Installer shall observe and check all phases of the geocomposite installation. Upon completion of liner system construction, the Geosynthetic Installer shall submit a Letter of Acceptance to the Owner that the installation conforms to the requirements of the Manufacturer.

9 Nonwoven Geotextile

Non-woven geotextiles are incorporated as part of the LCS and cover system.

9.1 Materials

A non-woven geotextile shall be used for separation/filtration and cushioning in the leachate collection and detection system and for separation/filtration in the alternative cover system in conjunction with a -40mil textured LLDPE structured geomembrane with integral drainage layer.

9.2 Geosynthetic Manufacturer and Contractor

The Geosynthetic Installer is the party responsible for installation of the non-woven geotextile. The manufacturer is the party that supplies the geosynthetic products.

9.2.1 Manufacturer Submittals

The Geosynthetic Installer will submit manufacturer quality control test data to the CQA Engineer. Test data for geotextile material. The results of these tests must meet the minimum required physical and hydraulic properties for geotextile specified in Table 313240-B found in Section 313240 of the Technical Specifications.

9.2.2 Contractor Submittals

The Geosynthetic Installer shall submit a material properties sheet for the geotextile, including at a minimum all properties, test methods and test values as required by section 313240 in the Technical Specifications.

9.3 Geotextile Material Testing

Geotextile will consist of both manufacturer quality control and conformance testing, described as follows.

9.3.1 Manufacturer Quality Control Testing

The manufacturer shall sample and test the geotextile material prior to shipment to the site, at minimum frequencies specified in Table 313240-A found in Section 313240 of the Technical Specifications.

Any geotextile sample that does not comply with the requirements of Section 313240 of the Technical Specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no additional cost to the Owner. The Contractor shall require the manufacturer to sample and test each roll manufactured in the same lot or batch, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until acceptable results are established.

9.3.2 Conformance Testing

The need for conformance testing will be as specified by the Engineer.

9.4 Geotextile Installation

The non-woven geotextile shall be continuously sewn at the seams. Geotextiles shall be overlapped a minimum of 6 inches overlap. Any holes or tears in the geotextile shall be repaired with a patch made from the same geotextile. The CQA Engineer will monitor repairs.

10 HDPE Pipe

HDPE Piping will be installed during the construction of the LCS.

10.1 Material

HDPE pipes consist of perforated and non-perforated HDPE piping ranging in sizes indicted on the Engineering Drawings. Pipe wall thicknesses are specified in terms of the standard dimension ratio (SDR) as indicated in the Engineering Drawings.

10.2 HDPE Pipe Manufacturer and Contractor Submittals

The supplier of the HDPE pipe shall provide the CQA Engineer with the manufacturer's Technical Specifications and quality control information.

10.3 HDPE Pipe Installation

Butt fusion welding of the pipe shall be monitored by the CQA Engineer or his representative.

Butt fusion welds shall exhibit a uniform melt bead. The melt bead shall be removed or reamed from the interior of the pipe prior to placement.

Pressure testing of the HDPE sump discharge lines and force main will be performed by the Contractor and observed by the CQA Engineer or his representative. The pressure and time at the beginning and end of the test will be recorded for each section of pipe tested. The Contractor will repair pipe sections not meeting the test requirements at no cost to the Owner.

The contractor shall perform camera inspections on all LCS system piping within the landfill limits to demonstrate the pipe is free of obstructions and capable of conveying camera equipment.

10.4 Acceptance and Closeout Procedures

The Contractor is responsible for providing record drawings of the completed HDPE pipe installation. The record drawings shall include LCS pipe locations within the cell, LCS pipe cleanout locations, and leachate force main locations at a spacing that is adequate to identify the position of the pipe. Survey timing should be coordinated with the Geosynthetics Installer and the CQA Engineer so as not to impact the construction schedule of the geosynthetics and overlying materials.

11 Protective Cover Soils

Protective cover material will be placed over the geosynthetic liner system to protect the liner system during landfill operation.

11.1 Material

The protective cover will consist of on-site or off-site soils which are free of organic material refuse or debris placed directly over the geosynthetic liner system components. Protective cover material may also consist of CCR materials that meet the project specifications.

11.2 Construction

Placement of the protective cover will be placed in one lift in a method to be approved by the Engineer. The CQA Engineer will monitor operational cover placement on a full-time basis.

Wrinkles in the underlying geosynthetics resulting from protective cover placement will be "walked out" prior to additional protective cover placement. Excessive wrinkles will be observed by the CQA Engineer for possible repair by the Geosynthetic Installer.

The final surface of the protective cover will be rolled with a non-vibratory smooth drum roller.

When placing protective soil cover, do not drive directly on the geosynthetic materials. Only use equipment to place, spread, and compact soil fill that produces ground pressures compliant with the following for minimum thickness over geosynthetic materials: less than 5 psi for overlying thickness of 12 inches and less than 10 psi for overlying thickness of 18 inches.

11.3 Testing

The protective cover testing will consist of the laboratory testing described as follows.

11.3.1 In-Place Testing

In-place testing of protective cover is not required. However, the CQA Engineer or his representative will monitor protective cover placement.

11.3.2 Laboratory Testing

Bulk samples of the protective cover will be retained for each 3,000 cubic yards of material placed. The CQA Engineer may reduce or increase the number of bulk samples needed depending on the variability of the soil being used. Laboratory testing will include but not be limited to the following tests:

Table 11.3.2 - Laboratory Testing Requirements of Protective Cover

TEST	METHOD	FREQUENCY
Moisture Content	ASTM D2216	One (1) test every 3,000 cubic yards
Atterberg Limits	ASTM D4318	
Grain Size	ASTM D422	

12 Final Cover Soil and Vegetation

Final cover soil consists of compacted fill, referenced as compacted soil cover in Section 4 of this CQA Plan, and vegetative cover. The compacted soil cover and vegetative cover will be at least 2 feet thick and placed and compacted in accordance with Section 312000 of the Technical Specifications and this CQA Plan.

The thickness of the final cover soil will be randomly tested by the CQA Engineer to verify adequate coverage.

12.1 Construction

Placement of the final cover will be placed in minimum 12-inch thick lifts in a method to be approved by the Engineer. The CQA Engineer will monitor final cover placement.

Wrinkles in the geosynthetics resulting from final cover placement will be "walked out" prior to additional material placement. Excessive wrinkles will be observed by the CQA Engineer for possible repair by the Geosynthetic Installer.

The final surface of the final cover will be rolled with a non-vibratory smooth drum roller.

When placing final cover, do not drive directly on the geosynthetic materials. Only use equipment to place, spread, and compact soil fill that produces ground pressures compliant with the following for minimum thickness over geosynthetic materials: less than 5 psi for overlying thickness of 12 inches and less than 10 psi for overlying thickness of 18 inches.

12.2 Testing

The final cover soil testing will consist of in-place and laboratory testing described as follows.

12.2.1 In-Place Testing

In-place sampling and testing of the final cover soil shall be as follows:

Table 12.2.1 - In-Place Field Density Testing Requirements of Final Cover Soil

TEST	METHOD	FREQUENCY
Field Density	Sand Cone (ASTM D1556)	One (1) test per one (1) acre per lift
	Drive Cylinder (ASTM D2937)	
	Nuclear Gauge (ASTM D6938)	
Moisture Content	Field Moisture (ASTM D2216)	

12.2.2 Laboratory Testing

Bulk samples of the final cover will be retained for each 10,000 cubic yards of soil placed. The CQA Engineer may reduce or increase the number of bulk samples needed depending on the variability of the soil being used. Laboratory testing will include but not be limited to the following properties:

Table 12.2.2 - Laboratory Testing Requirements of Final Cover Soil

TEST	METHOD	FREQUENCY
Water (Moisture) Content	ASTM D2216	One (1) test per 10,000 cubic yards
Particle Size	ASTM D422	
Liquid Limit, Plastic Limit, and Plasticity Index	ASTM D4318	
Standard Proctor Compaction Characteristics	ASTM D698	

13 Record Drawings

The Contractor shall retain a third-party surveyor registered in the state that the work is performed. The Contractor shall be responsible for submitting to the Engineer the following:

- Existing Conditions Survey
- Final Subgrade Survey
- Compacted Soil Liner Survey
- Secondary Geomembrane Survey
- Primary Geomembrane Survey
- Protective Cover Survey
- Installed leachate piping elevations and locations
- Installed stormwater piping elevations and locations
- Material certification and warranty information for installed material and equipment
- Final Cover Survey

The final subgrade, protective cover, and final cover topographic surveys shall be performed on a 100-foot grid with anchor trenches, berms, toes, crests and breaks-in-slope also surveyed. Topographic surveys shall be performed on the same grid such that survey point locations are consistent with the survey points of the underlying layer. Surveys shall also include a table summarizing northings, eastings, and elevations for each grid point to provide a comparison for thickness verification. Surveys shall also show contours of the completed surface at two-foot contour intervals.

The geomembrane as-built drawing shall include panel corners, transitions in panel geometry, repair locations, the outside bottom corner of the anchor trench, and other significant features. Survey timing should be coordinated with the Geosynthetics Installer and the CQA Engineer so as not to impact the construction schedule of the geosynthetics. This does not replace the required Panel Layout As-Built to be submitted by the Geosynthetic Installer.

As-built locations and details for construction of the LCS shall also be submitted to the Engineer by the Contractor. Drawings shall include LCS pipe locations within the cell, LCS pipe cleanout locations, and leachate force main locations at a spacing that is adequate to identify the position of the pipe. Survey timing should be coordinated with the Geosynthetics Installer and the CQA Engineer so as not to impact the construction schedule of the geosynthetics and overlying materials.

14 Certification Report

The Engineer will prepare a certification report upon cell completion. The certification report will contain test results and monitoring documentation performed for construction including:

- Compacted fill and subgrade fill for cell floor, berms, roadways and surface water control structures
- Liner system geosynthetics installation including:
  - MQC data and test results
  - CQA data, test results, and documentation
- LCS piping information
- Cover system geosynthetics installation including:
  - MQC data and test results
  - CQA data, test results, and documentation
- Geosynthetic Clay Liner
- Geocomposite Drainage Layers
- Compacted soil cover
- Final cover soil

Portions of the above items may be submitted to the Division of Waste Management as individual certification reports during construction. Following construction, the individual certification reports shall be compiled into one certification report for the final closure submittal.

Record drawings and a comprehensive narrative of the construction process and CQA activities, including daily reports from the CQA Engineer and documentation of progress meetings, will be included with the certification report. Color photographs of key elements for landfill construction shall also be included in the certification report.

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DAN RIVER LANDFILL
DUKE ENERGY CAROLINAS, LLC
ROCKINGHAM COUNTY, NORTH CAROLINA

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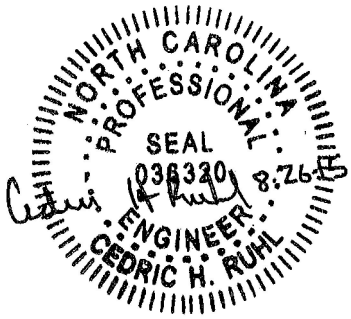

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:

1. Section 312000 “Earth Moving” for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.
2. Section 312005 “Trenching” for excavating, backfilling and compacting utility trenches.

1.2 REFERENCES

A. American Concrete Institute (ACI):

1. ACI 301, Specifications for Structural Concrete.
2. ACI 305.1, Specification for Hot Weather Concreting.
3. ACI 306.1, Standard Specification for Cold Weather Concreting.
4. ACI 318, Building Code Requirements for Structural Concrete.
5. ACI-MCP Manual of Concrete Practice (1-74).

B. ASTM International:

1. ASTM A185, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
2. ASTM C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
3. ASTM C33, Standard Specification for Concrete Aggregates.
4. ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
5. ASTM C143, Standard Test Method for Slump of Hydraulic Cement Concrete.
6. ASTM C150, Standard Specification for Portland Cement.
7. ASTM C172, Standard Practice for Sampling Freshly Mixed Concrete.
8. ASTM C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
9. ASTM C260, Standard Specification for Air Entraining Admixtures for Concrete.
10. ASTM C494, Standard Specification for Chemical Admixtures for Concrete.

1.3 SUBMITTALS

A. Product Data: For each type of product.

1. Concrete mix design at least 14 days prior to using the mixture.

B. Design Data:

1. Submit the following to the Engineer, for review and approval, prior to shipment of materials to the Site:
   a. Concrete mix designs
   b. Manufacturer's product data sheets for reinforcing steel, concrete admixtures, curing aids, and other furnished materials.

C. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

D. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Engineer.

F. Submit copy of truck ticket for every load of concrete delivered to the site.

G. Qualification Data: For Installer, manufacturer and testing agency.

H. Welding certificates.

I. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.
4. Fiber reinforcement.
5. Curing compounds.
6. Bonding agents.
7. Adhesives.
8. Joint-filler.

J. Material Test Reports: For the following, from a qualified testing agency:

1. Aggregates**:** Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

K. Formwork Shop Drawings: Submit separate drawings for location of construction joints to the Engineer approval. Prepared by or under the supervision of a qualified professional Engineer, detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

L. Field quality-control reports

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Accurately record actual locations of embedded utilities and components concealed from view in finished construction.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301.

B. Perform any waterproofing in accordance with Manufacturer's recommendations.

C. Acquire cement and aggregate from one source for Work.

D. Conform to ACI 305R when concreting during hot weather.

E. Conform to ACI 306.1 when concreting during cold weather.

F. Contractor shall obtain materials from same source throughout the Work.

G. Any concrete found to be defective from any cause whatever, at any time before the final acceptance of the Work, shall be either repaired or removed and replaced at the expense of the Contractor.

H. Codes and Standards: Comply with provisions of following codes, specifications and standards, except where more stringent requirements are shown or specified:

I. ACI 318 - "Building Code Requirements for Structural Concrete."

J. Concrete Reinforcing Steel Institute (CRSI) - "Manual of Standard Practice."

K. ASTM C94 - "Specifications for Ready-Mix Concrete."

L. Concrete Testing Service: Contractor shall engage an independent testing laboratory acceptable to Engineer to perform material evaluation tests and to design concrete mixes.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. Cement shall comply with ASTM C150, Portland cement, Type I or II.

B. Fine and coarse aggregates shall comply with ASTM C33. Maximum coarse aggregate size shall be one inch.

C. Water shall be clean and not detrimental to concrete.

D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301 (ACI 301M).
2. ACI 117 (ACI 117M).

2.2 ADMIXTURES

A. Furnish materials in accordance with NCDOT standards.

B. The use of chemical admixtures shall be approved by the Engineer.

C. Air entrainment admixtures shall conform to ASTM C260.

D. Chemical admixtures (including any combination of water-reducing, retarding, and accelerating admixtures) shall conform to the requirements of ASTM C494.

E. Fly Ash: ASTM C618, Class Type C or F, limit fly ash to maximum 25 percent of cement content by weight.

F. Plasticizing: ASTM C1017.

2.3 CONCRETE MIXES

A. Select and proportion materials for concrete mixes in accordance with the applicable requirements of ACI 301.

B. Mix Designs:

1. Concrete mixes shall be proportioned such that 28 day compressive strength of moist cured laboratory samples achieve not less than 4,000 pounds per square inch (psi).
2. Slump Range: 2 to 4 inches.
3. Entrained Air Content: 3.5 to 6 percent (as determined by ASTM C231).
4. Maximum water/cement ratio: 0.49.

2.4 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I or Type II.
2. Fine and coarse aggregates shall comply with ASTM C33. Maximum coarse aggregate size shall be one inch.
3. Plasticizing: ASTM C1017.

C. Normal-Weight Aggregates: ASTM C33/C33M, coarse aggregate or better, graded. Provide aggregates from a single source.

D. Lightweight Aggregate: ASTM C330/C330M, 1-inch (25-mm**)** nominal maximum aggregate size.

E. Air-Entraining Admixture: ASTM C260/C260M.

F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C 494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C 94M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

G. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.

2.5 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

2. Deliver concrete in accordance with ASTM C94.

B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.
3. Slag Cement: 50 percent.
4. Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
5. Silica Fume: 10 percent.
6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
7. Combined Fly Ash or Pozzolans, Slag Cement, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.05 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water reducing, high range water reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify requirements for concrete cover over reinforcement.

B. Verify anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.

C. Verify substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of waterproofing materials.

D. Verify items penetrating surfaces to receive waterproofing are securely installed.

E. Verify substrate surface slopes to drain for horizontal waterproofing applications.

3.2 PREPARATION

A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent.

B. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.

C. Seal cracks and joints with sealant materials using depth to width ratio as recommended by sealant manufacturer.

3.3 PLACING CONCRETE

A. Place concrete in accordance with ACI 318.

B. Notify Engineer minimum 24 hours prior to commencement of operations.

C. Ensure reinforcement, inserts, and embedded parts are not disturbed during concrete placement.

D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

E. Do not interrupt successive placement; do not permit cold joints to occur.

F. If inside lined area, protect liner and all geosynthetic components from damage during installation and placement of concrete. Any damage caused to the liner as a result of the Contractor's action shall be repaired at his expense

3.4 CONCRETE FINISHING

A. Provide formed concrete surfaces to be left exposed with smooth rubbed finish.

3.5 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

C. Cure all concrete in accordance with ACI 308 unless otherwise directed by Engineer.

3.6 BACKFILLING

A. Notify Engineer prior to backfilling against concrete structures.

B. Concrete should have a minimum of 75 percent of design 28-day compressive strength prior to backfilling concrete structures unless approved by the Engineer

3.7 FIELD QUALITY ASSURANCE

A. Provide free access to Work and cooperate with appointed firm.

B. Submit proposed mix design of each class of concrete to inspection and testing firm and Engineer for review 14 days prior to commencement of Work.

C. Tests of cement and aggregates may be performed to ensure conformance with specified requirements.

D. The CQA Engineer shall obtain four concrete test cylinders for every 100 cu yds or fraction thereof or a minimum of one set of cylinders per each structure or type/class of concrete placed.

E. One additional test cylinder will be taken during cold weather concreting, cured on job site under same conditions as concrete it represents.

F. One slump test will be taken for each set of test cylinders taken.

G. One air content test will be made for each set of test cylinders taken.

H. Maintain records of concrete placement. Record date, location, quantity, air temperature and test samples taken.

END OF SECTION 033000

SECTION 034100 - PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast structural concrete.
2. Outlet wingwalls stormwater.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for placing connection anchors in concrete.
2. Section 312000 "Earth Moving" for excavation and backfill.
3. Section 312005 “Trenching” for excavation, and backfill of utilities.

1.2 REFERENCES

A. American Concrete Institute

1. ACI 318 - Building Code Requirements for Reinforced Concrete.
2. ACI 350 - Environmental Engineering Concrete Structures.

B. ASTM International

1. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
2. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
3. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
4. ASTM C33 - Standard Specification for Concrete Aggregates.
5. ASTM C150 - Standard Specification for Portland Cement.
6. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
7. ASTM C443 - Joints.
8. ASTM C789 – Pre-cast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers.
9. ASTM C850 – Pre-cast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with less than 2 feet of cover subjected to highway loadings.
10. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Pre-cast Concrete Water and Wastewater Structures.
11. ASTM C913 - Standard Specification for Pre-cast Concrete Water and Wastewater Structures.
12. ASTM C923 - Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.

13. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Pre-cast Box Sections Using Preformed Flexible Joints Sealants.
14. ASTM C1433 - Standard Specification for Pre-cast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers.
15. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
16. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
17. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

C. American Association of State Highway and Transportation Officials

1. AASHTO M198 - Butyl Rubber Sealants.
2. AASHTO M259 – Pre-cast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers.
3. AASHTO M273 – Pre-cast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with less than 2 feet of cover subjected to highway loadings.

1.3 DESIGN REQUIREMENTS

A. Design Criteria:

1. Honeycombed or retempered concrete is not permitted.
2. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318, Design for H20 Loading.
3. Design of Lifting Devices for Pre-cast Structures: In accordance with ASTM C913.
4. Design of Joints for Pre-cast Structures: In accordance with ASTM C443.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project Site: Dan River Steam Station.

1.5 SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each precast concrete mixture. Include compressive strength and, if required, water-absorption tests.

C. Shop Drawings:

1. Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement.
2. Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.
3. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.

D. Material Certificates: For the following:

1. Cementitious materials.
2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Bearing pads.
5. Insulation.

E. Material Test Reports: For aggregates, by a qualified testing agency.

F. Preconstruction test reports.

G. Source quality-control reports.

H. Field quality-control reports.

I. Project Record Documents: Accurately record actual locations of embedded utilities and components concealed from view in finished construction.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Accurately record actual locations and inverts of buried pipe, components and connections

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with State and Local Municipality standards.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.

B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.

1. Store units with dunnage across full width of each bearing point unless otherwise indicated.
2. Place adequate dunnage of even thickness between each unit.
3. Place stored units so identification marks are clearly visible, and units can be inspected.

C. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.

D. Lift and support units only at designated points indicated on Shop Drawings.

E. Mark each pre-cast structure by indentation or waterproof paint showing date of manufacture, Manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE STRUCTURES

A. Manufacturer's products and configurations shall be provided and installed as specified on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Do not install precast concrete units until supporting, cast-in-place concrete has attained minimum allowable design compressive strength and until supporting steel or other structure is structurally ready to receive loads from precast concrete units.

D. Verify connections, sizes, locations and inverts are as indicated on Drawings.

E. Verify items provided by other sections of Work are properly sized and located.

F. Verify excavations for the structures are correct.

3.2 PREPARATION

A. Coordinate placement of connecting pipes required by other Sections of Work as described in these Specifications.

B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.

C. Inspect pre-cast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.3 INSTALLATION

A. Excavation and Backfill:

1. Excavate for pre-cast concrete structures in accordance with Section 312000 and Section 312005 of these Specifications in location and to depth shown. Provide clearance around sidewalls of structure for construction operations.
2. When groundwater is encountered, prevent accumulation of water in excavations. Place pre-cast concrete structures in dry trench.

3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.

B. Lift pre-cast structures at lifting points designated by Manufacturer.

C. When lowering pre-cast concrete structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.

D. Set cover frames and covers level without tipping, to correct elevations.

E. Coordinate with other Sections of Work as described in these Specifications to provide correct size, shape, and location.

3.4 FIELD QUALITY ASSURANCE

A. Request observation by Engineer prior to placing cover over piping.

B. Compaction Testing: In accordance with Section 312000 and or Section 312005.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

END OF SECTION 034100

SECTION 311000 – SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes site clearing for the Dan River Landfill:

1. Clearing and grubbing.
2. Stripping and stockpiling topsoil Soil stockpiling.

B. Related Requirements:

1. Section 312000 “Earth Moving.”
2. Section 313520 “Erosion and Sediment Control.”

1.2 SUBMITTALS

A. Prior to undertaking clearing and/or grubbing activities, the Contractor shall provide the Engineer with the name and address of the facility to where cleared and/or grubbed materials shall be disposed.

B. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

C. Topsoil stripping and stockpiling program. Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

D. Record Drawings: Perform existing conditions topographic survey. Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

E. Burning (if allowed by Owner): Documentation of compliance with burning requirements and permitting of authorities having jurisdiction. Identify location(s) and conditions under which burning will be performed.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with State and local standards and ordinances.

PART 2 - PRODUCTS

2.1 Clearing and grubbing: Removal of surface vegetation, roots, and stumps.

2.2 Stripping: removal of top six inches of surficial soil material.

PART 3 - EXECUTION

3.1 PREPARATION

A. Do not proceed with work on adjoining property until directed by Engineer. Locator Service: Notify utility locator service Call Before You Dig and private utility contractor North Carolina 811, www.nc811.org or area where Project is located before site clearing.

B. Protect and maintain benchmarks and survey control points from disturbance during construction.

C. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified.

D. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Engineer and at no additional cost to the Owner.

E. Identify waste area for placing removed materials. May dispose on site if permitted by Owner in Owner designated area.

3.2 EROSION AND SEDIMENTATION CONTROL

A. Adhere to the approved Erosion and Sediment Control Plan as provided by the Engineer.

B. Provide erosion and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion and sedimentation control Drawings and requirements of authorities having jurisdiction.

C. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

D. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

E. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 CLEARING AND GRUBBING

A. Clearing and grubbing shall be performed within the limits of disturbance as indicated on the Drawings and only in those areas that require construction activity. Clearing and grubbing shall be performed in such a manner as to minimize as much as possible the overall disturbance to the site.

B. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than 2 inches (50 mm) in diameter, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
3. Use only hand methods or airspade for grubbing within protection zones.

C. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

D. Areas outside of the limits of clearing shall be protected from damage and no equipment or materials shall be stored or work be performed in those areas.

3.4 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches and as indicated on the Drawings in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, ash material, and other objects larger than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

D. Stockpile surplus topsoil to allow for respreading deeper topsoil or for future onsite rework grading or fill

3.5 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Burning tree, shrub, and other vegetation waste, if allowed by the Owner, may be permitted according to burning restrictions and requirements and permitting of authorities having

jurisdiction. Control such burning to produce the least smoke or air pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris is prohibited.

C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000 – EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes soil earthworks for the Dan River Landfill:

1. Soil mass excavation from on-site sources.
2. Soil import from off-site sources.
3. Soil undercut.
4. Rock removal.
5. Soil stockpiling.
6. Compacted fill placement.

B. Related Requirements:

1. Section 311000 “Site Clearing.”
2. Section 312005 “Trenching.”
3. Section 312015 “Geosynthetic Clay Liner.”
4. Section 312020 “Protective Cover Soils.”
5. Section 312030 “Vegetative Soil Cover”.
6. Section 313240 “Nonwoven Geotextiles.”
7. Section 313520 “Erosion and Sediment Control.”

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:

1. ASTM D422 – Standard Test Method for Particle Size Analysis of Soils with Hydrometer.
2. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
3. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
4. ASTM D2216 – Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
5. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
6. ASTM D2937 – Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
7. ASTM D2974 – Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
8. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

9. ASTM D4959 – Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating.
10. ASTM D4972 – Standard Test Method for pH of Soils.
11. ASTM D5084 – Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
12. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. The Contractor shall retain a third-party surveyor registered in the state that the work is performed.

B. The Contractor shall submit record drawings by the Registered Land Surveyor before and after excavation from on-site sources, soil undercut, or rock removal. The Land Surveyor shall be registered in North Carolina.

C. The Contractor shall provide environmental soils testing on any proposed soil import from off-site sources. Environmental soils testing shall be performed to the satisfaction of the Engineer.

D. Blasting Plan if rock removal is required.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with these specifications and the CQA Plan.

B. Conformance Testing - Compacted fill placement.

1. The performance of conformance testing shall be coordinated by the CQA Engineer.
2. Conformance testing will be performed by an independent laboratory at a frequency of at least 1 test per 10,000 cubic yards, when materials used for compacted fill changes, and/or as directed by the Engineer for the following:
   a. Laboratory moisture content (ASTM D2216)
   b. Atterberg limits (ASTM D4318)
   c. Grain size with hydrometer (ASTM D422)
   d. Moisture-density curve (ASTM D698)
   e. Other tests as required by the Engineer

PART 2 - PRODUCTS

2.1 SOIL MASS EXCAVATION FROM ON-SITE SOURCES

A. Soil to be used for onsite grading and compacted fill shall be obtained in the areas located and marked within limits of work as indicated in the Drawings. Soil mass excavation may be stockpiled or placed as compacted soil fill as directed by the Engineer.

B. The Contractor shall immediately cease excavation activities in any area where potential CCR materials or other industrial-related constituents are encountered and notify the Owner and

Engineer. The Owner or Engineer shall provide requirements for excavation and/or disposal of the potential CCR materials or other industrial-related constituents. Potential CCR materials or other industrial-related constituents shall be disposed of in accordance with local, state, and federal requirements.

2.2 SOIL IMPORT FROM OFF-SITE SOURCES

A. Provide borrow soil materials for compacted soil fill when sufficient satisfactory soil materials are not available from onsite excavations and stockpiles.

B. Soil import from off-site borrow sources shall meet the specification requirements for its intended use as follows:
   1. Compacted fill placement – Specification Section 312000.
   2. Compacted soil liner – Specification Section 312010.
   3. Protective cover – Specification Section 312020.
   4. Vegetative soil cover – Specification Section 312030.

2.3 SOIL UNDERCUT

A. Soil undercut shall be required when unsuitable materials are encountered. Materials determined unsuitable by the Engineer shall be excavated to a depth of 12 inches below the unsuitable material and to a lateral extent of 10 feet beyond the unsuitable area, or as directed by the Engineer.

B. Soil undercut material shall be disposed in a location approved by the Owner.

C. Excavated unsuitable areas shall be replaced with compacted soil fill, aggregate, lean concrete, or aggregate.

2.4 ROCK REMOVAL

A. The Contractor shall notify the Engineer and Owner if potential rock material is encountered during excavation.

B. Rock is defined as material which is not rippable with a D9 dozer and single-shank blade capable of exerting a force of 35,000 lbs.

C. Rock shall not be defined prior to the Contractor’s attempt to remove the material with excavation equipment, rock drilling tools, or other means to the satisfaction of the Engineer.

2.5 SOIL STOCKPILING

A. Soil stockpiling is defined as excess soil from soil mass excavation from on-site sources that is stored in an area as approved by the Owner.

B. Soil material shall be stockpiled by material type as required by the Engineer and/or Owner. Anticipated material types include compacted fill, potential compacted soil liner material, topsoil, and spoils.

2.6 COMPACTED FILL

A. Compacted fill placement is defined as soil placed as fill and compacted to specified moisture and density requirements.

B. Compacted Fill shall consist of excavated earthen materials classifying as sand (SM, SW, SP, SC, SW-SM, SW-SC, SC-SM) silt (ML), or clay (CL) under the Unified Soil Classification System per ASTM D2487. Soils classifying as Organic Silt or Organic Clay (OL or OH) or High Plasticity Silt or Clay (MH or CH) shall not be used for Compacted Fill and shall be designated as an Unsuitable Material. Compacted fill may not consist of coal combustion residual (CCR) material.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Do not commence earth-moving operations until erosion and sedimentation control measures specified in Section 313520 “Erosion and Sediment Control” and Section 311000 “Site Clearing” are permitted, in place and inspected and approved by the governing authority and the Engineer.

B. The following materials shall be stockpiled separately: materials potentially suitable for re-use as compacted soil liner, materials potentially suitable for re-use as compacted fill, materials potentially suitable for re-use as vegetative soil cover, and spoils material.

C. Potential CCR materials or other industrial-related constituents shall be disposed of in accordance with local, state, and federal requirements and as approved by the Owner or Engineer.

D. Stockpile locations shall be approved by the Owner.

E. Work shall be performed in a manner that does not disturb the Owner’s operation or facilities, existing survey monuments, monitoring wells, utilities, or other facilities active or inactive not indicated to be removed.

F. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
3. Contractor shall be responsible for damage to roads due to truck traffic.

3.2 EXCAVATION PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations including required inspections, monitoring and recordkeeping.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.3 BACKFILL PREPARATION

A. The Contractor shall proof roll subgrade to identify soft spots under observation by the CQA Engineer. The Contractor shall fill and compact to density equal to or greater than requirements for subsequent fill material.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with compacted soil fill or as specified by the Engineer and compact to density equal to or greater than requirements for subsequent fill material.

C. Scarify subgrade surface to depth of 6 inches prior to placing fill

D. Begin backfilling after Engineer's acceptance of the appropriate survey for underlying surface.

3.4 DEWATERING

A. The Contractor shall prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

C. Reroute surface water runoff away from excavated areas as directed by the Engineer. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.5 EXCAVATION

A. Contractor shall excavate all soil from within designated limits of work to final subgrade.

B. Excavated materials may be stockpiled or placed as compacted soil fill as appropriate.

C. Contractor shall be responsible for constructing stockpile(s) and for installing E&SC controls, inspection, maintenance, modification and repair of stockpile(s) as required.

D. During excavation or relocation of soil, the material shall be protected and conditioned to control fugitive dust and to limit erosion of the exposed surface. If the surface is dry and dust is observed, apply water to the material to effectively moisture condition the material as approved by the Owner and Engineer. For erosion control, conform to the minimum requirements of the Erosion and Sedimentation and Pollution Control Plan on the Drawings. Additional measures may be required to control erosion of the exposed material, such as the installation of diversion berms, covers, moisture control and sediment fencing as approved by the Owner and Engineer.

E. Shape the graded surfaces to be free from irregular surface changes. Finished grade shall not vary more than 0.10 feet above or below required elevations where shown on the drawings. Material located within 1-foot of geosynthetics shall have a maximum particle size of 3 inches with a maximum protrusion of ¼ inch above surrounding grades.

F. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or other fill material as directed.

G. Proof-roll subgrade with at least 2 passes of a 20-ton loaded dump truck to identify soft pockets and areas of excess yielding, otherwise, compact subgrade by other methods approved by the Engineer. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph (5 km/h).
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or other fill material as directed.

H. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

I. The Contractor shall reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

J. The graded surface shall be surveyed to check that the surface elevations are consistent with the Drawings and that the surface is suitable for placement of overlying materials. The surveyed elevations shall be reviewed and approved by the Engineer before proceeding with subsequent construction.

3.6 COMPACTED FILL

A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. The first lift over geosynthetics shall have a minimum loose lift thickness of 12 inches.

C. Compact each lift to a minimum of 95 percent of the material's maximum dry density and to within 3 percent of optimum moisture content as determined by ASTM D698.

D. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

E. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 3 percent and is too wet to compact to specified dry density.

3.7 FIELD QUALITY ASSURANCE

A. Field quality assurance shall be performed by the CQA Engineer.

B. Compacted Fill
   1. Perform in-place compaction testing using the sand cone method (ASTM D1556), drive cylinder method (ASTM D2937), or nuclear method (ASTM D6938).
   2. Perform in-place moisture content testing in accordance with ASTM D2216.
   3. Frequency of compaction and moisture tests:
      a. Perform compaction and moisture tests at an average rate of one test per acre per lift for mass grading areas such as the landfill subgrade and landfill cover soils.
      b. Perform compaction at a minimum frequency of one test per lift per 5,000 square feet for linear features such as perimeter berms and roadways.
   4. Compaction and moisture test criteria:
      a. Compact to a minimum 95 percent of Standard Proctor (ASTM D698) maximum dry density.
      b. Fill placed for roadway subgrade shall be compacted to a minimum 98 percent of Standard Proctor (ASTM D698) maximum dry density.
      c. Compacted moisture content shall be within 3 percent of optimum or as directed by the Engineer.

3.8 PROTECTION OF WORK

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

   1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs prior to Substantial Completion, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

D. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

END OF SECTION 312000

SECTION 312005 – TRENCHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes trenching for the Dan River Landfill including:

1. Liner system anchor trench.
2. Trenching for installation of utilities.

B. Related Requirements:

1. Section 312000 "Earth Moving."
2. Section 334100 "Storm Utility Drainage Piping."

1.2 REFERENCES

A. ASTM International:

1. ASTM A798 - Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
2. ASTM C1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations
3. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
4. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
5. ASTM D2216 - Standard Test Method for Natural Moisture Content.
6. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
7. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
8. ASTM D2937 - Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
9. ASTM D6938 – Standard Test Methods for in-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

B. North Carolina Department of Transportation (NCDOT):
1. "Standard Specifications for Roads and Structures", 2012 Edition (NCDOT Standard Specifications).

C. Amec Foster Wheeler:
1. "Hydrogeology Study – Dan River Landfill", July 13, 2015.

1.3 PERFORMANCE REQUIREMENTS

A. Proposed materials shall be approved by the Engineer as specified, prior to delivery and use of the materials in the construction.

B. Contractor shall design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.

1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified Professional Engineer.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.
5. The Contractor shall provide de-watering of the trench as required during construction.

1.4 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

B. Submit certifications by manufacturers/suppliers for imported bedding material (if furnished) showing conformance of the materials with the Specifications.

1.5 FIELD CONDITIONS

A. The Contractor is solely responsible for excavation slope stability. Excavation work shall be performed in compliance with applicable OSHA.

B. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Engineer and Owner’s Construction Manager no fewer than seven days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Owner/Engineer’s written permission.

C. Project-Site Information: A geotechnical report (Hydrogeology Study – Dan River Landfill, Amec Foster Wheeler, July 13, 2015) has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a Geotechnical Engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a Geotechnical Engineer. Owner is not responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection according to the performance requirements.
2. Historic geotechnical information may be available for the Contractor review.

D. Survey Work: Engage a qualified land surveyor or Professional Engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 BEDDING MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Unless otherwise indicated, Bedding Material shall consist of either excavated material or imported material conforming to the specifications in the following paragraphs, depending on type of pipe or culvert. On-site excavated materials will be considered suitable, provided that the material conforms to the specified maximum particle sizes and is substantially free of roots, trash and other material which may be compressible or which cannot be compacted properly.

C. For precast reinforced concrete pipe (RCP) and drop inlets, Bedding Material shall conform to the requirements for Category I, II or III materials as defined in ASTM C1479 and as specified in the following paragraphs. Maximum particle size shall be one inch.

1. Category I materials consist of clean coarse-grained soils and having characteristics consistent with SW, SP, GW or GP classifications as defined by the Unified Soil Classification System (USCS).
2. Category II materials consist of coarse-grained soils with fines and having characteristics consistent with SM, SC, GM or GC classifications as defined by the USCS.
3. Category III materials consist of fine-grained soils having characteristics consistent with CL, ML, or CL-ML classifications as defined by the USCS.

2.2 INITIAL TRENCH BACKFILL

A. Initial Trench Backfill for non-perforated piping shall conform to the requirements for Bedding Material as required in this specification. The specified Initial Trench Backfill material is required for all non-perforated piping.

2.3 FINAL TRENCH BACKFILL

A. Final Trench Backfill for landfill leachate conveyance and sediment basin outlet piping and culverts shall conform to the requirements for compacted fill material specified in Section 312000.

2.4 BACKFILL FOR DROP INLETS

A. Backfill for drop inlets shall consist of excavated material, provided that it is substantially free of rocks larger than approximately three inches in greatest dimension, roots, trash and other material which may be compressible or which cannot be compacted properly.

2.5 AGGREGATE FOR PLACEMENT AROUND PERFORATED PIPE

A. Aggregate shall be rounded, stone or gravel. Quality shall comply with the requirements of Section 1005 of the NCDOT Specifications. Gradation shall comply with NCDOT Specifications

B. Aggregate shall meet specified gradation and quality prior to placement. All processing shall be completed at the source.

2.6 BACKFILL FOR NON-PERFORATED CORRUGATED POLYETHYLENE PIPE

A. Backfill shall consist of Compacted Fill soil material and other surface material as applicable.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner/Engineer and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

3.2 EXCAVATION

A. Excavate to the dimensions and elevations required for installation of piping and structures. Slope sides of excavations as required to conform to applicable OSHA regulations.

B. Excavation and preparation of bedding for pipe installation shall conform to the following standards as appropriate for the type of pipe or culvert installed:
   1. Precast reinforced concrete pipe: ASTM C1479.
   2. Thermoplastic gravity-flow pipe (including corrugated polyethylene pipe and smooth lined pipe): ASTM D2321.

C. If existing material below the required subgrade elevation is unsuitable for properly installing pipe and structures, as determined by the Engineer, excavate and remove the unsuitable material to a minimum depth of approximately six inches and replace the same with Bedding Material meeting the material specifications of this specification, properly compacted to produce a firm and even bearing surface.

D. Removal of materials beyond the indicated subgrade elevations, without authorization by the Engineer, shall be classified as unauthorized excavation and shall be backfilled and compacted at no additional cost to the Project.

E. Where suitable subgrade conditions are encountered, as determined by the Engineer, level and shape the existing exposed materials as required to provide a firm and uniform bearing for piping and structures. Thoroughly compact the subgrade using manually-guided compaction equipment.

F. A minimum of four-inch thickness of Bedding Material shall be placed under all reinforced concrete pipe unless otherwise approved by the Engineer. Thoroughly compact Bedding Material using manually-guided compaction equipment and accurately grade to the required elevations.

G. Remove water from the excavations as required for installation of piping and placement of backfill in accordance with these specifications and the details shown on the Drawings.

3.3 BACKFILLING FOR CULVERTS AND SEDIMENT BASIN OUTLET PIPES

A. Do not completely backfill trenches until the installed piping conforms to the specifications.

B. Placement of Backfill:

   1. Place Initial Trench Backfill around and over the piping, in layers not exceeding six inches loose thickness, up to approximately twelve inches above the top of the pipe. Each layer shall be thoroughly compacted using manually-guided compaction equipment.
   2. Final Trench Backfill placed shall be placed over the Initial Trench Backfill in layers not exceeding eight inches loose thickness up to final grade or aggregate surfacing subgrade elevation, as applicable. Except as required below, compact Final Trench Backfill to achieve at least 95 percent of the material's maximum dry density as determined by ASTM D698.
   3. Backfill placed within 12 inches of the finished subgrade under aggregate surfacing for roads shall be compacted to a minimum of 98 percent of the material's maximum dry density as determined by ASTM D698.

C. Placement and compaction of trench backfill shall be performed in a manner that does not damage the pipe. Pipe that is damaged shall be replaced at the Contractor's expense.

D. Compacted backfill not meeting density specification requirement (if applicable) shall be scarified, recompacted and retested at Contractor's expense.

3.4 BACKFILLING FOR ANCHOR TRENCH

A. Do not completely backfill trenches until the installed geosynthetics conforms to the specifications.

B. Placement of Backfill:

1. Place Anchor Trench Backfill in layers not exceeding eight inches loose thickness. Each layer shall be thoroughly compacted using manually-guided compaction equipment.
2. Compact Anchor Trench Backfill to achieve at least 95 percent of the material's maximum dry density as determined by ASTM D698.

C. Placement and compaction of trench backfill shall be performed in a manner that does not damage the geosynthetics. Geosynthetics that are damaged shall be replaced at the Contractor's expense.

D. Compacted backfill not meeting density specification requirement (if applicable) shall be scarified, recompacted and retested at Contractor's expense.

3.5 TOLERANCES

A. Top Surface of backfilled trench: Plus or minus 0.10 feet from required elevations shown on Drawings.

3.6 FIELD QUALITY ASSURANCE

A. Field quality assurance shall be performed by the CQA Engineer.

B. Perform in place compaction tests in accordance with the following:

1. Perform in-place compaction testing using the sand cone method (ASTM D1556), drive cylinder method (ASTM D2937), or nuclear method (ASTM D6938).
2. Perform in-place moisture content testing in accordance with ASTM D2216.
3. Frequency of compaction and moisture tests:
   a. Perform compaction and moisture tests at an average rate of one test per 200 linear feet of trench.
4. Compaction and moisture test criteria:
   a. Compact to a minimum 95 percent of Standard Proctor (ASTM D698) maximum dry density.
   b. Compacted moisture content shall be between 3 percent of optimum moisture content.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

END OF SECTION 312005

SECTION 312010 – COMPACTED SOIL LINER

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes compacted soil liner for the Dan River Landfill. Compacted soil liner shall meet the following hydraulic conductivity requirement:

1. Maximum hydraulic conductivity of $1x10^{-5}$ cm/s (ASTM D 5084)

B. Related Requirements:

1. Section 312000 "Earth Moving."
2. Section 312015 "Geosynthetic Clay Liner."

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:
1. ASTM D422 – Standard Test Method for Particle-Size Analysis of Soils (Grain Size with Hydrometer).
2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3) (Standard Proctor Test).
3. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
4. ASTM D2216 - Standard Test Method for Natural Moisture Content.
5. ASTM D2487 – Standard Practices for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
6. ASTM D2937 - Standard Test Method for Density of Soil in place by the Drive-Cylinder Method Test.
7. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
8. ASTM D5084 - Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter (Remolded and Undisturbed Permeability).
9. ASTM D6938 – Standard Test Methods for in-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Submit record drawings by an independent (third-party) Registered Land Surveyor retained by the Contractor before and after placement of compacted soil liner. The Land Surveyor shall be registered in North Carolina.

B. Soil amendment plan to achieve specified hydraulic conductivity in the event on-site soils do not meet specified requirements for use as compacted soil liner.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with these specifications and the CQA Plan.

B. Conformance Testing - Compacted soil fill.

1. The performance of conformance testing shall be coordinated by the CQA Engineer.
2. Conformance testing will be performed by an independent laboratory at a frequency of at least 1 test per 3,000 cubic yards, when materials used for compacted fill changes, and/or as directed by the Engineer for the following:
   a. Laboratory moisture content (ASTM D2216)
   b. Atterberg limits (ASTM D4318)
   c. Grain size with hydrometer (ASTM D422)
   d. Moisture-density curve (ASTM D698)
   e. Undisturbed permeability test (ASTM D5084)
      1) Compact and moisture condition the sample to the requirements described in this specification.
      2) Perform testing with a maximum hydraulic gradient of 30 and a maximum confining pressure of 10 psi.
   f. Other tests as required by the Engineer

PART 2 - PRODUCTS

2.1 COMPACTED SOIL LINER

A. The compacted soil liner material shall be inorganic clay, silty clay, or sandy clay. It shall have 100 percent by weight passing the l-inch sieve, more than 80 percent by weight of fines passing the No. 200 sieve (as determined by ASTM D422) with more than 25 percent clay size fine fraction (ASTM D422) by weight, a plasticity index between 10 and 30, a liquid limit greater than or equal to 30, plot above the A-LINE on Casagrandes' plasticity chart (1948), clod size less than 6 inches, and a permeability when compacted to 95 percent of Standard Proctor of 1.0×10^{-5} cm/sec or less.

B. Compacted soil liner material shall be classified as SC, CL, CH, ML, or MH soils according to the Unified Soil Classification System (ASTM D2487).

C. Free of ash, gypsum, ferrous, topsoil, roots, stumps, brush, rocks larger than 1-inch, subsoil, debris, vegetation, calcareous concretions or nodules, and other foreign matter.

D. Fill material shall have a maximum size aggregate of 1-inch. The compacted soil liner material shall be raked or sieved by the Contractor, if necessary, to remove all aggregate greater than 1 inch in diameter. No more than 5 percent of the compacted soil liner fill material should be retained on the No. 4 sieve. Top 6 inches adjacent to the geosynthetic clay liner shall have a maximum protrusion size of ¼ inch.

E. All material clods will be broken down with tillers and/or discs to provide a homogeneous soil (prior to compaction) that is free of clay clods greater than 2 inches in diameter.

2.2 ACCESSORIES

A. Contractor shall provide a soil amendment material for amendment of clay soils, sealing test holes due to Shelby tubes, nuclear density gauges, depth probe checks, and compaction testing. The soil sealant material shall be free flowing high swelling granular sodium bentonite (also known as Wyoming Bentonite) containing an optimum level of sodium polyacrylate polymer to maximize wetting, expansion and dispersing action in all types of soils. The soil sealant shall be Volclay SG-40, as manufactured by American Colloid Company, Skokie, Illinois, or equal.

B. Water

1. Water used to adjust the moisture content of the compacted soil liner shall be:
   a. Clean, odorless, fresh water
   b. pH range between 5.5 to 9.5
   c. TDS < 400 mg/l
   d. Free of any other materials which may be deleterious to the soil liner or bentonite additive.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Engineer will assist the Contractor in the determination of compacted soil liner material and non-select material during excavation operations (see Section 312000). The Contractor will be responsible for excavating, transporting, stockpiling, placing and compacting all materials as needed.

B. Continuous and repeated visual observation of the materials will be performed by the Contractor to ensure proper material is being used.

C. Engineer will make frequent observations of the compacted soil liner placement operations and materials, and will consult with the site personnel on suitable liner fill and locations of such. All compacted soil liner fill proposed shall be observed by the Engineer prior to actual use.

3.2 PREPARATION

A. Ensure subgrade compacted to density requirements specified in Section 312000.

B. A Test Pad shall be constructed to evaluate the ability of the proposed construction methods to achieve the permeability requirements. The Test Pad shall be constructed as follows:

1. A test pad 35 ft x 100 ft in area shall be constructed inside or outside the landfill footprint using the same construction methods, equipment and material to be used for the compacted soil liner.
2. Compaction and soil moisture content shall be in accordance with this specification.

3. Compacted soil liner material shall be placed six-inch thick compacted lifts for the total minimize design thickness of the compacted soil liner.
4. A minimum of 4 undisturbed samples will be obtained in the test pad by the CQA Engineer at a frequency of two samples per lift. The following laboratory tests will be performed on the undisturbed samples to document the soil's characteristics and to verify that the material, construction methods, and equipment can achieve a permeability of no greater than $1.0x10^{-5}$ cm/sec:
   a. Atterberg Limits Test (ASTM D4318) at frequency of 1 tests per lift
   b. Grain Size with Hydrometer (ASTM D422) at frequency of 1 test per lift.
   c. Remolded Permeability (ASTM D5084) at frequency of 1 test per lift.
   d. Undisturbed Permeability (ASTM D5084) at frequency of 1 test per lift.
   e. Standard Proctor Test (ASTM D698) at frequency of 1 test per lift.
5. Field moisture and field density tests will also be performed by the CQA Engineer during soil placing and compaction to document the conditions obtained by the construction method, equipment and material to correlate with the required permeability of $1.0x10^{-5}$ cm/sec for the compacted soil liner test pad.
   a. Field Density Test (ASTM D2937) at frequency of 3 tests per lift.
   b. Natural Moisture Content Test (ASTM D2216) at frequency of 3 tests per lift.
6. The Contractor shall coordinate with the Engineer and CQA Engineer to allow sufficient time for construction, testing, and evaluation of the test pad prior to placement of the compacted soil liner.
7. If the initial test pad does not meet the required permeability ($1.0x10^{-5}$ cm/sec), a second test pad shall be constructed prior to placement of the compacted soil liner.
8. Based on the classification, density, moisture, and permeability testing performed on the test pad, the Engineer will determine the specified range of acceptable densities and moisture contents required to achieve a permeability of less than or equal to $1.0x10^{-5}$ cm/sec for the compacted soil liner material.
9. If the compacted soil liner material differs in consistency to the material used in the test pad, the Engineer will require construction of another test pad with additional laboratory classification and permeability testing prior to placement.

C. Test pads constructed inside the landfill footprint shall be removed prior to construction of the compacted soil liner unless the Engineer approves to remain in place.

D. Prior to compacted soil liner placement, the prepared subgrade shall be proof rolled with a loaded dump truck (minimum 20 tons) or similar rubber tired pneumatic vehicle, a minimum of two passes in each direction. Proofrolling shall be conducted at the discretion of the Engineer or his representative. Any soft, saturated or yielding areas exhibited by pumping and/or rutting will require removal and replacement with the appropriate compacted soil as specified in Section 312000.

3.3 PLACEMENT OF COMPACTED SOIL LINER

A. Place fill to contours and elevations as shown on Drawings with unfrozen materials.

B. The compacted soil liner shall be the total minimize design thickness shown on the design plans. Thickness of the compacted soil liner on the side slopes shall be measured perpendicular to the slope.

C. Compacted soil liner fill lift thickness, before compaction, can be a maximum of 8-inches. Compacted soil liner fill lift thickness, after compaction, shall be 6 in. ± 1 in. Thinner lifts are permissible to achieve design grade.

D. Lift thickness may be sampled upon completion (but prior to subsequent lift placement) by hand augering through the lift and measuring the thickness. The resulting penetration shall be promptly backfilled by the Contractor with a hand tamped clayey soil mixture of one part bentonite and three parts compacted soil liner material.

E. Samples of the in-place compacted soil liner shall be tested and evaluated in accordance with provisions of the Construction Quality Assurance Plan this specification prior to final acceptance of the compacted soil liner. All compaction or permeability test locations shall be filled with a mixture of one part bentonite and three parts soil.

F. Equipment or truck traffic shall not be permitted during the period between scarifying and compaction of a lift unless approved by the Engineer.

G. After the lift to be compacted is conditioned, representative samples will be taken by the Engineer and tested for moisture content prior to any compactive efforts. If the moisture content is within the range specified in this specification, compaction may begin. If the moisture content is outside of this range, the compacted soil liner fill shall be wetted or dried and reworked accordingly. The compacted soil liner fill should be sprinkled or sprayed with water, utilizing equipment creating a uniform application and dozed, wind-rowed, and/or disc-plowed to uniformly increase the moisture content of the compacted soil liner if the material moisture content is too low. The compacted soil liner fill shall be dozed, wind-rowed, and/or disc-plowed to help air dry the soil if the moisture content is too high.

H. Each lift shall be thoroughly compacted and satisfy the moisture and density criteria established from the test pad results. Field testing shall be completed according to this specification before a subsequent lift is placed.

I. Compaction of lifts shall be as follows:

1. Compaction of lifts shall be performed with an appropriately heavy, properly ballasted, deep penetrating foot (sheepsfoot) compactor and shall be subject to approval of the Engineer (minimum compactive effort of 5,000 lbs/ft).
2. Dozer equipment shall not be used for primary compaction efforts.
3. A minimum number of passes will be required on each lift as determined by the test pad. A pass is defined as one trip of the compacting equipment over the lift and back to the starting point by a single drum roller or one trip across the lift surface from one side to the other if the compacting equipment has front and back compacting rollers. This requirement is to allow thorough remolding of the soil by kneading action.
4. The daily work area shall extend a distance so as to maintain moist soil conditions (facilitate bonding) and continuous operations. Desiccation, crusting, or cracking of the lift surface shall be avoided as much as possible. Each lift shall be protected, at all times after placement, from desiccation and crusting.
5. If desiccation, crusting, or cracking of the lift surface occurs before placement of the next lift, this area shall be scarified to a sufficient depth to mix with moist materials, or sprinkled with water and then scarified at the direction of the Engineer.
6. The surface of the underlying lift shall be scarified prior to compaction of each subsequent lift (i.e.: Lift 2 to Lift 3 etc) to facilitate bonding of the lifts.

7. The transition between the bottom and side slopes shall be accomplished by compacting parallel (bottom to top) to the slope.
8. Soil moisture and dry density requirements:
    a. To determine the moisture content and dry density requirements of the compacted soil are being satisfied, field and laboratory tests shall be performed at the frequencies specified this specification.
    b. Compacted moisture content shall be between 2 and 5 percent wet of optimum moisture content or as determined by the results of the compacted soil liner test pad.
    c. The compacted soil liner shall be compacted to a minimum dry density of 95 percent (or as required to meet the permeability requirements based on the results of the compacted soil liner test pad) of the maximum dry density determined from the standard Proctor test (ASTM D698). Where densities less than the specified density are measured, the compacted soil liner shall be recompacted and/or removed and reworked to meet density criteria.

J. Compacted soil liner fill shall not be placed or compacted during sustained periods with air temperature below 32°F. Compacted soil liner fill may be placed and compacted during periods of early morning and early evening freezing temperatures with warming trends above 45°F during the day. No fill shall be placed on frozen subgrade. If the compacted soil liner or compacted fill freezes or ices the fill section shall be rescarified and recompacted, at the discretion of the Engineer.

K. During construction, finished lifts or sections of compacted soil liner shall be sprinkled with water as needed to avoid excessive cracking or at least twice daily.

L. At the end of each construction day's activities, completed lifts or sections of compacted soil liner shall be sealed by rolling with rubber tired or smooth drum rollers and sprinkled with water as needed to avoid excessive cracking.

M. After completion of a segment of compacted soil liner, but before installation of the overlying geosynthetics, the surface of the compacted soil liner shall be surveyed by the Surveyor retained by the Contractor to ensure the specified thickness of compacted soil liner (12 inches).

N. The surface of the compacted soil liner shall be smooth drum rolled and maintained free of rocks, organics, voids and sharp edges.

O. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.

P. Bench the existing upstream and downstream slopes during fill placement to promote bonding of existing and new fill materials.

Q. Employ placement method that does not disturb or damage other work.

R. Make gradual grade changes. Blend slope into level areas.

S. Remove surplus fill materials from site unless authorized by Owner to dispose of on-site in an Owner designated location.

T. Leave fill material stockpile areas free of excess fill materials.

3.4 TOLERANCES

A. Top Surface of compacted soil liner: Plus or minus 0.10 feet from required elevations shown on Drawings.

B. The compacted soil liner must have a minimum thickness of 1.06 feet when measured in the vertical plane..

3.5 FIELD QUALITY ASSURANCE

A. Field quality assurance shall be performed by the CQA Engineer.

B. Perform in place compaction tests in accordance with the following:

1. Perform in-place compaction testing using the sand cone method (ASTM D1556), drive cylinder method (ASTM D2937), or nuclear method (ASTM D6938).
2. Perform in-place moisture content testing in accordance with ASTM D2216.
3. Frequency of compaction and moisture tests:
   a. Perform compaction and moisture tests at an average rate of one test per every other 100 foot by 100 foot grid per lift.
4. Compaction and moisture test criteria:
   a. Compact to a minimum 95 percent of Standard Proctor (ASTM D698) maximum dry density.
   b. Compacted moisture content shall be between 2 and 5 percent wet of optimum moisture content or as determined by the results of the compacted soil liner test pad.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

3.6 MOISTURE CONTROL

A. Control moisture content of clay to meet the requirements of this Section.

B. When necessary, add moisture using approved sprinkling equipment.

1. Add sufficient water during rolling and tamping to assure complete compaction of material.
2. Place no more clay material than can be compacted and tested the same day.
3. If, in the opinion of the Engineer, the material is too wet for satisfactory compaction, or compaction efforts may damage preceding layers of clay or geosynthetic components, temporarily stop work to allow the material to dry or replace material with suitable material at no additional cost to the Owner. The Contractor may scarify or aerate the soils to promote drying as long as the underlying materials are not damaged.
4. The placement or compaction of material will not be permitted during or immediately following rainfall or on top of standing water.
5. Replace compacted material that is damaged in a manner acceptable to the Engineer at no additional cost to Owner.
6. Maintain the moisture content of the clay to prevent excessive drying or the formation of desiccation cracks. Any areas that become dry or show evidence of desiccation cracking shall be scarified to the full depth of the damaged clay, moistened and recompacted to the minimum density and required permeability.

7. Desiccation cracks shall be removed or reworked to the satisfaction of the Owner at no additional cost to the Owner.
8. Desiccation cracks greater than 2 inches deep, but less than the depth of the disking blade (measured from the axle to the edge of the blade) shall be disked, rewetted, recompacted and retested at no additional cost to the Owner.
9. Desiccation cracks with a depth greater than the disking blades shall have the entire lift removed, replaced, and retested at no additional cost to the Owner.
10. Contractor shall be responsible for all costs associated with retesting of failed or rejected lifts including but not limited to Engineer's time.

C. No material shall be placed when free water is standing on the area to be covered.

D. No compaction of material will be permitted with free water on any portion of clay material to be compacted.

3.7 PROTECTION OF FINISHED WORK

A. The compacted soil liner shall be overbuilt a thickness of 3 inches or covered with a sacrificial 10 mil plastic sheeting where required to protect the finished surface from erosion, desiccation, or other damage.

1. If the overbuild option is selected for protecting the liner, upon removal of the overbuild, the surface of the compacted soil liner will be re-rolled with a smooth drum roller to achieve the surface condition specified in this Specification.
2. If excessive desiccation cracking becomes evident, as determined by the Engineer, the surface will require rewetting and rerolling prior to geomembrane liner placement. If excessive desiccation cracking remains evident after rerolling, the surface shall be scarified on the top 3-inches and reworked as specified in this specification.

B. Reshape and re-compact fills subjected to vehicular traffic

END OF SECTION 312010

SECTION 312015 – GEOSYNTHETIC CLAY LINER

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes geosynthetic clay liner for the Dan River Landfill. Geosynthetic clay liner shall have a maximum permeability of 2.48×10^{-9} cm/s.

B. Related Requirements:

1. Section 312010 "Compacted Soil Liner".
2. Section 313200 "HDPE Geomembrane."

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:
1. ASTM D5321 - Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
2. ASTM D5887 - Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
3. ASTM D5888 - Standard Guide for Storage and Handling of Geosynthetic Clay Liners.
4. ASTM D5890 - Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
5. ASTM D5891 - Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.
6. ASTM D5993 - Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners.
7. ASTM D 6102 – Standard Guide for Installation of Geosynthetic Clay Liners
8. ASTM D6243 - Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method.
9. ASTM D6496 - Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners.
10. ASTM D6768 - Standard Test Method for Tensile Strength of Geosynthetic Clay Liners.

1.3 SUBMITTALS

A. Submit the following to the Engineer with the Contractor's bid:

1. A material properties sheet for the geosynthetic clay liner, including at a minimum all properties, test methods, and test values as required by this specification.

B. Submit the following to the Engineer, for review and approval, no later than 30 calendar days prior to shipment of geocomposite to the Site:

1. Manufacturer's quality control program manual, or descriptive documentation.
2. The manufacturers' quality control certifications (including results of source quality control testing of the products as required by this specification) to verify that the materials supplied for the project are in compliance with the product specifications in this Section. The certifications shall be signed by a responsible party employed by the manufacturer, such as the geosynthetic clay liner QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers, and corresponding shipping information.
3. Manufacturer's instruction manual for geosynthetic clay liner on-site handling and installation, including but not limited to procedures for storage, transport, placement, and seaming/joining.

1.4 QUALIFICATIONS

A. Installer's Qualifications:

1. Refer to Specification Section 313200 "HDPE Geomembrane" for Installer's qualifications.

B. Manufacturer shall have manufactured a minimum of 10,000,000 square feet of geosynthetic clay liner during the last five years.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with these specifications and the CQA Plan.

B. Interface Friction Testing Requirements

1. Refer to Specification Section 313200 "HDPE Geomembrane" for interface friction testing requirements.

C. Conformance Testing

1. The performance of conformance testing shall be coordinated by the CQA Engineer.
2. Conformance testing shall be performed on material specifically manufactured for this project.
3. Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width. The machine direction shall be marked on the samples.
4. Conformance testing will be performed by an independent laboratory at a frequency of at least 1 test per 100,000 square feet for the following:
   a. Bentonite mass per unit area (ASTM D5993).
   b. Hydraulic conductivity (ASTM D5887).
   c. Peel strength (ASTM D6496).
   d. Tensile Strength (ASTM D6768).
   e. Internal Shear Strength (ASTM D6243) shall be conducted one per every 400,000 square feet.
   f. Other tests as required by the Engineer.

D. The Manufacturer shall sample and test the geosynthetic clay liner material at a minimum frequency as required by this specification.

E. If the conformance tests or Manufacturer tests do not conform to the requirements of this specification, retesting to determine conformance or rejection shall be done as set forth in the manufacturer's quality manual at no additional cost to the CQA Engineer or Owner.

F. Any geosynthetic sample that does not conform to the requirements of the specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no cost to the Owner.

PART 2 - PRODUCTS

2.1 GEOSYNTHETIC CLAY LAYER

A. Materials: Reinforced GCL.

1. Shall be a manufactured product consisting of a sodium montmorillonite clay (bentonite) layer evenly distributed between two geotextiles.
2. Shall be free of tears, holes, or other defects which may affect its serviceability.
3. Encapsulating geotextiles shall be mechanically bonded together using a needle punch or stitch bonding process. Needle punched and stitch bonded GCLs shall be continuously inspected for broken needles using an in-line metal detector and broken needles shall be removed.
4. A 6-inch (150 mm) overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing quality assurance of the overlap dimension. Lines shall be printed in easily visible, non-toxic ink.

B. Physical, Mechanical and Chemical Property Requirements

1. Geosynthetic clay liner shall meet or exceed the values presented in Table 312015A.

Table 312015A - Geosynthetic Clay Liner			
Properties	**Test Method**	**Test Value**	**Minimum Testing Frequency**
Bentonite			
Bentonite Swell Index (min. avg.)	D 5890	24 mL/2g	per 50 tons
Bentonite Fluid Loss (max. avg.)	D 5891	18 mL	per 50 tons
Geosynthetic Clay Liner			
Bentonite Mass per Unit Area (min. avg.) *(1)*	D 5993	0.75 psf	5,000 sy
Tensile Strength (min. avg.)	D 6768	23 lb/in	5,000 sy
Peel Strength (min. avg.)	D 6496	2.1 lb/in	5,000 sy
Hydraulic Flux (max. avg.)	D 5887	1E-6 cm^3/sec-cm^2	30,000 sy
Hydraulic Conductivity (max.)	D 5887	2.48E-9 cm/sec	30,000 sy
Hydrated Internal Shear Strength (min. avg.)	D 6243	500 psf	periodic

NOTES:
(1) bentonite mass/unit area shall be computed at 0 percent moisture content. Moisture content shall be determined by ASTM D2216 or ASTM D4643. Bentonite mass/unit area is exclusive of glues added to the bentonite.

2.2 ACCESSORIES

A. Accessory Bentonite: The granular bentonite or bentonite sealing compound used for seaming, penetration sealing and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL Manufacturer.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Each roll of geosynthetic clay liner delivered to the Site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, lot number, material thickness, roll number, roll dimensions, and roll weight.

B. Procedures for storage and handling of geosynthetic clay liner shall conform to ASTM D5888 and the manufacturer instructions, including the following:

1. Geosynthetic clay liner shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.
2. Rolls shall be stored away from high traffic areas, protected from theft and vandalism.
3. Supplied in rolls wrapped in relatively impermeable, waterproof, and opaque protective cover that is resistant to photodegradation by ultraviolet (UV) light.
4. Tears in the packaging shall be repaired to restore a waterproof protective barrier around the GCL.
5. Continuously and uniformly support rolls on a prepared level surface (not on wooden pallets) away from standing water. Rolls shall not be stacked more than two rolls high.

C. Shipping and Handling

1. The Contractor and/or Geosynthetics Installer shall be liable for all damages to the materials incurred prior to and during transportation to the site and during the unloading of the material.
2. The Party responsible for unloading the GCL should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.
3. The Contractor and/or Geosynthetics Installer is responsible for unloading on-site. Unloading of the rolls from the delivery vehicles shall be done in a manner which prevents damage to the GCL and its packaging.
4. The GCL shall be dry and free of holes or any sign of contamination by foreign matter. The Engineer may reject all or portions of the GCL if significant quantities of production flaws are observed.
5. Rolls shall not be dragged, lifted by one end, or dropped to the ground from the delivery vehicle. A pipe or solid bar of sufficient strength to support the full weight of the roll without significant bending shall be used for all unloading and handling activities. The diameter of the pipe shall be small enough to be easily inserted through the core of the GCL roll. Chains shall be used to link the ends of the core pipe to the ends of a spreader bar. The spreader bar shall be wide enough to prevent the chains from rubbing against the ends of the GCL roll.
6. Alternatively, a stinger bar protruding from the end of a forklift or other equipment may be used. The stinger bar shall be at least three-fourths the length of the core and also must be capable of supporting the full weight of the GCL without significant bending. If recommended by the Manufacturer, a sling handling method utilizing appropriate loading straps may be used.

D. Storage

1. Storage of the GCL rolls shall be the responsibility of the Contractor and/or Geosynthetics Installer.
2. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry and well-drained.
3. Shall be protected from excessive heat or cold, puncture, or other damaging deleterious conditions.
4. Shall be stored off the ground.
5. Shall be stored out of direct sunlight.
6. Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks or by use of the dunnage shipped between rolls.
7. Storage of the rolls on blocks or pallets will not be allowed unless the GCL rolls are fully supported.
8. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (no higher than three).
9. All stored GCL materials and the accessory bentonite must be covered with a water proof plastic sheet or tarpaulin until their installation if stored outdoors.

E. The integrity and legibility of the labels shall be preserved during storage.

F. The CQA Engineer shall be present during delivery and unloading of the GCL. A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage.

G. Geosynthetic clay liner shall be observed by the CQA Engineer upon delivery of the product to the Site, and during installation and field seaming. Provide all labor and equipment required to assist CQA Engineer in the observation of the product.

H. CQA Engineer personnel shall generate an inventory of geosynthetic clay liner rolls received on-site from the manufacturer/distributor. The inventory shall be updated weekly and shall include all the information appearing on the label of each roll, and all observed damage shall be noted.

3.2 PREPARATION

A. Ensure acceptance of underlying layers before installing overlying layers. The Geomembrane Installer, Contractor, Engineer, and CQA Engineer shall provide written acceptance daily for the surface to be covered by geosynthetic clay liner in that day's operations. The surface shall be maintained as acceptable during GCL installation. A single form shall be used and signed by all parties to document acceptance each day. Compacted soil liner shall be compacted in accordance with Section 312010.

B. Immediately prior to GCL deployment, the compacted soil liner shall be final rolled and smooth surface. All voids or cracks shall be repaired and then smooth-rolled to provide the best surface for the GCL. At completion of this activity, no wheel ruts, footprints, rocks, stones, debris or other deleterious materials or irregularities shall exist in the compacted soil subgrade.

C. Verify anchor trench excavation, where GCL is to be secured, is in correct location and configuration. Corners shall be slightly rounded to avoid sharp bends in the GCL and properly drained to prevent ponding and softening of adjacent soils.

D. Verify and confirm that the compacted soil liner is not frozen prior to installation. The GCL shall not be installed on a frozen compacted soil liner.

E. On a continuing basis, the project CQA Engineer shall certify acceptance of the subgrade before GCL placement.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Installation of the geocomposite shall be in compliance with this Specification and with the Manufacturer's standard guidelines and specifications for geocomposite installation, subject to approval by the Engineer.

B. Geosynthetic Clay Liner Deployment:

1. GCL shall be installed as soon as practical after completion and approval of the compacted soil liner.
2. GCL shall not be deployed if compacted soil liner is frozen.
3. The GCL shall cover the cell bottom and side slopes in accordance with the Drawings.
4. The Contractor shall handle all GCL's in such a manner as to ensure they are not damaged in any way including dragging on rough surfaces

5. Deliver GCL rolls to the working area of the site in their original packaging. Immediately prior to deployment, carefully remove the packaging without damaging the GCL. Orient GCL (i.e., which side faces up) in accordance with the Manufacturer's and/or Engineer's recommendations.
6. The GCL shall be installed in accordance with the Manufacturers recommendations and in accordance with ASTM D 6102 as approved by the Engineer.
7. Reinforced GCL shall be placed wherever GCL is specified on the Drawings. The Installer and Project Engineer shall review and agree upon which GCL shall be placed on these areas prior to installation.
8. The GCL panels shall be placed so that the non-woven geotextile side is placed down onto the compacted soil subgrade.
9. Equipment which could damage the GCL shall not be allowed to travel directly on it. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.
10. Reinforced GCL panels shall be placed on the cell sides slopes first and extend a minimum of 10 feet beyond the toe of the slope. The panels on the side slopes shall extend the full length of the slope. No horizontal overlapping on the side slopes will be permitted. If a horizontal seam is required, a seaming method must be approved by the Engineer before placement.
11. On side slopes, reinforced GCL shall be placed in an anchor trench and anchored with sand bags at the top and deployed down the slope to minimize wrinkles.
12. The reinforced GCL panels in the cell bottom shall be placed from the upgradient end of the cell and progress downgradient in order to keep runoff from accumulating under the GCL. The panels on the bottom shall be placed so that the upgradient edge is on top of the downgradient edge so that potential silt run-off does not accumulate under a lapped seam.
13. Take care to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering (slip sheet or rub sheet) may be used to reduce friction damage during placement.
14. Lay all GCL panels flat on the underlying surface, with no wrinkles or fold, especially at the exposed edges of the panels.
15. After panels are initially in place, remove wrinkles as directed by the Engineer. Unroll several panels and allow the GCL to "relax" before beginning adjacent panels. The purpose of this is to make the edges that are to be overlapped as smooth and free of wrinkles as possible.
16. Geomembrane shall not be placed on a GCL which is hydrated. Hydrated GCL is defined as material which has become soft as determined by squeezing the material with finger pressure or material which has exhibited swelling.
17. The GCL shall be installed in a way that prevents hydration of the mat prior to completion of construction of the liner system.
18. The GCL shall not be installed during precipitation, high winds or other conditions that may cause hydration of or damage to the GCL.
19. All GCL's shall be sufficiently weighted with sandbags or the equivalent to avoid uplift from wind. Such sandbags shall be installed during placement and shall remain until replaced with cover material.
20. If the GCL is hydrated from rainfall or other surface water run-on and exhibits any bentonite swelling prior to placement of the geomembrane, it may be necessary to remove and replace the hydrated material. The project Engineer, CQA Engineer, and GCL Supplier should be consulted for specific guidance if premature hydration occurs. Any GCL replaced shall be done so at the Contractor's expense.
21. Unless otherwise directed by the Engineer or Technical Representative, HDPE geomembrane installation shall immediately follow the GCL installation. All GCL that is

placed during a day's work shall be covered with geomembrane before the Contractor leaves the site at the end of the day. Deploy only as much GCL as can be anchored and covered at the end of the working day with geomembrane, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight.

22. If exposed GCL cannot be permanently covered before the end of a working day, it shall be temporarily covered with plastic or other waterproof material and ballasted to prevent hydration until geomembrane placement can commence.

C. Seaming

1. Overlap adjacent GCL edges. Take care to ensure that the overlap zone is not contaminated with loose soil or other debris immediately prior to seaming.
2. Granular bentonite of the same type as the bentonite used for the GCL shall be placed along the entire overlap width at a minimum rate of 0.25 lbs/linear foot or as recommended by the Manufacturer. If using a GCL product with self-seaming edges, this qualification may be omitted with the Engineer approval.
3. The overlaps should be further sealed by tack-welding with a small blow torch.
4. The overlaps shall not be nailed or stapled to the underlying materials.
5. Minimum longitudinal overlap shall be 6 inches after shrinkage or as specified by the Manufacturer and/or Engineer. End-of-roll (along width) overlapped seams shall be similarly constructed, with a minimum overlap of 24 inches after shrinkage or as specified by the Manufacturer and/or Engineer.
6. Shingle seams at the ends of the panels such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone (seam).
7. GCL shall be placed with seams oriented parallel to the line of maximum slope and shall be free of tension or stress upon completion of the installation on side-slopes.
8. Seams should be located at least 10 feet from the toe and crest of slopes steeper than 10%.

D. Damage Repair

1. Any GCL repairs shall be made at no additional cost to the Owner.
2. All hydrated GCL shall be removed and replaced with new material by the Contractor at no additional cost to the Owner.
3. If GCL is damaged (torn, punctured, perforated, etc.) during installation, repair by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that a minimum overlap of 12 inches (300 mm) is achieved around all of the damaged area. If recommended by Manufacturer, dry bentonite or bentonite mastic shall be applied around the damaged area prior to placement of the patch. Patches shall be secured with a construction adhesive or other Manufacturer approved method, such as a water-based adhesive approved by the Manufacturer to affix the patch in place so that it is not displaced during cover placement.
4. Patches shall not be nailed or stapled.
5. Care shall be taken to remove any soil or other material which may have penetrated the torn GCL.

E. Penetrations

1. Penetration details shall be as recommended by the GCL Manufacturer.
2. As a minimum, pipe penetrations shall incorporate a collar of GCL wrapped around the pipe and securely fastened.

3. Dry bentonite or bentonite paste shall be placed around the penetration for additional protection.
4. Cut edges of the GCL encountered around the sump or surface water collection and removal (SWCR) pipe, shall be packed with a soil- bentonite mixture (3 parts soil to 1 part bentonite) below and above the edge. This can be accomplished by placing a notch sloped to the edge of the pipe, tucking the GCL onto the notch and backfilling over the notch with soil-bentonite.

F. Cover Placement

1. Although direct vehicular contact with the GCL is to be avoided, lightweight, low-ground pressure vehicles (such as 4-wheel all-terrain vehicles) may be used to facilitate the installation of any geosynthetic material placed over the GCL. Contact GCL Supplier or CQA Engineer with specific recommendations on the appropriate procedures in this situation.
2. GCL shall not be covered prior to inspection and approval by the Engineer.
3. For textured geomembrane installation over the GCL, use a temporary geosynthetic covering (slip sheet or rub sheet) so as to minimize friction during placement and to allow the textured geomembrane to be more easily moved into its final position.
4. Protective cover soil overlying the liner system shall immediately follow the installation of the geomembrane and other geosynthetics. The GCL shall be removed and replaced if it becomes hydrated before the protective cover soil is placed.

3.4 FIELD QUALITY CONTROL

A. The Contractor shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

B. Before placement of geomembrane liner, inspect seams and repaired areas to ensure tight, continuously bonded installation. Repair damaged GCL and seams and reinspect repaired work.

C. The CQA Engineer shall observe repairs and report noncompliance in writing to Owner and Engineer.

3.5 PROTECTION OF FINISHED WORK

A. The Contractor shall place all materials above the GCL in such a manner as to ensure that the GCL is not damaged.

B. The Contractor shall use all means necessary to protect all prior Work, and all materials and completed Work of other Sections of these Specifications.

C. Requirements for traffic over HDPE geomembrane shall govern. Refer to Section 313200.

D. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

END OF SECTION 312015

SECTION 312020 – PROTECTIVE COVER

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes protective cover for the Dan River Landfill. Protective cover may consist of coal combustion residual (CCR) material within the limit of waste.

B. Related Requirements:

1. Section 31205 "Trenching."
2. Section 313220 "Geocomposite Drainage Layer."

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:

1. ASTM D421 - Standard Practices for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.
2. ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils (Grain Size with Hydrometer)
3. ASTM D2487 - Standard Practices for Classification of Soil for Engineering Purposes (Unified Soil Classification System)
4. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.3 SUBMITTALS

A. Submit record drawings by the Registered Land Surveyor retained by the Contractor before and after placement of protective cover. The Land Surveyor shall be registered in North Carolina.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with these specifications and the CQA Plan.

B. Conformance Testing - Compacted soil fill.

1. The performance of conformance testing shall be coordinated by the CQA Engineer.
2. Conformance testing will be performed by an independent laboratory at a frequency of at least 1 test per 3,000 cubic yards, when materials used for protective cover changes, and/or as directed by the Engineer for the following:
   a. Laboratory moisture content (ASTM D2216)
   b. Atterberg limits (ASTM D4318)

c. Grain size with hydrometer (ASTM D422)
d. Other tests as required by the Engineer

C. The maximum percentage passing the No. 200 sieve (ASTM D422) shall be as specified by the Engineer after hydraulic conductivity ratio (HCR) testing as described in Specification Section 313220.

PART 2 - PRODUCTS

2.1 PROTECTIVE COVER

A. Protective cover within the limit of waste may consist of CCR material or soil. Protective cover material beyond the limit of waste must consist of soil.

B. Protective cover material consisting of soil shall be classified as SW, SP, SM, SC, or ML soils according to the Unified Soil Classification System (ASTM D2487).

C. Free of ferrous material, topsoil, roots, stumps, brush, rocks larger than 1-inch, subsoil, debris, vegetation, calcareous concretions or nodules, and other foreign matter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify installation of geosynthetics and stormwater and leachate conveyance structures has been inspected, and approved by the Engineer.

3.2 PREPARATION

A. Backfill liner anchor trench prior to placing protective cover on the side slopes in accordance with Section 312005 Trenching.

B. Ash material may not be used to backfill anchor trenches.

3.3 FILLING

A. Protective cover shall be placed such that the geocomposite drainage layer is not exposed for a period of 20 days or more. Ensure acceptance of geocomposite drainage layer prior to placement of protective cover.

B. Protective cover shall be placed to prevent wrinkling or tension of underlying geosynthetics. Underlying geosynthetics that develop excessive wrinkles, crimp (fold over), or are otherwise damaged shall be repaired by the Installer at the Contractor's expense.

1. Protective cover shall not be placed when temperature effects produce excessive wrinkles or tension in underlying geosynthetics.

2. Contractor shall modify placement methods if excessive wrinkles develop, or stop placing protective cover until the underlying geosynthetics cool and wrinkles decrease in size.
3. Wrinkles that exceed approximately 6 inches in height or underlying geosynthetics that become crimped shall be cut and repaired by the Geosynthetics Installer in a method approved by the Engineer.

C. Protective cover on the side slopes shall be placed from the toe of slope upward using a small, low ground pressure dozer, 5 psi or less.

D. Protective cover shall be placed in one continuous lift to a minimum thickness of 2.12 feet. Compaction of the protective cover shall be performed by a minimum of 3 passes of non-vibratory smooth drum roller. A pass is defined as one trip of the compacting equipment over the lift and back to the starting point by a single drum roller or one trip across the lift surface from one side to the other if the compacting equipment has front and back compacting rollers. This requirement is to allow thorough remolding of the soil by kneading action.

E. The Contractor shall be responsible for maintaining the protective cover until the final completion date.

F. General construction traffic shall be limited to areas designated by the Engineer that have been protected by at least 24 inches of compacted fill material.

G. Any damage to the geosynthetics or stormwater and leachate conveyance structures (e.g., tears, punctures, creases, folds, strain-yield areas, entrapped air pockets, etc.) shall be brought to the immediate attention of the Engineer and shall be repaired by the Installer. Any damage resulting from the Contractor's activities or negligence shall be repaired at the Contractor's expense.

3.4 TOLERANCES

A. Top Surface of protective cover: Plus or minus 0.10 feet from required elevations shown on Drawings.

B. The protective cover must have a minimum thickness of 2.12 feet when measured in the vertical plane..

3.5 FIELD QUALITY ASSURANCE

A. The CQA Engineer shall observe all aspects of protective cover soil placement.

3.6 PROTECTION OF FINISHED WORK

A. Limit vehicular traffic for protection of liner system below protective cover. Vehicular traffic shall be limited to 5 psi in areas which have been protected by at least 18 inches of protective cover above the liner and 10 psi in areas which have been protected by at least 24 inches of protective cover above the liner. Vehicles shall be prohibited from performing tight turning radii and rapid braking on the operational cover.

B. Reshape and re-compact fills subjected to vehicular traffic.

C. Contractor is responsible for making any repairs necessary if any portion of the project is damaged due to protective cover placement or interior berm placement.

D. Upon achieving protective cover final grades, the Contractor shall apply a stabilizing agent to the protective cover to prevent erosion. The stabilizing agent shall be approved by the Owner and Engineer prior to use.

END OF SECTION 312020

SECTION 312030 – VEGETATIVE COVER

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes vegetative cover for the Dan River Landfill final cover system.

B. Related Requirements:

1. Section 312000 "Earth Moving."
2. Section 313520 "Erosion and Sediment Control"
3. Section 329200 "Seeding."

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:
1. ASTM D422 - Standard test Method for Particle-Size Analysis of Soils (Grain Size with Hydrometer).
2. ASTM D2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
4. ASTM D2487 – Standard Practices for Classification of Soil for Engineering Purposes (Unified Soil Classification System).

1.3 SUBMITTALS

A. Submit record drawings by the Registered Land Surveyor retained by the Contractor before and after placement of vegetative cover. The Land Surveyor shall be registered in North Carolina.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with these specifications and the CQA Plan.

PART 2 - PRODUCTS

2.1 VEGETATIVE COVER

A. Vegetative soil is defined as fill placed to support vegetation establishment in areas outside the landfill cells and on the Final Cover System.

B. Excavated and reused materials from designated on-site or off-site borrow areas and/or stockpiles.

C. Shall be classified as SM, SC, SW-SM, SW-SC, SP-SM, ML, MH, or CL soils according to the Unified Soil Classification System (ASTM D2487).

D. Free of roots, stumps, brush, rocks larger than 2 inches, debris, and other foreign matter.

E. Topsoil material shall have nutrient content and pH capable of supporting vegetation.

F. Shall have a minimum organic contact of 2% by weight.

G. All material clods will be broken down with tillers or and/ discs to provide a homogeneous soil that is free of clods greater than 2 inches in diameter with no more than 15 SEED % retained on the No. 4 sieve.

2.2 EROSION AND SEDIMENT CONTROL MEASURES

A. Erosion and sediment control measures shall be installed as required by the approved Erosion and Sediment Control Plan and in accordance with Specification Section 313520.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify installation of underlying materials has been inspected and approved by the Engineer.

3.2 FILLING

A. Backfill areas to contours and elevations as shown on Drawings with unfrozen materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

C. Scarify subgrade, place material in one lift and track in with backhoe or other equipment approved by Engineer.

D. Employ placement method that does not disturb or damage other work.

E. Backfill against supported structures. Do not backfill against unsupported structures. Backfill simultaneously on each side of unsupported structures until supports are in place.

F. Protect backfill from desiccation, crusting, or cracking.

3.3 TOLERANCES

A. Top Surface of vegetative cover: Plus or minus 0.10 feet from required elevations shown on Drawings.

B. The vegetative cover must have a minimum thickness of 0.53 feet when measured in the vertical plane.

3.4 FIELD QUALITY ASSURANCE

A. The CQA Engineer shall observe all aspects of vegetative cover soil placement.

3.5 PROTECTION OF FINISHED WORK

A. Reshape and re-compact fills subjected to vehicular traffic.

B. Contractor is responsible for making any repairs necessary if any portion of the project is damaged due to protective cover placement or interior berm placement.

END OF SECTION 312030

SECTION 313200 – HDPE GEOMEMBRANE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes geomembrane liner for the Dan River Landfill (primary and secondary Bottom Liner Geomembrane system) fabricated from the following:

1. 60-mil high-density polyethylene (HDPE) double sided textured membrane.

B. Related Requirements:

1. Section 312000 “Earth Moving”.
2. Section 312005 “Trenching.”
3. Section 312015 “Geosynthetic Clay Liner.”
4. Section 312020 “Protective Cover Soils.”
5. Section 313220 “Geocomposite Drainage Layer.”
6. Section 313240 “Nonwoven Geotextiles.”

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:

1. ASTM D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
2. ASTM D1004, Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting
3. ASTM D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique
4. ASTM D1603, Standard Test Method for Carbon Black Content in Olefin Plastics
5. ASTM D3895, Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
6. ASTM D4218, Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
7. ASTM D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
8. ASTM D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
9. ASTM D5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
10. ASTM D5321, Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear

11. ASTM D5397, Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test (Appendix - Procedure to Perform a Single Point Notched Constant Tensile Load (SP-NCTL) Test)
12. ASTM D5596, Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
13. ASTM D5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
14. ASTM D5721, Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
15. ASTM D5820, Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
16. ASTM D5885, Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
17. ASTM D5994, Standard Test Method for Measuring Core Thickness of Textured Geomembrane
18. ASTM D6243, Standard Test Method for Determining the Internal and Interface Resistance of Geosynthetic Clay Liner by the Direct Shear Method
19. ASTM D6365, Standard Practice for the Nondestructive Testing of Geomembrane Seams using the Spark Test
20. ASTM D6370, Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
21. ASTM D6392, Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
22. ASTM D6693, Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
23. ASTM D7238, Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
24. ASTM D7466, Standard Test Method for Measuring the Asperity Height of Textured Geomembrane

C. Geosynthetic Research Institute (GRI):
1. GRI GM6 – Pressurized Air Channel Test for Dual Seamed Geomembranes
2. GRI-GM 13, “Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes”
3. GRI-GM 19, “Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes”

1.3 SUBMITTALS

A. Submit the following to the Engineer with the Contractor’s bid:

1. A material properties sheet for each geomembrane product, including at a minimum all properties, test methods, and test values as required by this specification.
2. Example Material Warranty and Liner Installation Guarantee as required by this specification.
3. The “Geosynthetic Contractor Qualifications Questionnaire” included in the contract bid documents.

B. Submit the following to the Engineer, for review and approval, no later than 30 calendar days prior to shipment of geomembrane to the site:

1. Manufacturer's quality control program manual, or descriptive documentation.
2. The manufacturers' quality control certifications (including results of source quality control testing of the products as required by this specification) to verify that the materials supplied for the project are in compliance with the product specifications in this section. The certifications shall be signed by a responsible party employed by the manufacturer, such as the geomembrane QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers, and corresponding shipping information.
3. A written certificate from the geomembrane manufacturer stating that the geomembrane was continuously spark tested during manufacturing.
4. A written certificate from the geomembrane manufacturer stating that the resin and geomembrane materials supplied are in compliance with this specification.
5. A written certificate from the geomembrane manufacturer stating that no more than 2% by weight of factory regrind was used to manufacture the geomembrane. Factory regrind shall have resin documentation.
6. Documentation of installers' qualifications, as required by this specification.
   a. Submit a list of at least ten completed facilities. For each installation, provide: name and type of facility; its location; the date of installation; name and telephone number of the facility's owner, design Engineer, manufacturer, and fabricator, if applicable; name and telephone number of contact at the facility; thickness of geomembrane and surface area of the installed geomembrane; and type of seaming, patching, and tacking equipment.
   b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and all technicians to be assigned to this project.
7. Manufacturer's instruction manual for geomembrane on-site handling and installation, including but not limited to procedures for storage, transport, placement, seaming, and testing.
8. Submit copies of shop drawings. Shop drawings shall show a proposed installation panel layout identifying seams and details (including sealing of penetrations).

C. On a continuous basis throughout construction, submit the following to the Engineer, for review and approval, with final documents provided no later than 14 calendar days following completion of geosynthetics installation:

1. Geosynthetics Forms
   a. Daily Field Reports
   b. Field Inventory Control, Storage, Inspection, and Cross-Reference Roll Numbers
   c. Subgrade Certification
   d. Geomembrane Trial Seam Log
   e. Geomembrane Deployment Report
   f. Geomembrane Seam Log
   g. Geomembrane Defect Log
   h. Geomembrane Repair Testing Log
   i. Geomembrane Laboratory Destructive Test Results
2. Record drawing for each geomembrane layer showing panel corners, transitions in panel geometry, repair locations, destructive test locations, anchor trench breaklines, and other significant features.
3. Provide a Letter of Acceptance indicating that the installation conforms to the requirements of the Manufacturer.
4. Manufacturer's material warranty as required by this specification.
5. Geomembrane installation guarantee as required by this specification.

1.4 QUALIFICATIONS

A. Installer's Qualifications:

1. The Geomembrane Installer shall be the manufacturer or an approved contractor qualified to install the manufacturer's geomembrane, and have current AIC status issued by the International Association of Geosynthetic Installers (IAGI).
2. The Geomembrane Installer shall have installed at least 10 million square feet of the specified types of geomembrane during the last five years.
3. Installation shall be performed under the constant direction of a single Field Installation Supervisor who shall remain on site and be in responsible charge, throughout the geomembrane installation, for geomembrane layout, seaming, patching, testing, repairs, and all other activities by the Geomembrane Installer. This Field Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 5 million square feet of geomembrane of the types specified.
4. The Geomembrane Installer shall designate a Master Seamer. The Master Seamer shall be present during all seaming operations and shall have a minimum of 3 million square feet of field seaming experience and hold an IAGI Certified Welding Technician (CWT) welding certification in both extrusion welding and fusion welding.
5. All seaming, patching, other welding operations, and designated field testing shall be performed by qualified technicians employed and trained by the Geomembrane Installer. Other specified quality control inspection and testing shall be performed by the CQA Engineer and laboratory.
6. Geosynthetic Contractor Equipment and Personnel:
   a. Quality Control Foreman (QCF)
      1) The Geosynthetics Installer shall provide an individual whose title is “Quality Control Foreman” (QCF) who shall be experienced in all phases of quality control testing and procedures.
      2) The QCF will be dedicated to performing or directing the Geosynthetics Installer’s quality control activities, (i.e. air pressure, vacuum box and spark non-destructive testing and field destructive testing).
      3) The QCF and the Superintendent may be the same person if approved by the Engineer.
   b. Crew/Equipment
      1) During geomembrane installation the Geosynthetic Installer shall provide a minimum crew size of 9, for which at least 6 must be qualified installers (a Superintendent and/or QCF and a minimum of 4 skilled technicians).
      2) Geosynthetic Contractor shall supply and maintain at least three extrusion welders and three double hot wedge fusion welders, at least one of which must be available at the working space at all times.
   c. At least one extra generator shall be supplied and maintained by the Geosynthetic Contractor to be used as a spare.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with these specifications and the CQA Plan.

B. Interface Friction Testing Requirements

1. The performance of interface friction testing shall be coordinated by the CQA Engineer.

2. Interface friction testing shall be performed in accordance with ASTM D5321 / ASTM D6243.
3. The required liner system interface effective shear strength envelope friction angle is 16.5 degrees for the specified normal loads below.
   a. The liner system effective interface shear strength envelope shall exceed that characterized by the effective peak shear stresses of 296, 1,185, 2,370, and 4,740 psf at confining stresses of 1,000, 4,000, 8,000, and 16,000 psf.
4. Furthermore, the geocomposite drainage layer to protective cover layer shall have a required interface effective shear strength envelope friction angle of 22.6 degrees for the specified normal loads below.
   a. The geocomposite drainage layer to protective cover effective interface shear strength envelope shall exceed that characterized by the effective peak shear stresses of 52, 104, and 208 psf at confining stresses of 125, 250, and 500 psf.
5. The confining load shall be applied for a minimum period of 24 hours prior to conducting interface friction testing.
6. Interfaces shall be saturated with water.
7. Interface friction testing should be performed prior to construction using site specific soils and the specified geosynthetic materials proposed for the cover system to verify that the minimum interface friction can be achieved.
8. Soil components shall be compacted and moisture conditioned as may be required by these specifications.
9. All geosynthetic-geosynthetic and geosynthetic-soil interfaces shall be tested. The anticipated interfaces are:
   a. Compacted soil liner to geosynthetic clay liner;
   b. Geosynthetic clay liner to geomembrane;
   c. Geomembrane to geocomposite drainage layer; and
   d. Geocomposite drainage layer to protective cover.
10. Geosynthetic products may have different texturing or surface treatments on each side. If such a geosynthetic is proposed for the cover system, all possible interfaces should be tested.

C. Conformance Testing

1. The performance of conformance testing shall be coordinated by the CQA Engineer.
2. Conformance testing shall be performed on material specifically manufactured for this project.
3. Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width. The machine direction shall be marked on the samples.
4. Conformance testing will be performed by an independent laboratory at a frequency of at least 1 test per 100,000 square feet for the following:
   a. Thickness (ASTM D5199 and/or ASTM D5994)
   b. Asperity height (ASTM D7466)
   c. Density (ASTM D1505 and/or ASTM D792)
   d. Carbon black content (ASTM D1603 and/or ASTM D4218)
   e. Tensile properties (ASTM D6693)
   f. Tear resistance (ASTM D1004)
   g. Other tests as required by the Engineer.

D. The Manufacturer shall sample and test the HDPE geomembrane material at a minimum frequency as required by this specification.

E. If the conformance tests or Manufacturer tests do not conform to the requirements of this specification, retesting to determine conformance or rejection shall be done as set forth in the manufacturer's quality manual at no additional cost to the CQA Engineer or Owner.

F. Any geosynthetic sample that does not conform to the requirements of the specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no cost to the Owner.

1.6 MANUFACTURER'S MATERIAL WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace geomembrane liner that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Leaks in geomembrane liner.
   b. Defects in seams.
   c. Cracks and holes in liner.

2. Warranty Period: Five year(s) from date of Substantial Completion.

1.7 GEOMEMBRANE INSTALLATION GUARANTEE

A. Guarantee the geomembrane installation against defects in installation and workmanship for two years commencing with the date of final acceptance.

B. The guarantee shall include the services of qualified service technicians and all material required for the repairs at no expense to the Owner.

1.8 GEOMEMBRANE PRE-DEPLOYMENT MEETING

A. Geomembrane Pre-Deployment Meeting shall be held at the site prior to installation of the geomembrane. At a minimum, the meeting shall be attended by the Geomembrane Installer, Owner, CQA Engineer, Engineer, and Contractor.

B. Topics for this meeting shall include, but not be limited to, the following:

1. Responsibilities of each party.
2. Lines of authority and communication.
3. Methods for documenting and reporting, and for distributing documents and reports.
4. Procedures for collecting and packaging archive samples.
5. Review of time schedule for all installation and testing.
6. Review of panel layout and numbering systems for panels, seams, and repairs.
7. Temperature and weather limitations, and installation procedures for adverse weather conditions.
8. Deployment techniques, including plans for controlling expansion, contraction and wrinkling of the geomembrane, access points, acceptable equipment and protection of geosynthetics.
9. Preparation of the geomembrane record survey drawing.

C. The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties.

PART 2 - PRODUCTS

2.1 HDPE GEOMEMBRANE

A. HDPE Sheet: Formulated from virgin PE, compounded for use in hydraulic structures, and formed into uniform sheets with material properties complying with this specification.

B. The geomembrane shall consist of new, first quality products designed and manufactured specifically for this type of project, which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes.

C. Geomembrane shall contain no plasticizers, fillers, chemical additives, or extenders. Sprayed-on texturing of textured polyethylene geomembrane will not be accepted.

D. Geomembrane shall be supplied as continuous sheets with no factory seams in rolls. The roll lengths and widths shall be maximized to provide the largest manageable sheets for the fewest field seams.

E. Geomembrane material shall be produced free of holes, blisters, or contaminants, and leak-free as verified by spark testing using ASTM D6365.

F. Physical, Mechanical and Chemical Property Requirements

1. Textured HDPE geomembrane sheet shall meet or exceed the values specified in GRI-GM13, as summarized in Table 313200A at the end of this specification.
2. Textured HDPE geomembrane seams shall meet or exceed the values specified in GRI-GM19, as summarized in Table 313200B at the end of this specification.

2.2 EQUIPMENT

A. Welding Equipment: Extrusion welding equipment shall be provided with thermocouples and temperature readout devices which continuously monitor the temperature of the extrudate. Radiant wedge welding equipment shall be provided with thermocouples and temperature readout devices which continuously monitor the temperature of the wedge. Equipment shall be maintained in adequate number to avoid delaying work, and shall be supplied by a power source capable of providing constant voltage under a combined-line load. Use a rub sheet, sand bags, or other method approved by the CQA Engineer to separate the electric generators from the geomembrane.

B. Field Tensiometer: The Geomembrane Installer shall provide a tensiometer for on-site shear and peel testing of geomembrane seams. The tensiometer shall be in good working order, built to ASTM D6693 (Type IV, 2 ipm) specifications, and accompanied by evidence of recent calibration. The tensiometer shall be motor driven and be equipped with a gauge that measures the force in unit pounds exerted between the jaws as displayed on a digital readout.

C. Vacuum Box: The Geomembrane Installer shall provide a minimum of 2 vacuum box assemblies consisting of a rigid housing, a transparent viewing window, a soft closed cell neoprene gasket attached to the bottom, a port hole or valve assembly, a vacuum gauge, a vacuum pump assembly equipped with a pressure control, a rubber pressure/vacuum hose with fittings and connections, and a soapy solution and an applicator. The equipment shall be capable of inducing and holding a minimum vacuum of 5 psi.

D. Air Pressure Test: The Geomembrane Installer shall provide the necessary air pump and fittings required to perform the GRI GM6 air pressure test on dual seams.

E. Roll Handling Equipment: The Geomembrane Installer shall provide handling equipment that is adequate and does not pose a risk to the geomembrane rolls, subject to the approval of the CQA Engineer.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Each roll of geomembrane delivered to the Site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, lot number, material thickness, roll number, roll dimensions, and roll weight.

B. Procedures for storage and handling of geomembrane shall conform to ASTM D4873 and the manufacturer instructions, including the following:

1. Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.
2. Rolls shall be stored away from high traffic areas, protected from theft and vandalism.
3. Continuously and uniformly support rolls on a prepared level surface (not on wooden pallets) away from standing water. Rolls shall not be stacked more than two rolls high.

C. Geomembrane shall be observed by the CQA Engineer upon delivery of the product to the Site, and during installation and field seaming. Provide all labor and equipment required to assist CQA Engineer in the observation of the product.

D. CQA Engineer personnel shall generate an inventory of geomembrane rolls received on-site from the manufacturer/distributor. The inventory shall be updated weekly and shall include all the information appearing on the label of each roll, and all observed damage shall be noted.

3.2 SUBGRADE PREPARATION

A. Examine substrates, with Installer present, for compliance with requirements for soil compaction and grading; for subgrade free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, and ground water; and for other conditions affecting performance of geomembrane liner.

B. Examine anchor trench excavation, where geomembrane liner will be secured, for substrate conditions indicated above and for correct location and configuration.

C. The geomembrane subgrade shall be prepared as specified in Section 312000 and as shown on the Drawings. The subgrade shall be smooth and uniform, and free of all trash and debris, prior to installation of the geomembrane.

D. Qualified representatives of the Geomembrane Installer, Contractor, Engineer, and CQA Engineer shall observe the surface to be covered with geomembrane on each day's operations prior to placement of geomembrane.

E. The Geomembrane Installer, Contractor, Engineer, and CQA Engineer shall provide written acceptance daily for the surface to be covered by geomembrane or GCL as applicable in that day's operations. The surface shall be maintained as acceptable during geomembrane installation. A single form shall be used and signed by all parties to document acceptance each day.

F. Subgrade damaged by erosion, rutting, or other means during geomembrane deployment shall be exposed and the damage repaired. The subgrade shall then be re-approved.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 GEOMEMBRANE PLACEMENT

A. No geomembrane shall be deployed and seamed until the surfaces to be covered have been approved by the Engineer. Should geomembrane material be deployed prior to Engineer's approval, it shall be at sole risk of the Geomembrane Installer and Contractor, and if the material does not meet project specifications, it shall be removed from the project at no additional cost to the Owner.

B. At the beginning of each day's work, the CQA Engineer shall provide the Engineer with a daily field installation report for all work accomplished on the previous workday before additional geomembrane is installed.

C. Geomembrane shall be installed to the required limits over the prepared compacted soil liner as shown on the Drawings and specified in this Section. Install geomembrane in anchor trenches as indicated on the Drawings.

D. No geomembrane material shall be unrolled and deployed if the material temperatures are lower than approximately 32 degrees F unless otherwise approved by the Engineer and unless special precautions are taken such as storing the rolls inside a heated enclosure providing ambient temperatures of 50 degrees F or above. The specified minimum temperature for material deployment may be adjusted by the Engineer based on recommendations by the manufacturer.

E. Geomembrane shall be placed in an effort to reduce wrinkles and subsequent fishmouths at the field seam interfaces. In general, “Leister” welds or “tack” welds shall not be used to temporarily hold sheets in position, however “Leister” welds may be used to secure small patches prior to extrusion welding.

F. All geomembrane handling and installation procedures shall be performed by workers wearing shoes that will not damage the geomembrane. Only low ground pressure, rubber-tired, vehicular traffic shall be permitted to travel on the geomembrane. The maximum equipment ground pressure shall be eight pounds per square inch (psi). Conform to other written recommendations of the geomembrane manufacturer for pedestrian and vehicular traffic on the geomembrane.

G. Only the panels which will be anchored and seamed together in one day shall be deployed.

H. Sand bags shall be used as necessary to hold the geomembrane material in position during installation. Sand bags shall be sufficiently close-knit to preclude fines from working through the bags. Paper bags, whether or not lined with plastic, shall not be used. Burlap bags, if used, must be lined with plastic. Bags shall contain not less than 20 nor more than 60 pounds of sand, and shall be securely closed after filling and not over-filled to prevent sand loss. Bags that are split, torn, or otherwise losing their contents shall be immediately removed from the work area and any spills immediately cleaned up.

I. Panels that become seriously damaged (torn or twisted permanently) shall be replaced. Less serious damage shall be repaired according to the requirements herein. Damaged panels, or portions of the damaged panels which have been rejected, shall be marked and their removal from the work area recorded.

J. Geomembrane shall be installed so that there will be neither tension nor wrinkles at the average expected daily ambient temperature.

K. Geomembrane shall not be allowed to “bridge over” (be pulled taut over) voids or low areas in the subgrade. Geomembrane in these areas shall be cut and patched to provide adequate material to allow the geomembrane to rest on the subgrade surface.

L. In general, seams shall be oriented with the long dimension parallel to (down) the line of the maximum slope. Where seams can only be oriented across the slope, the upper panel shall be lapped over the lower panel. The total length of field seams shall be minimized. In corners and odd shaped geometric locations, the total length of field seams shall be minimized. Seams shall not be located at low points in the subgrade unless geometry requires seaming at such locations, and if approved by CQA Engineer personnel.

M. Geomembrane panels shall be overlapped prior to seaming to whatever extent is necessary to provide a good weld. In no case shall overlaps be less than six inches for fusion welding at the time the welds are made.

N. The Geomembrane Installer shall label panels at the time of deployment. Label date of deployment, roll number, and panel number.

3.4 SEAMING PROCEDURES

A. No geomembrane material shall be seamed when ambient temperatures are less than 32 degrees Fahrenheit unless the following conditions are complied with:

1. Seaming of the geomembrane at ambient temperatures below 32 degrees Fahrenheit is allowed if the Geomembrane Installer can demonstrate to the Engineer and the CQA Engineer, using pre-qualification test seams, that field seams complying with the specifications can be fabricated at sub-freezing temperatures. Consistent passing test seams are required.
2. In addition, the Geomembrane Installer shall submit to the Engineer for review, detailed procedures for seaming at low temperatures, including the following: preheating the geomembrane; and providing a tent or other device to prevent heat losses during seaming and rapid heat losses subsequent to seaming.

B. No geomembrane material shall be seamed when the ambient temperature is above 104 degrees Fahrenheit and when the sheet temperature of the material is above 122 degrees Fahrenheit (as measured by an infrared thermometer or surface thermocouple), unless otherwise approved by the Engineer.

C. Geomembrane seaming at temperatures outside the above stated temperature ranges will only be approved if: the manufacturer certifies that the seaming procedure shall not cause physical or chemical modification to the geomembrane; and an increased number of test welds is performed to determine appropriate seaming conditions when required by the CQA Engineer or Engineer. However, should the overall quality of the geomembrane decrease under such conditions, in the opinion of the Engineer, then seaming outside the allowable temperatures shall be discontinued.

D. Seaming is not allowed while precipitation is occurring unless proper precautions are made to allow the seam to be made on dry geomembrane material or the welding process is protected from rain. The surface below the geomembrane shall not be saturated or frozen.

E. Extra care shall be taken to clean and remove dirt, dust and other foreign materials from the surfaces of the geomembrane to be seamed. Surfaces shall be cleaned immediately prior to seaming.

F. Seaming shall be performed using an automatic double wedge fusion welding system, equipment, and techniques. Extrusion welding shall only be used where fusion welding is not possible and as approved by the Engineer.

G. The fusion-welding apparatus shall be an automated device, and shall be equipped with gauges giving applicable temperatures and pressures. Each welding machine shall be calibrated at least twice daily. The calibration procedure shall be witnessed by CQA Engineer personnel and shall be in accordance with the recommendations of the welding machine manufacturer. Certificates of calibration shall be provided to the CQA Engineer.

H. The extrusion welding apparatus shall be equipped with gauges giving the temperature in the apparatus and at the nozzle. The extruder shall be purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel. Whenever the extruder is stopped, the barrel shall be purged of all heat degraded extrudate.

I. The Geomembrane Installer shall maintain at least one spare operable seaming apparatus of each kind on site. Equipment used for seaming shall not damage the geomembrane, and the geomembrane shall be protected from damage in areas with heavy traffic.

J. The surface of the seam edges shall be prepared as recommended by the manufacturer to provide a seam to equal or exceed the seam strength requirements in this specification. The welding process shall bond the exposed edge of the panel to the underlying geomembrane panel.

K. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkles back into the panel so as to effect a flat overlap. The cut fishmouths or wrinkles shall be seamed as completely as possible, and shall then be patched with an oval or round patch of the same geomembrane material extending a minimum of six inches beyond the cut in all directions.

L. Seaming shall extend to the outside edges of panels to be placed in the anchor trenches.

M. The Geomembrane Installer shall label seams at the time of seaming. Label date of seaming, start time, initials of the seaming technician, and the number of the seaming unit.

3.5 PIPE PENETRATION SEALING SYSTEM

A. Provide penetration sealing system as shown on the Drawings, or as otherwise approved by the Engineer, using compatible geomembrane material, boots, stainless steel clamps, Neoprene gaskets and accessories.

B. The penetration sealing system shall be fabricated and installed to prevent leakage.

3.6 FIELD QUALITY ASSURANCE

A. Panels shall be observed by CQA Engineer personnel when the panels are initially deployed. Observation shall be for identification of defects, holes, and any sign of contamination by foreign matter. Defects in seam and non-seam areas shall be repaired as required by this specification.

B. Prequalification Test Seams

1. Engineer shall be notified when prequalification testing will be performed.
2. Welding machine calibration and test seams shall be performed by the Geomembrane Installer's personnel and observed by CQA Engineer personnel to verify that seaming conditions are adequate. Test seams shall be conducted by each seamer at the beginning of each seaming period, and as determined by CQA Engineer personnel for each welding machine used that day. Test seaming shall be performed under the same conditions and with the same equipment as production seaming. Each test seam shall be at least ten feet long for hot wedge welding and three feet long for extrusion welding with the seam centered lengthwise.
3. Two adjoining one-inch wide specimens shall be die-cut by the Geomembrane Installer from each opposite end and from the center of the test seam. These specimens shall be tested by the Geomembrane Installer. Each specimen shall be tested in peel. The tests shall be performed using a field tensiometer, and shall not fail in the weld. Both welds of double wedge seams shall be tested in peel. Any failures through the seam shall be considered a failing test, regardless of the stress at failure.
4. The minimum acceptable seam strength values to be obtained for all specimens tested are those indicated in Table 313200B.
5. If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming apparatus shall be rejected and not used for production seaming until the deficiencies are corrected and a successful test seam is produced.
6. CQA Engineer personnel shall observe and record testing of prequalification test specimens. Records shall be included in the Daily Field Installation Reports.

C. Non-Destructive Field Seam Testing

1. All field seams shall be non-destructively tested by the Geomembrane Installer over their full length. Each seam shall be assigned a unique number consisting of the adjacent panel numbers (for example, the seam between panels 1 and 3 would be S–1/3). The location, date, test unit, name of tester, and outcome of all non-destructive testing shall be observed and recorded by CQA Engineer personnel.

2. All defects found during testing shall be numbered and marked by CQA Engineer personnel immediately after detection. All defects found shall be repaired, retested and re-marked to indicate completion of the repair and acceptability.
3. Non-destructive testing shall be performed by the Geosynthetics Installer using vacuum boxes (in accordance with ASTM D5641), air pressure testing (in accordance with ASTM D5820), spark testing (in accordance with ASTM D6365), or other test methods approved by the Engineer. All test equipment shall be furnished by the Geomembrane Installer.
4. Non-destructive tests shall be performed by experienced personnel thoroughly familiar with the specified test methods. The Geomembrane Installer shall field demonstrate all test methods to verify to CQA Engineer personnel that the test procedures are valid.
5. Extrusion seams shall be vacuum box tested by the Geomembrane Installer according to the following methods:
    a. Equipment for testing extrusion seams shall be comprised of, but not limited to: a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge; a steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connections; a plastic bucket; sponge or mop; and a soapy solution. The vacuum box shall be similar to the series A 100 Straight Seam Tester as supplied by the American Parts Service Company.
    b. The glass for vacuum box shall be unscratched and clean, and the rubber gasket shall be firmly attached to the box.
    c. The vacuum pump shall be charged and the tank pressure adjusted to three to four pounds per square inch, gauge (psig).
    d. CQA Engineer personnel shall periodically observe that a leak tight seal is created by the Geomembrane Installer. The Geomembrane Installer shall create the leak tight seal by wetting a strip of geomembrane approximately 12 inches by length of box with a soapy solution, placing the box over the wetted area and then compressing. The Geomembrane Installer shall then close the bleed valve, open the vacuum valve, maintain five psig for a period of approximately 15 seconds, and CQA Engineer personnel shall observe the geomembrane through the viewing window for the presence of soap bubbles. If no bubbles appear after 15 seconds, the area shall be considered leak tight. The box shall be moved over the next adjoining area with a minimum three inches overlap and the process repeated.
    e. All areas where soap bubbles appear shall be marked and repaired, and then retested under the observation of CQA Engineer personnel.
    f. CQA Engineer personnel shall observe all testing operations for uniformity and completeness, and shall record results at time of testing.
    g. All seams that are vacuum tested shall be marked by the Geomembrane Installer at the time of testing. Marking shall consist of the date tested, technician performing the test, and the results of the test.
6. Double Fusion seams with an enclosed space shall be air pressure tested by the Geomembrane Installer according to the following methods:
    a. Equipment for testing double fusion seams shall be comprised of, but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 30 psig, mounted on a cushion to protect the geomembrane; a rubber hose with fittings and connections; and a manometer equipped with a sharp hollow needle, or other approved pressure feed device.
    b. CQA Engineer personnel shall ensure that the Geomembrane Installer creates a leak-tight seal. The Geomembrane Installer shall perform the testing activities. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure

feed device inserted into the tunnel created by the double wedge fusion weld. The air pump pressure shall be adjusted, the valve closed, and the pressure stabilized for two minutes at a pressure of 28 psig (for 60-mil thickness). After the stabilization period, pressure shall be maintained for five minutes for the seam to be considered leak tight. The Geomembrane Installer shall remove the seal at the opposite end of the tested seam while CQA Engineer personnel observe the gauge. The needle or other approved pressure feed device shall be removed and the feed hole sealed if not covered by a patch at the end of the seam. Pressure tests shall be conducted in accordance with the procedures outlined in ASTM D5820.

c. If loss of pressure exceeds three psig (for 60-mil thickness) during testing period, or pressure does not stabilize, the faulty area shall be located, repaired, and retested by the Geomembrane Installer.

d. All seams that are vacuum tested shall be marked by the Geomembrane Installer at the time of testing. Marking shall consist of the date tested, technician performing the test, test start and end times, and test start and end pressures.

7. All non-destructive field seam tests shall be observed by CQA Engineer personnel and recorded at the time of testing. Records shall be included in the Daily Field Installation Reports.

D. Destructive Field Seam Testing

1. A minimum of one destructive test sample per 500 feet of seam length shall be cut by the Geomembrane Installer from a location specified by CQA Engineer personnel. The Geomembrane Installer shall not be informed in advance of the sample location. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Geomembrane Installer as the seaming progresses.

2. CQA Engineer personnel shall mark all samples with their location and seam number at the time of sample collection. CQA Engineer personnel shall observe field testing of the samples and record the date, time, location, seam number, ambient temperatures, and pass or fail description according to ASTM D6392. A copy of the information must be attached to each sample portion. The Geomembrane Installer shall repair all holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum tested. If a permanent patch cannot be installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.

3. Each destructive test sample shall be 12 inches wide by 54 inches long, with the seam centered lengthwise. The sample shall be cut into three sections and distributed as follows: one 18-inch section shall be given to CQA Engineer personnel for testing; one 12-inch section retained by the Geomembrane Installer for field testing; and one 12-inch section shall be set aside for an archive sample. Holes for destructive seam testing shall be repaired as required in this specification.

4. The Geomembrane Installer shall die-cut at least three one-inch wide replicate specimens from the installer's sample for field testing. Replicate specimens will not be required for extrusion welds. The specimens shall be tested for peel strength. Both welds of dual hot-wedge seams shall be tested in peel. To be acceptable, all replicate test specimens shall meet the seam strength requirements as required in this specification. Any specimen that fails through the weld or by partial failure exceeding 50 percent of the weld shall be considered a Non-Film Tear Bond break and shall be considered a failure. Die cutting and field testing of the replicate specimens shall be performed in the presence of CQA Engineer personnel. If the field tests pass, the sample qualifies for testing by the CQA Engineer.

5. Laboratory testing coordinated by the CQA Engineer shall conform to ASTM D6392. The preference is for the CQA Engineer to establish an on-site laboratory to the satisfaction of the Engineer for performing laboratory destructive tests. Five replicate specimens shall be tested in peel and five replicate specimens shall be tested in shear. Both welds of dual hot-wedge seams shall be tested in peel. To be acceptable, all replicate test specimens shall meet the seam strength requirements as required in this specification.
6. If a destructive sample fails the field or laboratory destructive tests, an additional sample shall be obtained at a distance of approximately 10 feet on each side of the failed sample location. Test specimens shall be obtained and field tested as specified in accordance with destructive field seam testing requirements. The process shall be repeated until the failed area is bounded by samples with passing test results.
7. The Geomembrane Installer shall repair the seam between the two nearest passed test locations with the failed location in between, or as directed by the CQA Engineer and/or Engineer.
8. Reports of the results of destructive field seam tests shall be prepared by the CQA Engineer and included in the Daily Field Installation Reports.

E. Daily Field Installation Reports: At the beginning of each day's work, the CQA Engineer shall provide the Engineer with Daily Field Installation Reports for all work accomplished on the previous work day. Reports shall include the following:

1. Total amount and location of geomembrane placed;
2. Total amount and location of seams and repairs completed, names of individuals doing seaming and repairing, and units used;
3. Drawings of the previous day's installed geomembrane showing panel numbers and seam numbers;
4. Results of pre-qualification test seams; and
5. Results of non-destructive testing and field destructive testing.

3.7 REPAIR PROCEDURES

A. Defective seams shall be repaired with a capstrip or extrusion weld over the full length of the defect. Each capstrip shall be numbered, shall be made of the same geomembrane material as for the geomembrane sheet, and shall extend a minimum of six inches beyond both sides of the seam.

B. Blisters, tears and holes in the geomembrane sheet shall be repaired with patches. Each patch shall be numbered by CQA Engineer personnel at the time the defect is identified.

C. Abrasions and other defects and damage of the geomembrane material that are not punctured through the material may be repaired using extrudate, unless otherwise directed by the Engineer or CQA Engineer.

D. Capstrips and patches shall be rounded at the corners, made of the same material as for the geomembrane sheet, and extend a minimum of six inches beyond the edge of defects.

E. Repaired areas shall be numbered and shall be measured and recorded from a known survey point to document location.

F. Verification of Repair Patches and Capstrips: Each repair shall be non-destructively tested using vacuum box testing or air testing. Tests that pass the non-destructive test shall be taken as an

indication of an adequate repair. Failed tests shall be reseamed and retested until a passing test results. CQA Engineer personnel shall observe all non-destructive testing of repairs. CQA Engineer personnel shall record the number of each capstrip and patch, date, location, name of person who installed the capstrip or patch, and test outcome on a form to be submitted with the daily field installation reports.

3.8 GEOMEMBRANE ACCEPTANCE

A. The geomembrane will be accepted by the Engineer when:

1. The geomembrane is clean (brooming and washing of the geomembrane surface shall be required if the amount of surface dust or mud inhibits inspection);
2. The entire installation is finished, or an agreed upon subsection of the installation is finished;
3. All documentation of installation is completed;
4. Verification of the adequacy of all field seams and repairs, and associated testing is complete; and
5. A record survey drawing is prepared as required by this specification, and is submitted to and approved by the Engineer.

B. Record Survey Drawing Requirements: Record drawing for each geomembrane layer showing panel corners, transitions in panel geometry, repair locations, destructive test locations, anchor trench breaklines, and other significant features shall be surveyed. The survey results shall be certified by a North Carolina Registered Land Surveyor.

C. Work shall not proceed with any materials which will cover geomembrane seams, capstrips and patches until laboratory test results with passing values have been received and the portion of the geomembrane has been accepted in writing by the Engineer.

D. Accepted areas of geomembrane that have not been covered within a reasonable time will require reinspection as determined by the Engineer.

E. Archive samples will be held by the Owner or Engineer until Engineer’s approval of the installation and the CQA Engineer Report.

3.9 DISPOSAL OF SCRAP MATERIALS

A. At the end of each work day, all scraps of material and other debris shall be removed from the geomembrane surface.

B. On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap materials off-site, remove equipment used in connection with geomembrane installation, and leave the premises in a neat and acceptable manner. No scrap material shall be allowed to remain on the geomembrane or adjacent areas.

3.10 PROTECTION

A. Protect installed geomembrane liner according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

B. Before placement of cover materials, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane liner and seams and reinspect repaired work.

Table 313200A - High Density Polyethylene (HDPE) Geomembrane Sheet - Textured [GRI-GM13]

Properties	Test Method	Test Value							Minimum Testing Frequency
		30-mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. avg.)	D 5994	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	per roll
● lowest individual for 8 out of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	
● lowest individual for any of the 10 values		-15%	-15%	-15%	-15%	-15%	-15%	-15%	
Asperity Height mils (min. avg) *(1)*	D 7466	16 mil	16 mil	16 mil	16 mil	16 mil	16 mil	16 mil	every 2nd roll *(2)*
Density (min. avg.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (min. avg.) *(3)*	D 6693 Type IV								20,000 lb
● yield strength		63 lb/in	84 lb/in	105 lb/in	126 lb/in	168 lb/in	210 lb/in	252 lb/in	
● break strength		45 lb/in	60 lb/in	75 lb/in	90 lb/in	120 lb/in	150 lb/in	180 lb/in	
● yield elongation		12%	12%	12%	12%	12%	12%	12%	
● break elongation		100%	100%	100%	100%	100%	100%	100%	
Tear Resistance (min. avg.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. avg.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb	45,000 lb
Stress Crack Resistance *(4)*	D 5397 (App.)	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	per GRI GM10
Carbon Black Content (range)	D 4218 *(5)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lb
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	45,000 lb
Oxidative Inductive Time (OIT) (min. avg.) *(7)*									200,000 lb
(a) Standard OIT **OR**	D 3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	
(b) High Pressure OIT	D 5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	
Oven Aging at 85°C *(7) (8)*	D 5721								per each formulation
(a) Standard OIT (min. avg.) - % retained after 90 days **OR**	D 3895	55%	55%	55%	55%	55%	55%	55%	
(b) High Pressure OIT (min. avg.) - % retained after 90 days	D 5885	80%	80%	80%	80%	80%	80%	80%	
UV Resistance *(9)*	D 7238								per each formulation
(a) Standard OIT (min. avg.) **OR**	D 3895	N. R. *(10)*	N. R. *(10)*	N. R. *(10)*	N. R. *(10)*	N. R. *(10)*	N. R. *(10)*	N. R. *(10)*	
(b) High Pressure OIT (min. avg.) - % retained after 1600 hrs *(11)*	D 5885	50%	50%	50%	50%	50%	50%	50%	

NOTES:

(1) Of 10 readings; 8 out of 10 must be ≥ 14 mils, and lowest individual reading must be ≥ 12 mils; also see Note 6

(2) Alternate the measurement side for double sided textured sheet

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction

Yield elongation is calculated using a a gage length of 1.3 inches

Break elongation is calculated using a gage length of 2.0 inches

(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials. The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(5) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane

(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response

(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C

(10) Not recommended since the high temperature of the Std.-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples

(11) UV resistance is based on percent retained value regardless of the original HP-OIT value

Table 313200B - High Density Polyethylene (HDPE) Geomembrane Seams [GRI-GM19]							
Properties	**Test Value**						
	30-mils	**40 mils**	**50 mils**	**60 mils**	**80 mils**	**100 mils**	**120 mils**
Hot Wedge Seams *(1)*							
● shear strength *(2)*	57 lb/in	80 lb/in	100 lb/in	120 lb/in	160 lb/in	200 lb/in	240 lb/in
● shear elongation at break *(3)*	50%	50%	50%	50%	50%	50%	50%
● peel strength *(2)*	45 lb/in	60 lb/in	76 lb/in	91 lb/in	121 lb/in	151 lb/in	181 lb/in
● peel separation	25%	25%	25%	25%	25%	25%	25%
Extrusion Fillet Seams							
● shear strength *(2)*	57 lb/in	80 lb/in	100 lb/in	120 lb/in	160 lb/in	200 lb/in	240 lb/in
● shear elongation at break *(3)*	50%	50%	50%	50%	50%	50%	50%
● peel strength *(2)*	39 lb/in	52 lb/in	65 lb/in	78 lb/in	104 lb/in	130 lb/in	156 lb/in
● peel separation	25%	25%	25%	25%	25%	25%	25%

NOTES:

(1) Also for hot air and ultrasonic seaming methods

(2) Value listed for shear and peel strengths are for 4 out of 5 test specimens; the 5th specimen can be as low as 80% of the listed values

(3) Elongation measurements should be omitted for field testing

END OF SECTION 313200

SECTION 313205 – LLDPE GEOMEMBRANE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes geomembrane liner for the Dan River Landfill final cover system fabricated from the following:

1. 40-mil linear low-density polyethylene (LLDPE) double sided textured membrane.

B. Related Requirements:

1. Section 312000 “Earth Moving”.
2. Section 312005 “Trenching.”
3. Section 313220 “Geocomposite Drainage Layer.”
4. Section 313240 “Nonwoven Geotextiles.”

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:

1. ASTM D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
2. ASTM D1004, Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting
3. ASTM D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique
4. ASTM D1603, Standard Test Method for Carbon Black Content in Olefin Plastics
5. ASTM D3895, Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
6. ASTM D4218, Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
7. ASTM D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
8. ASTM D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
9. ASTM D5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
10. ASTM D5321, Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
11. ASTM D5323, Standard Practice for Determination of 2% Secant Modulus for Polyethylene Geomembranes.

12. ASTM D5397, Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test (Appendix - Procedure to Perform a Single Point Notched Constant Tensile Load (SP-NCTL) Test)
13. ASTM D5596, Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
14. ASTM D5617, Standard Test Method for Multi-Axial Tension for Geosynthetics.
15. ASTM D5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
16. ASTM D5721, Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
17. ASTM D5820, Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
18. ASTM D5885, Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
19. ASTM D5994, Standard Test Method for Measuring Core Thickness of Textured Geomembrane
20. ASTM D6243, Standard Test Method for Determining the Internal and Interface Resistance of Geosynthetic Clay Liner by the Direct Shear Method
21. ASTM D6365, Standard Practice for the Nondestructive Testing of Geomembrane Seams using the Spark Test
22. ASTM D6370, Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
23. ASTM D6392, Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
24. ASTM D6693, Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
25. ASTM D7238, Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
26. ASTM D7466, Standard Test Method for Measuring the Asperity Height of Textured Geomembrane

C. Geosynthetic Research Institute (GRI):
1. GRI GM 6 – Pressurized Air Channel Test for Dual Seamed Geomembranes
2. GRI-GM 17, “Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes”
3. GRI-GM 19, “Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes”

1.3 SUBMITTALS

A. Submit the following to the Engineer with the Contractor’s bid:

1. A material properties sheet for each geomembrane product, including at a minimum all properties, test methods, and test values as required by this specification.
2. Example Material Warranty and Liner Installation Guarantee as required by this specification.
3. The “Geosynthetic Contractor Qualifications Questionnaire” included in the contract bid documents.

B. Submit the following to the Engineer, for review and approval, no later than 30 calendar days prior to shipment of geomembrane to the site:

1. Manufacturer's quality control program manual, or descriptive documentation.
2. The manufacturers' quality control certifications (including results of source quality control testing of the products as required by this specification) to verify that the materials supplied for the project are in compliance with the product specifications in this Section. The certifications shall be signed by a responsible party employed by the manufacturer, such as the geomembrane QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers, and corresponding shipping information.
3. A written certificate from the geomembrane manufacturer stating that the geomembrane was continuously spark tested during manufacturing.
4. A written certificate from the geomembrane manufacturer stating that the resin and geomembrane materials supplied are in compliance with this specification.
5. A written certificate from the geomembrane manufacturer stating that no more than 2% by weight of factory regrind was used to manufacture the geomembrane. Factory regrind shall have resin documentation.
6. Documentation of installers' qualifications, as required by this specification.
   a. Submit a list of at least ten completed facilities. For each installation, provide: name and type of facility; its location; the date of installation; name and telephone number of the facility's owner, design engineer, manufacturer, and fabricator, if applicable; name and telephone number of contact at the facility; thickness of geomembrane and surface area of the installed geomembrane; and type of seaming, patching, and tacking equipment.
   b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and all technicians to be assigned to this project.
7. Manufacturer's instruction manual for geomembrane on-site handling and installation, including but not limited to procedures for storage, transport, placement, seaming, and testing.
8. Submit copies of shop drawings. Shop drawings shall show a proposed installation panel layout identifying seams and details (including sealing of penetrations).

C. On a continuous basis throughout construction, submit the following to the Engineer, for review and approval, with final documents provided no later than 14 calendar days following completion of geosynthetics installation:

1. Geosynthetics Forms
   a. Daily Field Reports
   b. Field Inventory Control, Storage, Inspection, and Cross-Reference Roll Numbers
   c. Subgrade Certification
   d. Geomembrane Trial Seam Log
   e. Geomembrane Deployment Report
   f. Geomembrane Seam Log
   g. Geomembrane Defect Log
   h. Geomembrane Repair Testing Log
   i. Geomembrane Laboratory Destructive Test Results
2. Record drawing for each geomembrane layer showing panel corners, transitions in panel geometry, repair locations, destructive test locations, anchor trench breaklines, and other significant features.
3. Provide a Letter of Acceptance indicating that the installation conforms to the requirements of the Manufacturer.
4. Manufacturer's material warranty as required by this specification.
5. Geomembrane installation guarantee as required by this specification.

1.4 QUALIFICATIONS

A. Installer's Qualifications:

1. The Geomembrane Installer shall be the manufacturer or an approved contractor qualified to install the manufacturer's geomembrane, and have current AIC status issued by the International Association of Geosynthetic Installers (IAGI).
2. The Geomembrane Installer shall have installed at least 10 million square feet of the specified types of geomembrane during the last five years.
3. Installation shall be performed under the constant direction of a single Field Installation Supervisor who shall remain on site and be in responsible charge, throughout the geomembrane installation, for geomembrane layout, seaming, patching, testing, repairs, and all other activities by the Geomembrane Installer. This Field Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 5 million square feet of geomembrane of the types specified.
4. The Geomembrane Installer shall designate a Master Seamer. The Master Seamer shall be present during all seaming operations and shall have a minimum of 3 million square feet of field seaming experience and hold an IAGI Certified Welding Technician (CWT) welding certification in both extrusion welding and fusion welding.
5. All seaming, patching, other welding operations, and designated field testing shall be performed by qualified technicians employed and trained by the Geomembrane Installer. Other specified quality control inspection and testing shall be performed by the CQA Engineer and laboratory.
6. Geosynthetic Contractor Equipment and Personnel:
   a. Quality Control Foreman (QCF)
      1) The Geosynthetics Installer shall provide an individual whose title is “Quality Control Foreman” (QCF) who shall be experienced in all phases of quality control testing and procedures.
      2) The QCF will be dedicated to performing or directing the Geosynthetics Installer’s quality control activities, (i.e. air pressure, vacuum box and spark non-destructive testing and field destructive testing).
      3) The QCF and the Superintendent may be the same person if approved by the Engineer.
   b. Crew/Equipment
      1) During geomembrane installation the Geosynthetic Installer shall provide a minimum crew size of 9, for which at least 6 must be qualified installers (a Superintendent and/or QCF and a minimum of 4 skilled technicians).
      2) Geosynthetic Contractor shall supply and maintain at least three extrusion welders and three double hot wedge fusion welders, at least one of which must be available at the working space at all times.
   c. At least one extra generator shall be supplied and maintained by the Geosynthetic Contractor to be used as a spare.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with these specifications and the CQA Plan.

B. Interface Friction Testing Requirements

1. The performance of interface friction testing shall be coordinated by the CQA Engineer.

2. Interface friction testing shall be performed in accordance with ASTM D5321 / ASTM D6243.
3. The required liner system interface effective shear strength envelope friction angle is 26.6 degrees for the specified normal loads below.
    a. The liner system effective interface shear strength envelope shall exceed that characterized by the effective peak shear stresses of 63, 126, and 252 psf at confining stresses of 125, 250, and 500 psf.
4. The confining load shall be applied for a minimum period of 24 hours prior to conducting interface friction testing.
5. Interfaces shall be saturated with water.
6. Interface friction testing should be performed prior to construction using site specific soils and the specified geosynthetic materials proposed for the cover system to verify that the minimum interface friction can be achieved.
7. Soil components shall be compacted and moisture conditioned as may be required by these specifications.
8. All geosynthetic-geosynthetic and geosynthetic-soil interfaces shall be tested. The anticipated interfaces are:
    a. Interim cover to geomembrane;
    b. Geomembrane to geocomposite drainage layer; and
    c. Geocomposite drainage layer to final soil cover.
9. Geosynthetic products may have different texturing or surface treatments on each side. If such a geosynthetic is proposed for the cover system, all possible interfaces should be tested.

C. Conformance Testing

1. The performance of conformance testing shall be coordinated by the CQA Engineer.
2. Conformance testing shall be performed on material specifically manufactured for this project.
3. Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width. The machine direction shall be marked on the samples.
4. Conformance testing will be performed by an independent laboratory at a frequency of at least 1 test per 100,000 square feet for the following:
    a. Thickness (ASTM D5199 and/or ASTM D5994)
    b. Asperity height (ASTM D7466)
    c. Density (ASTM D1505 and/or ASTM D792)
    d. Carbon black content (ASTM D1603 and/or ASTM D4218)
    e. Tensile properties (ASTM D6693)
    f. Tear resistance (ASTM D1004)
    g. Other tests as required by the Engineer

D. The Manufacturer shall sample and test the LLDPE geomembrane material at a minimum frequency as required by this specification.

E. If the conformance tests or Manufacturer tests do not conform to the requirements of this specification, retesting to determine conformance or rejection shall be done as set forth in the manufacturer's quality manual at no additional cost to the CQA Engineer or Owner.

F. Any geosynthetic sample that does not conform to the requirements of the specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no cost to the Owner.

1.6 MANUFACTURER'S MATERIAL WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace geomembrane liner that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Leaks in geomembrane liner.
   b. Defects in seams.
   c. Cracks and holes in liner.

2. Warranty Period: Five year(s) from date of Substantial Completion.

1.7 GEOMEMBRANE INSTALLATION GUARANTEE

A. Guarantee the geomembrane installation against defects in installation and workmanship for two years commencing with the date of final acceptance.

B. The guarantee shall include the services of qualified service technicians and all material required for the repairs at no expense to the Owner.

1.8 GEOMEMBRANE PRE-DEPLOYMENT MEETING

A. Geomembrane Pre-Deployment Meeting shall be held at the site prior to installation of the geomembrane. At a minimum, the meeting shall be attended by the Geomembrane Installer, Owner, CQA Engineer, Engineer, and Contractor.

B. Topics for this meeting shall include, but not be limited to, the following:

1. Responsibilities of each party.
2. Lines of authority and communication.
3. Methods for documenting and reporting, and for distributing documents and reports.
4. Procedures for collecting and packaging archive samples.
5. Review of time schedule for all installation and testing.
6. Review of panel layout and numbering systems for panels, seams, and repairs.
7. Temperature and weather limitations, and installation procedures for adverse weather conditions.
8. Deployment techniques, including plans for controlling expansion, contraction and wrinkling of the geomembrane, access points, acceptable equipment and protection of geosynthetics.
9. Preparation of the geomembrane record survey drawing.

C. The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties.

PART 2 - PRODUCTS

2.1 LLDPE GEOMEMBRANE

A. LLDPE Sheet: Formulated from virgin PE, compounded for use in hydraulic structures, and formed into uniform sheets with material properties complying with this specification.

B. The geomembrane shall consist of new, first quality products designed and manufactured specifically for this type of project, which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes.

C. Geomembrane shall contain no plasticizers, fillers, chemical additives, or extenders. Sprayed-on texturing of textured polyethylene geomembrane will not be accepted.

D. Geomembrane shall be supplied as continuous sheets with no factory seams in rolls. The roll lengths and widths shall be maximized to provide the largest manageable sheets for the fewest field seams.

E. Geomembrane material shall be produced free of holes, blisters, or contaminants, and leak-free as verified by spark testing using ASTM D6365.

F. Physical, Mechanical and Chemical Property Requirements

1. Textured LLDPE geomembrane sheet shall meet or exceed the values specified in GRI-GM17, as summarized in Table 313205A at the end of this specification.
2. Textured LLDPE geomembrane seams shall meet or exceed the values specified in GRI-GM19, as summarized in Table 313205B at the end of this specification.

2.2 EQUIPMENT

A. Welding Equipment: Extrusion welding equipment shall be provided with thermocouples and temperature readout devices which continuously monitor the temperature of the extrudate. Radiant wedge welding equipment shall be provided with thermocouples and temperature readout devices which continuously monitor the temperature of the wedge. Equipment shall be maintained in adequate number to avoid delaying work, and shall be supplied by a power source capable of providing constant voltage under a combined-line load. Use a rub sheet, sand bags, or other method approved by the CQA Engineer to separate the electric generators from the geomembrane.

B. Field Tensiometer: The Geomembrane Installer shall provide a tensiometer for on-site shear and peel testing of geomembrane seams. The tensiometer shall be in good working order, built to ASTM D6693 (Type IV, 2 ipm) specifications, and accompanied by evidence of recent calibration. The tensiometer shall be motor driven and be equipped with a gauge that measures the force in unit pounds exerted between the jaws as displayed on a digital readout.

C. Vacuum Box: The Geomembrane Installer shall provide a minimum of 2 vacuum box assemblies consisting of a rigid housing, a transparent viewing window, a soft closed cell neoprene gasket attached to the bottom, a port hole or valve assembly, a vacuum gauge, a vacuum pump assembly equipped with a pressure control, a rubber pressure/vacuum hose with fittings and connections,

and a soapy solution and an applicator. The equipment shall be capable of inducing and holding a minimum vacuum of 5 psi.

D. Air Pressure Test: The Geomembrane Installer shall provide the necessary air pump and fittings required to perform the GRI GM6 air pressure test on dual seams.

E. Roll Handling Equipment: The Geomembrane Installer shall provide handling equipment that is adequate and does not pose a risk to the geomembrane rolls, subject to the approval of the CQA Engineer.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Each roll of geomembrane delivered to the Site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, lot number, material thickness, roll number, roll dimensions, and roll weight.

B. Procedures for storage and handling of geomembrane shall conform to ASTM D4873 and the manufacturer instructions, including the following:

1. Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.
2. Rolls shall be stored away from high traffic areas, protected from theft and vandalism.
3. Continuously and uniformly support rolls on a prepared level surface (not on wooden pallets) away from standing water. Rolls shall not be stacked more than two rolls high.

C. Geomembrane shall be observed by the CQA Engineer upon delivery of the product to the Site, and during installation and field seaming. Provide all labor and equipment required to assist CQA Engineer in the observation of the product.

D. CQA Engineer personnel shall generate an inventory of geomembrane rolls received on-site from the manufacturer/distributor. The inventory shall be updated weekly and shall include all the information appearing on the label of each roll, and all observed damage shall be noted.

3.2 SUBGRADE PREPARATION

A. Examine substrates, with Installer present, for compliance with requirements for soil compaction and grading; for subgrade free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, and ground water; and for other conditions affecting performance of geomembrane liner.

B. Examine anchor trench excavation, where geomembrane liner will be secured, for substrate conditions indicated above and for correct location and configuration.

C. The geomembrane subgrade shall be prepared as specified in Section 312000 and as shown on the Drawings. The subgrade shall be smooth and uniform, and free of all trash and debris, prior to installation of the geomembrane.

D. Qualified representatives of the Geomembrane Installer, Contractor, Engineer, and CQA Engineer shall observe the surface to be covered with geomembrane on each day's operations prior to placement of geomembrane.

E. The Geomembrane Installer, Contractor, Engineer, and CQA Engineer shall provide written acceptance daily for the surface to be covered by geomembrane in that day's operations. The surface shall be maintained as acceptable during geomembrane installation. A single form shall be used and signed by all parties to document acceptance each day.

F. Subgrade damaged by erosion, rutting, or other means during geomembrane deployment shall be exposed and the damage repaired. The subgrade shall then be re-approved.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 GEOMEMBRANE PLACEMENT

A. No geomembrane shall be deployed and seamed until the surfaces to be covered have been approved by the Engineer. Should geomembrane material be deployed prior to Engineer's approval, it shall be at sole risk of the Geomembrane Installer and Contractor, and if the material does not meet project specifications, it shall be removed from the project at no additional cost to the Owner.

B. At the beginning of each day's work, the CQA Engineer shall provide the Engineer with a daily field installation report for all work accomplished on the previous workday before additional geomembrane is installed.

C. Geomembrane shall be installed to the required limits over the prepared compacted soil liner as shown on the Drawings and specified in this Section. Install geomembrane in anchor trenches as indicated on the Drawings.

D. No geomembrane material shall be unrolled and deployed if the material temperatures are lower than approximately 32 degrees F unless otherwise approved by the Engineer and unless special precautions are taken such as storing the rolls inside a heated enclosure providing ambient temperatures of 50 degrees F or above. The specified minimum temperature for material deployment may be adjusted by the Engineer based on recommendations by the manufacturer.

E. Geomembrane shall be placed in an effort to reduce wrinkles and subsequent fishmouths at the field seam interfaces. In general, “Leister” welds or “tack” welds shall not be used to temporarily hold sheets in position, however “Leister” welds may be used to secure small patches prior to extrusion welding.

F. All geomembrane handling and installation procedures shall be performed by workers wearing shoes that will not damage the geomembrane. Only low ground pressure, rubber-tired, vehicular traffic shall be permitted to travel on the geomembrane. The maximum equipment ground pressure shall be eight pounds per square inch (psi). Conform to other written recommendations of the geomembrane manufacturer for pedestrian and vehicular traffic on the geomembrane.

G. Only the panels which will be anchored and seamed together in one day shall be deployed.

H. Sand bags shall be used as necessary to hold the geomembrane material in position during installation. Sand bags shall be sufficiently close-knit to preclude fines from working through the bags. Paper bags, whether or not lined with plastic, shall not be used. Burlap bags, if used, must be lined with plastic. Bags shall contain not less than 20 nor more than 60 pounds of sand, and shall be securely closed after filling and not over-filled to prevent sand loss. Bags that are split, torn, or otherwise losing their contents shall be immediately removed from the work area and any spills immediately cleaned up.

I. Panels that become seriously damaged (torn or twisted permanently) shall be replaced. Less serious damage shall be repaired according to the requirements herein. Damaged panels, or portions of the damaged panels which have been rejected, shall be marked and their removal from the work area recorded.

J. Geomembrane shall be installed so that there will be neither tension nor wrinkles at the average expected daily ambient temperature.

K. Geomembrane shall not be allowed to “bridge over” (be pulled taut over) voids or low areas in the subgrade. Geomembrane in these areas shall be cut and patched to provide adequate material to allow the geomembrane to rest on the subgrade surface.

L. In general, seams shall be oriented with the long dimension parallel to (down) the line of the maximum slope. Where seams can only be oriented across the slope, the upper panel shall be lapped over the lower panel. The total length of field seams shall be minimized. In corners and odd shaped geometric locations, the total length of field seams shall be minimized. Seams shall not be located at low points in the subgrade unless geometry requires seaming at such locations, and if approved by CQA Engineer personnel.

M. Geomembrane panels shall be overlapped prior to seaming to whatever extent is necessary to provide a good weld. In no case shall overlaps be less than six inches for fusion welding at the time the welds are made.

N. The Geomembrane Installer shall label panels at the time of deployment. Label date of deployment, roll number, and panel number.

3.4 SEAMING PROCEDURES

A. No geomembrane material shall be seamed when ambient temperatures are less than 32 degrees Fahrenheit unless the following conditions are complied with:

1. Seaming of the geomembrane at ambient temperatures below 32 degrees Fahrenheit is allowed if the Geomembrane Installer can demonstrate to the Engineer and the CQA Engineer, using pre-qualification test seams, that field seams complying with the specifications can be fabricated at sub-freezing temperatures. Consistent passing test seams are required.
2. In addition, the Geomembrane Installer shall submit to the Engineer for review, detailed procedures for seaming at low temperatures, including the following: preheating the geomembrane; and providing a tent or other device to prevent heat losses during seaming and rapid heat losses subsequent to seaming.

B. No geomembrane material shall be seamed when the ambient temperature is above 104 degrees Fahrenheit and when the sheet temperature of the material is above 122 degrees Fahrenheit (as measured by an infrared thermometer or surface thermocouple), unless otherwise approved by the Engineer.

C. Geomembrane seaming at temperatures outside the above stated temperature ranges will only be approved if: the manufacturer certifies that the seaming procedure shall not cause physical or chemical modification to the geomembrane; and an increased number of test welds is performed to determine appropriate seaming conditions when required by the CQA Engineer or Engineer. However, should the overall quality of the geomembrane decrease under such conditions, in the opinion of the Engineer, then seaming outside the allowable temperatures shall be discontinued.

D. Seaming is not allowed while precipitation is occurring unless proper precautions are made to allow the seam to be made on dry geomembrane material or the welding process is protected from rain. The surface below the geomembrane shall not be saturated or frozen.

E. Extra care shall be taken to clean and remove dirt, dust and other foreign materials from the surfaces of the geomembrane to be seamed. Surfaces shall be cleaned immediately prior to seaming.

F. Seaming shall be performed using an automatic double wedge fusion welding system, equipment, and techniques. Extrusion welding shall only be used where fusion welding is not possible and as approved by the Engineer.

G. The fusion-welding apparatus shall be an automated device, and shall be equipped with gauges giving applicable temperatures and pressures. Each welding machine shall be calibrated at least twice daily. The calibration procedure shall be witnessed by CQA Engineer personnel and shall be in accordance with the recommendations of the welding machine manufacturer. Certificates of calibration shall be provided to the CQA Engineer.

H. The extrusion welding apparatus shall be equipped with gauges giving the temperature in the apparatus and at the nozzle. The extruder shall be purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel. Whenever the extruder is stopped, the barrel shall be purged of all heat degraded extrudate.

I. The Geomembrane Installer shall maintain at least one spare operable seaming apparatus of each kind on site. Equipment used for seaming shall not damage the geomembrane, and the geomembrane shall be protected from damage in areas with heavy traffic.

J. The surface of the seam edges shall be prepared as recommended by the manufacturer to provide a seam to equal or exceed the seam strength requirements in this specification. The welding process shall bond the exposed edge of the panel to the underlying geomembrane panel.

K. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkles back into the panel so as to effect a flat overlap. The cut fishmouths or wrinkles shall be seamed as completely as possible, and shall then be patched with an oval or round patch of the same geomembrane material extending a minimum of six inches beyond the cut in all directions.

L. Seaming shall extend to the outside edges of panels to be placed in the anchor trenches.

M. The Geomembrane Installer shall label seams at the time of seaming. Label date of seaming, start time, initials of the seaming technician, and the number of the seaming unit.

3.5 PIPE PENETRATION SEALING SYSTEM

A. Provide penetration sealing system as shown on the Drawings, or as otherwise approved by the Engineer, using compatible geomembrane material, boots, stainless steel clamps, Neoprene gaskets and accessories.

B. The penetration sealing system shall be fabricated and installed to prevent leakage.

3.6 FIELD QUALITY ASSURANCE

A. Panels shall be observed by CQA Engineer personnel when the panels are initially deployed. Observation shall be for identification of defects, holes, and any sign of contamination by foreign matter. Defects in seam and non-seam areas shall be repaired as required by this specification.

B. Prequalification Test Seams

1. Engineer shall be notified when prequalification testing will be performed.
2. Welding machine calibration and test seams shall be performed by the Geomembrane Installer's personnel and observed by CQA Engineer personnel to verify that seaming conditions are adequate. Test seams shall be conducted by each seamer at the beginning of each seaming period, and as determined by CQA Engineer personnel for each welding machine used that day. Test seaming shall be performed under the same conditions and with the same equipment as production seaming. Each test seam shall be at least ten feet long for hot wedge welding and three feet long for extrusion welding with the seam centered lengthwise.
3. Two adjoining one-inch wide specimens shall be die-cut by the Geomembrane Installer from each opposite end and from the center of the test seam. These specimens shall be tested by the Geomembrane Installer. Each specimen shall be tested in peel. The tests shall be performed using a field tensiometer, and shall not fail in the weld. Both welds of double wedge seams shall be tested in peel. Any failures through the seam shall be considered a failing test, regardless of the stress at failure.
4. The minimum acceptable seam strength values to be obtained for all specimens tested are those indicated in Table 313205B.
5. If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming apparatus shall be rejected and not used for production seaming until the deficiencies are corrected and a successful test seam is produced.
6. CQA Engineer personnel shall observe and record testing of prequalification test specimens. Records shall be included in the Daily Field Installation Reports.

C. Non-Destructive Field Seam Testing

1. All field seams shall be non-destructively tested by the Geomembrane Installer over their full length. Each seam shall be assigned a unique number consisting of the adjacent panel numbers (for example, the seam between panels 1 and 3 would be S–1/3). The location, date, test unit, name of tester, and outcome of all non-destructive testing shall be observed and recorded by CQA Engineer personnel.

2. All defects found during testing shall be numbered and marked by CQA Engineer personnel immediately after detection. All defects found shall be repaired, retested and re-marked to indicate completion of the repair and acceptability.
3. Non-destructive testing shall be performed by the Geosynthetics Installer using vacuum boxes (in accordance with ASTM D5641), air pressure testing (in accordance with ASTM D5820), spark testing (in accordance with ASTM D6365), or other test methods approved by the Engineer. All test equipment shall be furnished by the Geomembrane Installer.
4. Non-destructive tests shall be performed by experienced personnel thoroughly familiar with the specified test methods. The Geomembrane Installer shall field demonstrate all test methods to verify to CQA Engineer personnel that the test procedures are valid.
5. Extrusion seams shall be vacuum box tested by the Geomembrane Installer according to the following methods:
    a. Equipment for testing extrusion seams shall be comprised of, but not limited to: a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge; a steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connections; a plastic bucket; sponge or mop; and a soapy solution. The vacuum box shall be similar to the series A 100 Straight Seam Tester as supplied by the American Parts Service Company.
    b. The glass for vacuum box shall be unscratched and clean, and the rubber gasket shall be firmly attached to the box.
    c. The vacuum pump shall be charged and the tank pressure adjusted to three to four pounds per square inch, gauge (psig).
    d. CQA Engineer personnel shall periodically observe that a leak tight seal is created by the Geomembrane Installer. The Geomembrane Installer shall create the leak tight seal by wetting a strip of geomembrane approximately 12 inches by length of box with a soapy solution, placing the box over the wetted area and then compressing. The Geomembrane Installer shall then close the bleed valve, open the vacuum valve, maintain five psig for a period of approximately 15 seconds, and CQA Engineer personnel shall observe the geomembrane through the viewing window for the presence of soap bubbles. If no bubbles appear after 15 seconds, the area shall be considered leak tight. The box shall be moved over the next adjoining area with a minimum three inches overlap and the process repeated.
    e. All areas where soap bubbles appear shall be marked and repaired, and then retested under the observation of CQA Engineer personnel.
    f. CQA Engineer personnel shall observe all testing operations for uniformity and completeness, and shall record results at time of testing.
    g. All seams that are vacuum tested shall be marked by the Geomembrane Installer at the time of testing. Marking shall consist of the date tested, technician performing the test, and the results of the test.
6. Double Fusion seams with an enclosed space shall be air pressure tested by the Geomembrane Installer according to the following methods:
    a. Equipment for testing double fusion seams shall be comprised of, but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 30 psig, mounted on a cushion to protect the geomembrane; a rubber hose with fittings and connections; and a manometer equipped with a sharp hollow needle, or other approved pressure feed device.
    b. CQA Engineer personnel shall ensure that the Geomembrane Installer creates a leak-tight seal. The Geomembrane Installer shall perform the testing activities. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure

feed device inserted into the tunnel created by the double wedge fusion weld. The air pump pressure shall be adjusted, the valve closed, and the pressure stabilized for two minutes at a pressure of 28 psig. After the stabilization period, pressure shall be maintained for five minutes for the seam to be considered leak tight. The Geomembrane Installer shall remove the seal at the opposite end of the tested seam while CQA Engineer personnel observe the gauge. The needle or other approved pressure feed device shall be removed and the feed hole sealed if not covered by a patch at the end of the seam. Pressure tests shall be conducted in accordance with the procedures outlined in ASTM D5820.

c. If loss of pressure exceeds three psig during testing period, or pressure does not stabilize, the faulty area shall be located, repaired, and retested by the Geomembrane Installer.

d. All seams that are vacuum tested shall be marked by the Geomembrane Installer at the time of testing. Marking shall consist of the date tested, technician performing the test, test start and end times, and test start and end pressures.

7. All non-destructive field seam tests shall be observed by CQA Engineer personnel and recorded at the time of testing. Records shall be included in the Daily Field Installation Reports.

D. Destructive Field Seam Testing

1. A minimum of one destructive test sample per 500 feet of seam length shall be cut by the Geomembrane Installer from a location specified by CQA Engineer personnel. The Geomembrane Installer shall not be informed in advance of the sample location. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Geomembrane Installer as the seaming progresses.

2. CQA Engineer personnel shall mark all samples with their location and seam number at the time of sample collection. CQA Engineer personnel shall observe field testing of the samples and record the date, time, location, seam number, ambient temperatures, and pass or fail description according to ASTM D6392. A copy of the information must be attached to each sample portion. The Geomembrane Installer shall repair all holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum tested. If a permanent patch cannot be installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.

3. Each destructive test sample shall be 12 inches wide by 54 inches long, with the seam centered lengthwise. The sample shall be cut into three sections and distributed as follows: one 18-inch section shall be given to CQA Engineer personnel for testing; one 12-inch section retained by the Geomembrane Installer for field testing; and one 12-inch section shall be set aside for an archive sample. Holes for destructive seam testing shall be repaired as required in this specification.

4. The Geomembrane Installer shall die-cut at least three one-inch wide replicate specimens from the installer's sample for field testing. Replicate specimens will not be required for extrusion welds. The specimens shall be tested for peel strength. Both welds of dual hot-wedge seams shall be tested in peel. To be acceptable, all replicate test specimens shall meet the seam strength requirements as required in this specification. Any specimen that fails through the weld or by partial failure exceeding 50 percent of the weld shall be considered a Non-Film Tear Bond break and shall be considered a failure. Die cutting and field testing of the replicate specimens shall be performed in the presence of CQA Engineer personnel. If the field tests pass, the sample qualifies for testing by the CQA Engineer.

5. Laboratory testing coordinated by the CQA Engineer shall conform to ASTM D6392. Five replicate specimens shall be tested in peel and five replicate specimens shall be tested in shear. Both welds of dual hot-wedge seams shall be tested in peel. To be acceptable, all replicate test specimens shall meet the seam strength requirements as required in this specification.
6. If a destructive sample fails the field or laboratory destructive tests, an additional sample shall be obtained at a distance of approximately 10 feet on each side of the failed sample location. Test specimens shall be obtained and field tested as specified in accordance with destructive field seam testing requirements. The process shall be repeated until the failed area is bounded by samples with passing test results.
7. The Geomembrane Installer shall repair the seam between the two nearest passed test locations with the failed location in between, or as directed by the CQA Engineer and/or Engineer.
8. Reports of the results of destructive field seam tests shall be prepared by the CQA Engineer and included in the Daily Field Installation Reports.

E. Daily Field Installation Reports: At the beginning of each day's work, the CQA Engineer shall provide the Engineer with Daily Field Installation Reports for all work accomplished on the previous work day. Reports shall include the following:

1. Total amount and location of geomembrane placed;
2. Total amount and location of seams and repairs completed, names of individuals doing seaming and repairing, and units used;
3. Drawings of the previous day's installed geomembrane showing panel numbers and seam numbers;
4. Results of pre-qualification test seams; and
5. Results of non-destructive testing and field destructive testing.

3.7 REPAIR PROCEDURES

A. Defective seams shall be repaired with a capstrip or extrusion weld over the full length of the defect. Each capstrip shall be numbered, shall be made of the same geomembrane material as for the geomembrane sheet, and shall extend a minimum of six inches beyond both sides of the seam.

B. Blisters, tears and holes in the geomembrane sheet shall be repaired with patches. Each patch shall be numbered by CQA Engineer personnel at the time the defect is identified.

C. Abrasions and other defects and damage of the geomembrane material that are not punctured through the material may be repaired using extrudate, unless otherwise directed by the Engineer or CQA Engineer.

D. Capstrips and patches shall be rounded at the corners, made of the same material as for the geomembrane sheet, and extend a minimum of six inches beyond the edge of defects.

E. Repaired areas shall be numbered and shall be measured and recorded from a known survey point to document location.

F. Verification of Repair Patches and Capstrips: Each repair shall be non-destructively tested using vacuum box testing or air testing. Tests that pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests shall be reseamed and retested until a passing test

results. CQA Engineer personnel shall observe all non-destructive testing of repairs. CQA Engineer personnel shall record the number of each capstrip and patch, date, location, name of person who installed the capstrip or patch, and test outcome on a form to be submitted with the daily field installation reports.

3.8 GEOMEMBRANE ACCEPTANCE

A. The geomembrane will be accepted by the Engineer when:

1. The geomembrane is clean (brooming and washing of the geomembrane surface shall be required if the amount of surface dust or mud inhibits inspection);
2. The entire installation is finished, or an agreed upon subsection of the installation is finished;
3. All documentation of installation is completed;
4. Verification of the adequacy of all field seams and repairs, and associated testing is complete; and
5. A record survey drawing is prepared as required by this specification, and is submitted to and approved by the Engineer.

B. Record Survey Drawing Requirements: Record drawing for each geomembrane layer showing panel corners, transitions in panel geometry, repair locations, destructive test locations, anchor trench breaklines, and other significant features shall be surveyed. The survey results shall be certified by a North Carolina Registered Land Surveyor.

C. Work shall not proceed with any materials which will cover geomembrane seams, capstrips and patches until laboratory test results with passing values have been received and the portion of the geomembrane has been accepted in writing by the Engineer.

D. Accepted areas of geomembrane that have not been covered within a reasonable time will require reinspection as determined by the Engineer.

E. Archive samples will be held by the Owner or Engineer until Engineer's approval of the installation and the CQA Engineer Report.

3.9 DISPOSAL OF SCRAP MATERIALS

A. At the end of each work day, all scraps of material and other debris shall be removed from the geomembrane surface.

B. On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap materials off-site, remove equipment used in connection with geomembrane installation, and leave the premises in a neat and acceptable manner. No scrap material shall be allowed to remain on the geomembrane or adjacent areas.

3.10 PROTECTION

A. Protect installed geomembrane liner according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

B. Before placement of cover materials, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane liner and seams and reinspect repaired work.

Table 313205A - Linear Low Density Polyethylene (LLDPE) Geomembrane Sheet - Textured [GRI-GM17]

Properties	Test Method	Test Value								Minimum Testing Frequency
		20-mils	30-mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. avg.)	D 5994	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	per roll
● lowest individual for 8 out of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	-10%	
● lowest individual for any of the 10 values		-15%	-15%	-15%	-15%	-15%	-15%	-15%	-15%	
Asperity Height mils (min. avg) *(1)*	D 7466	16 mil	16 mil	16 mil	16 mil	16 mil	16 mil	16 mil	16 mil	every 2nd roll *(2)*
Density (max.)	D 1505/D 792	0.939 g/cc	0.939 g/cc	0.939 g/cc	0.939 g/cc	0.939 g/cc	0.939 g/cc	0.939 g/cc	0.939 g/cc	200,000 lb
Tensile Properties (min. avg.) *(3)*	D 6693 Type IV									20,000 lb
● break strength		30 lb/in	45 lb/in	60 lb/in	75 lb/in	90 lb/in	120 lb/in	150 lb/in	180 lb/in	
● break elongation		250%	250%	250%	250%	250%	250%	250%	250%	
2% Modulus (max.)	D 5323	1200 lb/in	1800 lb/in	2400 lb/in	3000 lb/in	3600 lb/in	4800 lb/in	6000 lb/in	7200 lb/in	per formulation
Tear Resistance (min. avg.)	D 1004	11 lb	16 lb	22 lb	27 lb	33 lb	44 lb	55 lb	66 lb	45,000 lb
Puncture Resistance (min. avg.)	D 4833	22 lb	33 lb	44 lb	55 lb	66 lb	88 lb	110 lb	132 lb	45,000 lb
Axi-Symmetric Break Resistance Strain (min.)	D 5617	30%	30%	30%	30%	30%	30%	30%	30%	per formulation
Carbon Black Content (range)	D 4218 *(4)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	45,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Inductive Time (OIT) (min. avg.) *(6)*										200,000 lb
(a) Standard OIT **OR**	D 3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	
(b) High Pressure OIT	D 5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	
Oven Aging at 85°C *(7)*	D 5721									per formulation
(a) Standard OIT (min. avg.) - % retained after 90 days **OR**	D 3895	35%	35%	35%	35%	35%	35%	35%	35%	
(b) High Pressure OIT (min. avg.) - % retained after 90 days	D 5885	60%	60%	60%	60%	60%	60%	60%	60%	
UV Resistance *(8)*	D 7238									per formulation
(a) Standard OIT (min. avg.) **OR**	D 3895	N. R. *(9)*	N. R. *(9)*	N. R. *(9)*	N. R. *(9)*	N. R. *(9)*	N. R. *(9)*	N. R. *(9)*	N. R. *(9)*	
(b) High Pressure OIT (min. avg.) - % retained after 1600 hrs *(10)*	D 5885	35%	35%	35%	35%	35%	35%	35%	35%	

NOTES:

(1) Of 10 readings; 8 out of 10 must be ≥ 14 mils, and lowest individual reading must be ≥ 12 mils

(2) Alternate the measurement side for double sided textured sheet

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Break elongation is calculated using a gage length of 2.0 inches

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C

(9) Not recommended since the high temperature of the Std.-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value

Table 313205B - Linear Low Density Polyethylene (LLDPE) Geomembrane Seams [GRI-GM19]								
Properties	**Test Value**							
	20-mils	**30-mils**	**40 mils**	**50 mils**	**60 mils**	**80 mils**	**100 mils**	**120 mils**
Hot Wedge Seams *(1)*								
● shear strength *(2)*	30 lb/in	45 lb/in	60 lb/in	75 lb/in	90 lb/in	120 lb/in	150 lb/in	180 lb/in
● shear elongation at break *(3)*	50%	50%	50%	50%	50%	50%	50%	50%
● peel strength *(2)*	25 lb/in	38 lb/in	50 lb/in	63 lb/in	75 lb/in	100 lb/in	125 lb/in	150 lb/in
● peel separation	25%	25%	25%	25%	25%	25%	25%	25%
Extrusion Fillet Seams								
● shear strength *(2)*	30 lb/in	45 lb/in	60 lb/in	75 lb/in	90 lb/in	120 lb/in	150 lb/in	180 lb/in
● shear elongation at break *(3)*	50%	50%	50%	50%	50%	50%	50%	50%
● peel strength *(2)*	22 lb/in	34 lb/in	44 lb/in	57 lb/in	66 lb/in	88 lb/in	114 lb/in	136 lb/in
● peel separation	25%	25%	25%	25%	25%	25%	25%	25%

NOTES:

(1) Also for hot air and ultrasonic seaming methods

(2) Value listed for shear and peel strengths are for 4 out of 5 test specimens; the 5th specimen can be as low as 80% of the listed values

(3) Elongation measurements should be omitted for field testing

END OF SECTION 313205

SECTION 313220 – GEOCOMPOSITE DRAINAGE LAYER

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes geocomposite drainage layer for the Dan River Landfill for the following:

1. Landfill liner leachate collection system.
2. Landfill liner leakage detection system.
3. Landfill cover system.

B. Related Requirements:

1. Section 312000 “Earth Moving”.
2. Section 312005 “Trenching.”
3. Section 312020 “Protective Cover Soils.”
4. Section 313200 “HDPE Geomembrane.”
5. Section 313205 “LLDPE Geomembrane.”
6. Section 313240 “Nonwoven Geotextiles.”

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:

1. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
2. ASTM D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
3. ASTM D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique
4. ASTM D1603, Standard Test Method for Carbon Black in Olefin Plastics
5. ASTM D4218, Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique
6. ASTM D4354, Standard Practice for Sampling of Geosynthetics for Testing
7. ASTM D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
8. ASTM D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity
9. ASTM D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
10. ASTM D4716, Standard Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
11. ASTM D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile

12. ASTM D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
13. ASTM D5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
14. ASTM D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles
15. ASTM D5321, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
16. ASTM D5567, Standard Test Method for Hydraulic Conductivity Ratio (HCR) Testing of Soil/Geotextile Systems.
17. ASTM D6241, Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
18. ASTM D7005, Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites
19. ASTM D7273, Standard Guide for Acceptance Testing Requirements for Geonets and Geonet Drainage Geocomposites.

C. Geosynthetic Research Institute (GRI):

1. GRI-GC7, Determination of adhesion and bond strength of geocomposites.
2. GRI-GC8, Determination of the allowable flow rate of a drainage geocomposite.

1.3 SUBMITTALS

A. Submit the following to the Engineer with the Contractor's bid:

1. A material properties sheet for each geocomposite product, including at a minimum all properties, test methods, and test values as required by this specification.

B. Submit the following to the Engineer, for review and approval, no later than 30 calendar days prior to shipment of geocomposite to the Site:

1. Manufacturer's quality control program manual, or descriptive documentation.
2. The manufacturers' quality control certifications (including results of source quality control testing of the products as required by this specification) to verify that the materials supplied for the project are in compliance with the product specifications in this Section. The certifications shall be signed by a responsible party employed by the manufacturer, such as the geocomposite QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers, and corresponding shipping information.
3. A written certificate from the geocomposite manufacturer stating that the resin and geocomposite materials supplied are in compliance with this specification.
4. A written certificate from the geocomposite manufacturer stating that no more than 2% by weight of factory regrind was used to manufacture the geonet core. Factory regrind shall have resin documentation.
5. Manufacturer's instruction manual for geocomposite on-site handling and installation, including but not limited to procedures for storage, transport, placement, and seaming/joining.

1.4 QUALIFICATIONS

A. Installer's Qualifications:

1. Refer to Specification Section 313200 “HDPE Geomembrane” or Specification Section 313205 “LLDPE Geomembrane” as applicable for Installer’s qualifications.

B. Manufacturer shall have manufactured a minimum of 10,000,000 square feet of geocomposite material during the last five years.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with these specifications and the CQA Plan.

B. Interface Friction Testing Requirements

1. Refer to Specification Section 313200 “HDPE Geomembrane” or Specification Section 313205 “LLDPE Geomembrane” as applicable for interface friction testing requirements.

C. Conformance Testing

1. The performance of conformance testing shall be coordinated by the CQA Engineer.
2. Conformance testing shall be performed on material specifically manufactured for this project and conform to ASTM D4354.
3. Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width. The machine direction shall be marked on the samples.
4. Conformance testing will be performed by an independent laboratory at a frequency of at least 1 test per 100,000 square feet for the following:
   a. Thickness (ASTM D5199)
   b. Density (ASTM D1505)
   c. Ply Adhesion (ASTM D7005)
   d. Transmissivity (ASTM D4716)
   e. Other tests as required by the Engineer

D. Conformance Testing – Hydraulic Conductivity Ratio (landfill liner leachate collection system only)

1. Hydraulic conductivity ratio (HCR) testing shall be performed for the leachate collection system geocomposite and the selected protective cover material for base liner system construction. Protective cover material may be coal combustion residual (CCR) material or soil.
2. HCR testing shall be performed for the cover system geocomposite and the final cover material.
3. Perform a minimum of three HCR tests in accordance with ASTM D5567.
4. HCR tests shall be performed on site-specific materials anticipated to be used as protective cover or final cover soil. A minimum of three discrete samples representative of the range of potential protective cover or final cover soil material shall be selected at the discretion of the Engineer. Protective cover or final cover material shall be characterized by performing the following geotechnical laboratory tests:

a. Liquid limit, plastic limit, and plasticity index (ASTM D4318)
b. Particle size with hydrometer (ASTM D422)

5. Conformance test results shall be reviewed by the Engineer to determine if the soil/geotextile system is acceptable.
6. The Engineer may require additional HCR tests at any point prior to, during, or after construction.
7. During construction, the protective cover will be tested in accordance with Specification Section 312020 and final cover will be tested in accordance with Specification Section 312000. The Engineer will compare the protective cover or final cover characteristics during construction to the HCR conformance test protective cover or final cover characteristics to ensure compatibility between the geocomposite and the protective cover or final cover material.

E. The Manufacturer shall sample and test the geocomposite material at a minimum frequency as required by this specification.

F. If the conformance tests or Manufacturer tests do not conform to the requirements of this specification, retesting to determine conformance or rejection shall be done as set forth in the manufacturer's quality manual at no additional cost to the CQA Engineer or Owner.

G. Any geosynthetic sample that does not conform to the requirements of the specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no cost to the Owner.

PART 2 - PRODUCTS

2.1 GEOCOMPOSITE DRAINAGE LAYER

A. The geocomposite shall consist of an HDPE geonet drainage core with 8 oz/sy nonwoven geotextiles heat bonded to each side.

B. The geocomposite provided by the Supplier shall be stock products.

C. The Supplier shall not furnish products specifically manufactured to meet the Specifications of this project unless authorized by the Owner and Engineer.

D. The synthetic mesh structure shall consist of solid rib extruded high density polyethylene.

E. Geocomposite shall contain no plasticizers, fillers, chemical additives, or extenders.

F. Physical, Mechanical and Chemical Property Requirements

1. Geocomposite shall meet or exceed the values presented in Table 313220A at the end of this specification.

G. In addition to the property values listed in Table 313220A, the geocomposite shall:
1. Retain its structure during handling, placement, and long-term service.

2. Be capable of withstanding outdoor exposure for a minimum of 30 days with no measurable deterioration.
3. Be chemically inert when immersed in the leachate from a typical sanitary landfill.

2.2 ACCESSORIES

A. Geonet Ties: Plastic fasteners recommended by Manufacturer for tying geonet panels together. Metallic ties shall not be used for joining the geonet strips.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Each roll of geocomposite delivered to the Site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, lot number, material thickness, roll number, roll dimensions, and roll weight.

B. Procedures for storage and handling of geocomposite shall conform to ASTM D4873 and the manufacturer instructions, including the following:

1. Geocomposite shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.
2. Rolls shall be stored away from high traffic areas, protected from theft and vandalism.
3. Continuously and uniformly support rolls on a prepared level surface (not on wooden pallets) away from standing water. Rolls shall not be stacked more than two rolls high.

C. Geocomposite shall be observed by the CQA Engineer upon delivery of the product to the Site, and during installation and field seaming. Provide all labor and equipment required to assist CQA Engineer in the observation of the product.

D. CQA Engineer personnel shall generate an inventory of geocomposite rolls received on-site from the manufacturer/distributor. The inventory shall be updated weekly and shall include all the information appearing on the label of each roll, and all observed damage shall be noted.

3.2 PREPARATION

A. Ensure acceptance of underlying layers before installing overlying layers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Installation of the geocomposite shall be in compliance with this Specification and with the Manufacturer's standard guidelines and specifications for geocomposite installation, subject to approval by the Engineer.

B. Geocomposite Deployment:

1. The Geosynthetics Installer shall handle all geocomposite in such a manner as to ensure the material is not damaged in any way.
2. The geocomposite roll should be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the Engineer.
3. On the cell floors, the geocomposite machine direction shall be installed in the slope direction. The slope direction is the direction perpendicular to the contour lines indicated on the Drawings.
4. On slopes, secure geocomposite and then roll geocomposite down slope in manner to continually keep geocomposite in tension. If necessary, position geocomposite by hand after unrolling to minimize wrinkles.
5. Weight geocomposite with sandbags or equivalent in presence of wind. Do not remove weight until replaced with cover material. Handle sandbags with care to prevent rupture or damage of sandbag.
6. If the project includes an anchor trench at the top of the slopes, the geocomposite shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geocomposite.
7. Do not weld geocomposite to geomembrane unless otherwise specified in construction plans.
8. Cut geocomposite using scissors or other cutting tools as specified by the Manufacturer.
9. Do not damage underlying geosynthetic layers during placement of geocomposite.
10. During geocomposite deployment, do not entrap dirt, excessive dust that could cause clogging of drainage system, or stones that could damage adjacent geomembrane. If dirt or excessive dust is entrapped in geocomposite, hose clean prior to placement of next layer of material.

C. Seam and Overlap: Each component of the geocomposite (i.e., geotextile(s) and geonet) will be secured or seamed to the like component at overlaps.

1. Geonet Components
   a. Overlap adjacent geonet rolls minimum of 4 in.
   b. Geonet roll ends (butt seams) shall be overlapped one foot in areas with less than 10 percent slope.
   c. In areas of greater than 10 percent slope, butt seams shall be overlapped two feet. Two staggered rows of ties shall be applied at 12 inch intervals.
   d. Tie geonet overlaps with plastic fasteners. Use white or yellow tying devices for easy inspection. Do not use metallic devices.
   e. Tie every 5 ft along edges, every 6 in. in anchor trench, and every 12 in. along end-to- end seams.
   f. Horizontal seams on side slopes shall be minimized. If horizontal seams on side slopes cannot be avoided, ensure that horizontal seams are staggered between adjacent panel sections.
   g. In corners of side slopes of rectangular landfills, where overlaps between perpendicular geonet strips are required, unroll an extra layer of geonet along slope, on top of previously installed geonet, from top to bottom of slope.
   h. Stagger joints when more than one layer of geonet is installed.
   i. When several layers of geonet are stacked, deploy rolls in same direction to prevent strands of one layer from penetrating channels of adjacent layer.
2. Geotextile Components
   a. The bottom layer of geotextiles shall be overlapped. The top layer of geotextile shall be continuously sewn. Geotextiles shall be overlapped a minimum of 4 inches prior to seaming.

b. Polymeric thread, with chemical resistance properties equal to or exceeding those of the geotextile component, shall be used for all sewing. The seams shall be sewn to provide a flat (prayer) seam, "J" seam or "butterfly-folded" seam and shall be a two-thread, double-lock stitch or a double row of single-thread, chain stitch.

3.4 FIELD QUALITY CONTROL

A. The Contractor shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

B. The finished geocomposite shall have good appearance qualities. It shall be free from such defects that would affect the specific properties of the geocomposite, or its proper functioning.

C. Defects and Repairs:
1. Repair damage to geocomposite as follows, if hole or tear width across roll is less than 50% of width of roll.
   a. Place patch extending 2 ft beyond edges of hole or tear.
   b. Secure patch to original geocomposite by tying every 6 in. Use approved tying devices specified by Manufacturer.
   c. The top geotextile component of the patch shall be heat sealed to the top geotextile of the geocomposite needing repair.
2. Repair damage to geocomposite as follows, if hole or tear width across roll is greater than 50% of width of roll.
   a. On base of landfill, cut out damaged area and replace with new geocomposite.
   b. On side slopes, remove and replace damaged geocomposite panel.
   c. Join in the new portions as noted above in this Section.

D. The CQA Engineer shall observe repairs and report noncompliance in writing to Owner and Engineer.

E. Before initial placement of overlying materials, inspect system seams and repaired areas to ensure tight, continuously bonded installation. Repair damaged system and re-inspect repaired work.

3.5 PROTECTION OF FINISHED WORK

A. Protect installed geocomposite according to geocomposite manufacturer's instructions. Repair or replace areas of geocomposite damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

B. The geotextile component of the geocomposite shall not be left exposed for a period in excess of 20 days unless a longer exposure period is approved by the Engineer based on a formal demonstration from the Contractor that the geotextile is stabilized against U.V. degradation for the proposed period of exposure.

C. The Geosynthetics Installer and Contractor shall use all means necessary to protect all prior Work and all materials and completed work of other Sections included in these Specifications.

D. In the event of damage, the Geosynthetics Installer and/or Contractor (depending on who damages the geocomposite) shall immediately make all repairs and replacements necessary, to the approval of the Engineer and at no additional cost to Owner.

Table 313220A - Geocomposite Drainage Layer			
Properties	**Test Method**	**Test Value**	**Minimum Testing Frequency**
Geonet			
Thickness (min. avg.)	D 5199	*(1)*	100,000 ft^2
Density (min. avg.)	D 1505	0.94 g/cc	100,000 ft^2
Carbon Black Content (% range)	D 4218	2.0 - 3.0	100,000 ft^2
Tensile Strength (min. avg.)	D 7179	75 lb/in	100,000 ft^2
Resin			
Polymer Density (min. avg.)	D 1505	0.94 g/cc	per lot
Melt Flow Index (max.)	D 1238	1.0 g/10 min.	per lot
Geotextile			
Mass per Unit Area (min. avg.)	D 5261	8 oz/sy	100,000 ft^2
Grab Tensile (min. avg.)	D 4632	200 lb	100,000 ft^2
Puncture (min. avg.)	D 6241	775 lb	100,000 ft^2
Apparent Opening Size, US Sieve	D 4751	80	500,000 ft^2
Permittivity (min. avg.)	D 4491	0.3 /s	500,000 ft^2
Geocomposite			
Ply Adhesion (min. avg.)	D 7005	1.0 lb/in	100,000 ft^2
Transmissivity (min.)	D 4716		200,000 ft^2
● landfill liner leachate collection system *(2)*		3.77E-4 m^2/s	
● landfill liner leakage detection system *(3)*		3.27E-4 m^2/s	
● landfill cover system *(4)*		6.87E-4 m^2/s	
Compression Strength (min. avg.)	D 1621	25,000 psf	500,000 ft^2

NOTES:

(1) thickness shall be that which is required to achieve the required transmissivity

(2) landfill liner leachate collection system geocomposite shall be tested as follows:
- upper material of protective cover compacted to 90 percent of Standard Proctor MDD and within 3% of OMC
- lower material of geomembrane
- seating time = 100 hours
- Hydraulic gradient = 0.02
- normal load = 15,000 psf

(3) landfill liner leakage detection system geocomposite shall be tested as follows:
- upper material of geomembrane
- lower material of geomembrane
- seating time = 100 hours
- Hydraulic gradient = 0.02
- normal load = 15,000 psf

(4) landfill cover system geocomposite shall be tested as follows:
- upper material of final soil cover compacted to 95 percent of Standard Proctor MDD and within 3% of OMC
- lower material of geomembrane
- seating time = 100 hours
- Hydraulic gradient = 0.33
- normal load = 1,000 psf

END OF SECTION 313220

SECTION 313240 – NONWOVEN GEOTEXTILE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes nonwoven geotextile.

B. Related Requirements:

1. Section 312020 “Protective Cover”.
2. Section 313520 “Erosion and Sediment Control”
3. Section 313700 “Aggregate and Riprap.”

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:

1. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)).
2. ASTM D3786 Standard Test Method for Hydraulic Burst Strength of Knitted Goods and Non-woven Fabrics (Diaphragm Bursting Strength Tester Method).
3. ASTM D4354 Practice for Sampling of Geosynthetics for Testing.
4. ASTM D4355 Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
5. ASTM D4491 Standard Test Method for Water Permeability of Geotextiles by Permittivity.
6. ASTM D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile.
7. ASTM D4533 Test Method for Trapezoidal Tearing Strength of Geotextiles.
8. ASTM D4632 Test Method for Grab Breaking Load and Elongation of Geotextiles.
9. ASTM D4759 Practice for Determining the Specification Conformance of Geosynthetics.
10. ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.
11. ASTM D4873 Guide for Identification, Storage and Handling of Geotextiles.
12. ASTM D5261 Test Method for Measuring Mass per Unit Area of Geotextiles.
13. ASTM D5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.

1.3 SUBMITTALS

A. Submit the following to the Engineer with the Contractor’s bid:

1. A material properties sheet for the geotextile, including at a minimum all properties, test methods, and test values as required by this specification.

B. Submit the following to the Engineer, for review and approval, no later than 30 calendar days prior to shipment of geocomposite to the Site:

1. Manufacturer's quality control program manual, or descriptive documentation.
2. The manufacturers' quality control certifications (including results of source quality control testing of the products as required by this specification) to verify that the materials supplied for the project are in compliance with the product specifications in this Section. The certifications shall be signed by a responsible party employed by the manufacturer, such as the geotextile QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers, and corresponding shipping information.
3. Manufacturer's instruction manual for geotextiles on-site handling and installation, including but not limited to procedures for storage, transport, placement, and seaming/joining.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with these specifications and the CQA Plan.

B. Conformance Testing

1. The need for conformance testing will be as specified by the Engineer.

C. The Manufacturer shall sample and test the geotextile material at a minimum frequency as required by this specification.

D. If the conformance tests or Manufacturer tests do not conform to the requirements of this specification, retesting to determine conformance or rejection shall be done as set forth in the manufacturer's quality manual at no additional cost to the CQA Engineer or Owner.

E. Any geosynthetic sample that does not conform to the requirements of the specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no cost to the Owner.

PART 2 - PRODUCTS

2.1 NONWOVEN GEOTEXTILE

A. Nonwoven geotextile shall be that which is specified on the Drawings.

B. The geotextiles provided by the supplier shall be stock products.

C. The geotextile shall be:

1. Nonwoven, needle punched, continuous filament polyester material; or
2. Nonwoven, needle punched, continuous filament polypropylene material; or
3. Nonwoven, needle punched, polypropylene staple or continuous fiber material.

D. The geotextile shall be manufactured from first quality virgin polymer.

E. The supplier shall not furnish products specifically manufactured to meet the specifications of this project unless authorized by the Owner and Engineer.

F. Physical, Mechanical and Chemical Property Requirements

1. Nonwoven geotextile shall meet or exceed the values presented in Table 313240A.

Table 313240A - Nonwoven Geotextile

Properties	Test Method	Test Value				Minimum Testing Frequency
		6 oz/sy	8 oz/sy	10 oz/sy	12 oz/sy	
Mass per Unit Area (min. avg.)	D 5261	6 oz/sy	8 oz/sy	10 oz/sy	12 oz/sy	100,000 sf
Grab Tensile Strength (min. avg.)	D 4632	160 lb	200 lb	230 lb	300 lb	100,000 sf
Grab Tensile Elongation (min. avg.)	D 4632	50%	50%	50%	50%	100,000 sf
Trapezoid Tear Strength (min. avg.)	D 4533	65 lb	80 lb	95 lb	115 lb	100,000 sf
Puncture Strength (min. avg.)	D 4833	85 lb	110 lb	120 lb	140 lb	100,000 sf
Apparent Opening Size (AOS, US Sieve)	D 4751	70	80	100	100	per lot
Permeability (min. avg.)	D 4491	0.25 cm/sec	0.30 cm/sec	0.30 cm/sec	0.30 cm/sec	per lot
UV Resistance (1)	D 4355	70%	70%	70%	70%	per lot

NOTES:

(1) Evaluation to be on 2.0 inch strip tensile specimen after 500 hours of exposure

2.2 ACCESSORIES

A. Sewing materials: Types recommended by manufacturer for sewing seams in geotextile.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Each roll of geotextile delivered to the Site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, lot number, material thickness, roll number, roll dimensions, and roll weight.

B. Procedures for storage and handling of geotextile shall conform to ASTM D4873 and the manufacturer instructions, including the following:

1. Geotextile shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.
2. Rolls shall be stored away from high traffic areas, protected from theft and vandalism.
3. Supplied in rolls wrapped in relatively impermeable, waterproof, and opaque protective cover that is resistant to photodegradation by ultraviolet (UV) light.
4. Continuously and uniformly support rolls on a prepared level surface (not on wooden pallets) away from standing water. Rolls shall not be stacked more than two rolls high.

C. CQA Engineer personnel shall generate an inventory of geotextile rolls received on-site from the manufacturer/distributor. The inventory shall be updated weekly and shall include all the information appearing on the label of each roll, and all observed damage shall be noted.

3.2 PREPARATION

A. Ensure acceptance of underlying layers before installing overlying layers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Installation of the geocomposite shall be in compliance with this Specification and with the Manufacturer's standard guidelines and specifications for geocomposite installation, subject to approval by the Engineer.

B. After unwrapping the geotextile from its opaque cover, the geotextile shall not be left exposed for a period in excess of 20 days unless a longer exposure period is approved by the Engineer based on a formal demonstration from the Contractor that the geotextile is stabilized against U.V. degradation for the proposed period of exposure.

C. The Contractor shall take care not to entrap stones, excessive dust, or moisture in the geotextile during placement.

D. Nonwoven geotextile shall be overlapped a minimum of 6 inches, or as otherwise specified in the Specifications.

E. Damage Repair

1. Any holes or tears in the geotextile shall be repaired with a patch made from the same geotextile. The patch shall be placed with a minimum of 12 inches overlap in all directions.
2. Care shall be taken to remove any soil or other material, which may have penetrated the torn geotextile.

3.4 FIELD QUALITY CONTROL

A. The Contractor shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

B. Before placement of overlying materials, inspect seams and repaired areas. Repair damaged geotextiles and reinspect repaired work.

C. The CQA Engineer shall observe repairs and report noncompliance in writing to Owner and Engineer.

3.5 PROTECTION OF FINISHED WORK

A. The Geosynthetic Installer and Contractor shall use all means necessary to protect all prior Work and all materials and completed work of other Sections of these Specifications.

B. In applying fill material, no equipment can drive directly across the geotextile. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure.

C. The geotextile shall be covered as soon as possible after installation and approval. The geotextile shall not be exposed to precipitation prior to being installed and shall not be exposed to direct sun light for more than 20 days after installation.

D. Placement of Cover Material:
   1. Placement of the cover soil or aggregate base course shall proceed immediately following placement and inspection of the geotextile
   2. The cover material shall be placed on the geotextile in such a manner that ensures that:
      a. The geotextile and underlying materials are not damaged.
      b. Minimal slippage occurs between the geotextile and underlying layers.
      c. Wrinkling of geosynthetics does not occur.

E. In the event of damage, the Installer shall immediately make all repairs and replacements necessary at the expense of the responsible party, to the approval of the Engineer.

F. Protect installed geotextile according to the Manufacturer's instructions.

G. Contractor shall not use heavy equipment to traffic above the geotextile with approved protection.

END OF SECTION 313240

SECTION 313520 – EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall implement and maintain best management practices (BMPs) and perform other required activities as indicated on the approved Erosion and Sedimentation Control Plan.

B. Related Requirements:

1. Section 311000 “Site Clearing.”
2. Section 312000 “Earth Moving.”
3. Section 313240 “Nonwoven Geotextile.”
4. Section 313700 “Aggregate and Riprap.”
5. Section 329200 “Seeding.”

1.2 REFERENCES

A. North Carolina Department of Environment and Natural Resources (NCDENR) and North Carolina Sedimentation Control Commission:

1. “Erosion and Sediment Control Planning and Design Manual”, latest edition.

B. North Carolina Department of Transportation:

1. “Standard Specifications for Roads and Structures” 2012 Edition (NCDOT Standard Specifications).

1.3 SUBMITTALS

A. Submit product data on proposed erosion and sedimentation control measures.

B. Dust Control Plan: Submit coordination drawing and narrative that indicates the dust control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:

1. Water Tank Capacity.
2. Method of water dispersing.

1.4 QUALITY ASSURANCE

A. Comply with the requirements of pollution control laws, rules and regulations of governmental authorities having jurisdiction, and applicable permit conditions as presented on the Drawings, including, but not limited to, the following:

1. "Sedimentation Pollution Control Act of 1973" (as amended through latest legislative session), North Carolina General Statutes (NCGS Chapter 113A, Article 4).
2. Chapter 4 of Title 15A of the North Carolina Administrative Code (T15A.04); Sedimentation Control.

PART 2 - PRODUCTS

2.1 EROSION AND SEDIMENT CONTROL DEVICES

A. Erosion and sediment control devices shall be as shown on the approved Erosion and Sediment Control Plan.

B. Additional E&SC measures may be required during construction to prevent erosion and offsite sedimentation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ensure approval of Erosion and Sediment Control Plan and all required notifications have been given prior to beginning work.

3.2 EROSION AND SEDIMENTATION CONTROL

A. Provide erosion and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion and sedimentation control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 REMOVAL OF TEMPORARY CONTROLS

A. Remove temporary erosion and sediment control measures upon stabilization of the tributary area and closure of the E&SC Permit and when approved by the Owner and Engineer.

END OF SECTION 313520

SECTION 313700 – AGGREGATE AND RIPRAP

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Aggregate base course road surfacing material consisting of NCDOT ABC aggregate.
2. Riprap consisting of NCDOT Class A, B, 1, or 2 aggregate.
3. Drainage aggregate consisting of NCDOT 78M aggregate.
4. Fine aggregate filter consisting of ASTM C33 concrete sand.

B. Related Requirements:

1. Section 313240 “Non-Woven Geotextiles”.
2. Section 313520 “Erosion and Sediment Control.”
3. Section 334110 “HDPE Pipe and Pipe Fittings.”

1.2 REFERENCES

A. ASTM International:
1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D75 - Standard Practice for Sampling Aggregates

B. American Association of State Highway and Transportation Officials (AASHTO):
1. AASHTO T27 - Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
2. AASHTO T180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
3. AASHTO T191 - Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method.
4. AASHTO T224 - Standard Method of Test for Correction for Coarse Particles in the Soil Compaction Test.
5. AASHTO T310 - Standard Method of Test for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

C. North Carolina Department of Transportation (NCDOT):
1. “Standard Specifications for Roads and Structures”, 2012 Edition (NCDOT Standard Specifications).

1.3 SUBMITTALS

A. Submit the following to the Engineer, for review and approval, no later than 30 calendar days prior to shipment of geocomposite to the Site:

1. Written documentation and certification (including gradation test results) signed by the material producer, indicating that aggregate, riprap and grout meet or exceed the specified requirements.
2. Modified Proctor compaction curve information for aggregate base course road surfacing material.

B. Submit the following during Work progress and at completion:
1. Copy of truck ticket for every load of aggregate and asphalt seal coating materials delivered to the Site.

1.4 QUALITY ASSURANCE

A. The CQA Engineer will perform specified tests to determine conformance of the materials and constructed work with the Specifications.

1.5 TESTING OF AGGREGATE

A. If determined necessary by the Engineer and/or Owner, verification testing will be performed by the Owner's QC Firm upon delivery of aggregate to the Site. Sampling will be at a minimum rate of one for every 1,000 tons of material, and for each visible change in material. Sampling will be in conformance with ASTM D75.

B. The following tests will be performed:
1. Sieve analysis (using AASHTO T27 or ASTM C136)

C. Moisture-Density relationship (using AASHTO T180, Method C, with coarse particle correction in accordance with AASHTO T224)

PART 2 - PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Proposed materials and source shall be approved by the Engineer as specified prior to delivery and use in the construction.

B. Riprap shall meet specified gradation prior to placement. All processing shall be completed at the source.

C. Aggregate shall meet specified gradation prior to placement. All processing shall be completed at the source. If the aggregate, at any time, deviates from the required gradation, the Contractor shall, at his own expense, correct the inconsistency to the satisfaction of the Engineer.

2.2 AGGREGATE MATERIAL

A. Aggregate base course road surfacing material shall consist of NCDOT ABC aggregate.

B. Riprap shall consist of NCDOT Class A, B, 1, or 2 aggregate as shown on the Drawings.

C. Drainage aggregate shall consist of NCDOT 78M aggregate.

D. Fine aggregate filter shall consist of ASTM C33 concrete sand

2.3 GEOTEXTILE

A. Specified in Section 313240.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Material shall be delivered and stockpiled on-site only in designated areas approved by the Owner.

B. Stockpile areas shall be maintained to prevent erosion.

C. Following construction stockpile areas shall be restored to pre-construction conditions and stabilized to the approval of the Owner.

3.2 PREPARATION

A. Verify that subgrade gradients and elevations are correct, and that subgrade is ready for placement of aggregate surfacing material.

B. Ensure acceptance of underlying layers before installing overlying layers.

C. Aggregate base course road surfacing material consisting of NCDOT ABC aggregate: Ensure subgrade meets requirements for road surfacing subgrade as specified in Section 312000.

D. Where required, install nonwoven geotextile as specified in Section 313240.

3.3 AGGREGATE PLACEMENT

A. Contractor shall take special care to avoid damaging installed ground stabilization geotextile when placing and compacting the aggregate. Damage to the geotextile shall be repaired at the Contractor's expense, and as approved by the Engineer.

B. Aggregate surfacing shall be constructed to the total depth indicated on the Drawings. Place in uniform horizontal layers, with each layer having a maximum compacted thickness of six inches.

C. Place, spread, shape, and compact the aggregate as continuously as practicable during each day's operations. Place the material in a manner to avoid segregation. Uncontrolled spreading shall not be permitted.

D. Level and contour surfaces to achieve the final grades and cross-sections indicated on the Drawings.

E. The depth of aggregate shall be carefully controlled, with periodic measurements of the loose and compacted depth.

F. At the time aggregate is placed, it shall have a moisture content sufficient to obtain the required compaction. If necessary, uniformly apply water over the aggregate during compaction. Prevent free water from appearing on the surface during, or subsequent to, compaction operations. Compaction shall follow the spreading operation closely to prevent loss of contained moisture and displacement of material.

3.4 FIELD QUALITY ASSURANCE

A. Aggregate base course road surfacing material consisting of NCDOT ABC aggregate: compact to a minimum density of 98 percent of NCDOT modified Proctor (AASHTO T180 as modified by NCDOT) maximum dry density. Field density testing shall be performed using AASHTO T310 at a minimum frequency of one test per 2,500 square feet per compacted lift, but no less than one test per 100 feet of road length as measured along the centerline of the road.

B. The CQA Engineer shall observe repairs and report noncompliance in writing to Owner and Engineer.

3.5 TOLERANCE

A. Aggregate base course road surfacing material consisting of NCDOT ABC aggregate: Acceptable tolerance for depth of aggregate surfacing shall be plus or minus 0.10 feet.

B. Based on the results of surveying, areas of the aggregate surfacing that are not constructed to the required depth and elevations, within the allowed tolerance, shall be adjusted to the proper thickness and elevations using methods approved by the Owner and Engineer.

3.6 PROTECTION OF FINISHED WORK

A. The Contractor shall use all means necessary to protect all prior Work, and all materials and completed Work of other Sections of these Specifications.

B. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

END OF SECTION 313700

SECTION 329200 – SEEDING

PART 1 - GENERAL

1.1 SUMMARY

A. The Work covered by this section consists of furnishing all equipment, tools, materials, and labor necessary for establishing temporary and permanent vegetative cover; e.g., seeding, fertilizing, and mulching, on all areas disturbed at the site.

B. Related Requirements:

1. Section 312030 “Vegetative Soil Cover.”
2. Section 313520 “Erosion and Sediment Control.”

1.2 REFERENCES

A. North Carolina Department of Environment and Natural Resources (NCDENR) and North Carolina Sedimentation Control Commission:

1. “Erosion and Sediment Control Planning and Design Manual”, latest edition.

1.3 SUBMITTALS

A. Product and certificates of compliance or reports:
1. Seed mix;
2. Fertilizer;
3. Mulch;
4. Agricultural Soil Test Reports; and
5. Other accessories and soil amendments.

B. Soil test results and fertilizer and soil amendment recommendations from the North Carolina Department of Agriculture and Consumer Affairs or a similar soil and nutrient testing laboratory.

C. Qualification Data: For the Installer.

D. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

E. Certification of each seed mixture for grass. Include identification of source and name and telephone number of supplier.

F. Seeding maintenance warranty.

G. Operation and Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer. Recommended procedures to be established by Owner for maintenance of vegetative cover system and grasses during a calendar year. Submit before expiration of required maintenance periods.

1.4 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.

B. Perform Work in accordance with North Carolina Erosion and Sedimentation Control Planning and Design Manual.

C. Installer Qualifications: A qualified landscape installer whose work has resulted in successful vegetation establishment that is similar species utilized for this project.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

PART 2 - PRODUCTS

2.1 SEED

A. Temporary Seed Mixture: As specified on the approved Erosion and Sediment Control Plan Drawings.

B. Permanent Seed Mixture: As specified on the approved Erosion and Sediment Control Plan Drawings.

2.2 ACCESSORIES

A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry and as described in the North Carolina Erosion and Sediment Control Planning and Design Manual.

B. Fertilizer: Commercial grade; recommended for grass; of proportion necessary to eliminate deficiencies of topsoil as described in the North Carolina Erosion and Sediment Control Planning and Design Manual and as indicated on Drawings.

C. Water: Clean, fresh and free of substances or matter capable of inhibiting vigorous growth of grass.

D. Limestone (if required by soil analysis): Agricultural grade limestone ground to pass an 8-mesh with 25 percent passing a 100-mesh sieve shall be furnished. In addition calcareous limestone

shall contain not less than 50 percent calcium oxide, and dolomitic limestone shall contain not less than 40 percent magnesium oxide. Coarser materials will be acceptable provided the specified rates of application are increased proportionately, on the basis of quantities passing the 8- and 100- mesh sieves, but no additional payment will be made for the increased quantity.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. During delivery, seed shall be protected from any drying or contamination by detrimental material.
2. Seeding material shall be inspected upon arrival at the site; unacceptable material shall be immediately removed from the site by the Contractor.
3. Fertilizer shall be delivered to the site in the original, unopened containers bearing the manufacturer's guaranteed chemical analysis, name, trade name, trademark, and conformance with State of North Carolina.
4. Pesticides and herbicides shall be delivered to the site in the original unopened containers. Containers without labels and U.S. Environmental Protection Agency (USEPA) registration numbers and the manufacturer's registered uses will be rejected by the Engineer.

B. Storage:

1. Seed and fertilizer shall be stored in cool, dry locations away from contaminants.
2. Pesticides and herbicides shall not be stored with other landscape materials and shall be handled and stored following manufacturer's directions.
3. Materials shall be stored in areas designated or approved by the Engineer.
4. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

3.2 PREPARATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.3 SEEDING

A. Apply seed at rate as indicated on Drawings evenly in two intersecting directions and in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual. Rake in lightly.

B. Do not seed areas in excess of that which can be mulched on same day.

C. Planting Season: As indicated on Drawings and in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual.

D. Do not sow immediately following rain, when ground is too dry, or when winds are over 12 mph.

E. Immediately following seeding, apply mulch to thickness as specified on Drawings and in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual. Maintain clear of shrubs and trees.

F. Apply water with fine spray immediately after each area has been mulched. Saturate to 2 inches of soil.

G. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h).

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

3.4 HYDROSEEDING

A. Apply fertilizer, mulch and seeded slurry with hydraulic seeder at rate of 2000 lbs per acres evenly in one pass.

B. After application, apply water with fine spray immediately after each area has been hydroseeded.

C. Saturate to 4 inches of soil and maintain moisture levels two to four inches.

D. Hydroseeding: Mix specified seed, commercial fertilizer, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

3.5 MAINTENANCE SERVICE

A. Mow grass at regular intervals to maintain at maximum height of 3 inches. Do not cut more than 1/3 of grass blade at each mowing. Perform first mowing when seedlings are 40 percent higher than desired height.

B. Neatly trim edges and hand clip where necessary.

C. Immediately remove clippings after mowing and trimming. Do not let clippings lay in clumps.

D. Water to prevent grass and soil from drying out.

E. Control growth of weeds. Apply herbicides. Remedy damage resulting from improper use of herbicides.

F. Immediately reseed areas showing bare spots.

G. Repair washouts or gullies.

H. Protect seeded areas with warning signs during maintenance period.

END OF SECTION 329200

SECTION 334100 – STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes HDPE corrugated, smooth interior stormwater pipe and associated appurtenances.

1.2 Related Requirements:

1. Section 033000 "Pre-Cast Concrete Structures."
2. Section 312005 "Trenching"
3. Section 313700 "Aggregate and Riprap."
4. Section 334110 "HDPE Pipe and Fittings."

1.3 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:

1. ASTM D2321 – Standard Practice for underground Installation of thermoplastic Pipe for Sewers and Other Gravity Flow Applications
2. ASTM F405 – Standard Specification for Corrugated Polyethylene Pipe and Fittings
3. ASTM F667 – Standard Specification for Large Diameter Corrugated Polyethylene Pipe and Fittings

1.4 SUBMITTALS

A. Record Drawings:
1. Record locations of pipe runs, connections and invert elevations by the Registered Land Surveyor retained by the Contractor before and after placement of protective cover. The Land Surveyor shall be registered in North Carolina.

B. Shop Drawings:
1. Submit shop drawings for HDPE Pipe, fittings, valves, vaults, sizes, locations, and other appurtenances. Indicate piece numbers and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between piping, and proximate structures. Shop drawings for fabricated fittings shall be submitted to the Engineer for approval at least two weeks prior to fabrication.
2. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet (1:500) and vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. The Contractor or Supplier shall submit a complete description of and data indicating pipe material used, and pipe accessories and fittings proposed for use to the Engineer for approval at least two weeks prior to installation. Pipe data shall conform to the standards set in Section 334110 "HDPE Pipe and Pipe Fittings"

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with these specifications and the CQA Plan.

B. Comply with the requirements of pollution control laws, rules and regulations of governmental authorities having jurisdiction, and applicable permit conditions as presented on the Drawings, including, but not limited to, the following:

1. "Clean Water Act of 1972" (as amended through latest legislative session), United States Environmental Protection Agency (40 CFR Part 122.26).

C. The CQA Engineer will perform specified test to determine conformance of the materials and construction as described in Specification Section 334110.

PART 2 - PRODUCTS

2.1 STORMWATER UTILITY DEVICES

A. Stormwater utility devices shall be as shown on the approved Erosion and Sediment Control Plan and Landfill Construction Plan.

B. HDPE Corrugated Stormwater Pipe
1. Stormwater pipe shall be HDPE corrugated, smooth interior pipe as manufactured by ADS (N-12) or Engineer approved equivalent, meeting the requirements of ASTM F405 and ASTM F667.
2. Watertight joints shall be used for non-perforated pipes, soil-tight joints are acceptable for perforated pipe.
3. HDPE material will meet specification set forth in Section 334110.
4. All Stormwater pre stressed concrete structures will meet specifications set forth in Section 033000

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify trench cut is ready to receive work and excavations, dimension, and elevations are as indicated on drawings.

3.2 PREPARATION

A. Ensure approval of Erosion and Sediment Control Plan and all required notifications have been given prior to beginning work.

B. Remove large stones or other hard matter which could damage piping or impede consistent

3.3 EXCAVATION

A. Excavate culvert trench in accordance with Section 312005 for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.

B. Perform temporary dewatering as necessary to keep bearing soils from softening.

3.4 INSTALLATION – PIPE

A. Place bedding material and compact as shown on Drawings

B. Place pipe culvert in trench and ensure pipe remains in correct position and to required slope with necessary support.

C. Install backfill at sides and over top of pipe. Install top cover to minimum compacted thickness of 18 inches.

D. Refer to Section 312005 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.

E. Installation of HDPE pipe shall be in accordance with ASTM D2321, the manufacturer's recommendations, and as described elsewhere in these specifications.

3.5 ERECTION TOLERANCES

A. Lay pipe to alignment and slope gradients noted on Drawings; with maximum variation from indicated slope of 1/8 inch in 10 feet.

B. Maximum variation from intended elevation of culver invert: ½ inch.

C. Maximum offset of pipe from indicated alignment: 1 inch.

D. Maximum variation in profile of structure from Intended Position: ½ percent.

3.6 FIELD QUALITY ASSURANCE

A. Request inspection prior to placing backfill over pipe.

B. Compacted soil will be in accordance to Section 312000.

C. Compaction Testing: in accordance with Section 312005.

D. When test indicate work does not meet specified requirements, remove work, replace and retest.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. Protect pipe and cradle from damage or displacement until backfilling operation is in progress.

END OF SECTION 334100

SECTION 334110 – HDPE PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pipe and pipe fittings for SDR 17 high density polyethylene (HDPE) pipe for the following pipe systems:

1. 12-inch diameter SDR-17 HDPE leachate collection system piping and fittings (perforated and non-perforated).
2. 8-inch diameter SDR-17 HDPE leakage detection system piping and fittings (perforated and non-perforated).
3. 24-inch diameter SDR-17 HDPE sideslope riser piping and fittings (perforated and non-perforated).
4. Leachate force main piping and fittings.

B. Related Requirements:

1. Section 312005 “Trenching.”
2. Section 313700 “Aggregate and Riprap.”

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:

1. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
2. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
3. ASTM D696 - Standard Test Method for Coefficient of Thermal Expansion of Plastics Between (-30°)C and 30°C With a Vitreous Silica Dilatometer.
4. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
5. ASTM D790 - Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
6. ASTM D1238 - Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
7. ASTM D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
8. ASTM D1505 - Standard Test Method for Density of Plastics by the Density Gradient.
9. ASTM D1603 - Standard Test Method for Carbon Black in Olefin Plastics.
10. ASTM D1693 - Standard Test Method for Environmental Stress Cracking of Ethylene Plastics.
11. ASTM D2240 - Standard Test Method for Rubber Property - Durometer Hardness.
12. ASTM D2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.

13. ASTM D2657 - Standard Practice for Heat Fusion joining of Polyolefin Pipe and Fittings.
14. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe materials.
15. ASTM D3261 - Standard Specification for Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
16. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
17. ASTM F405 - Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings.
18. ASTM F667 - Standard Specification for Large Diameter Corrugated Polyethylene Pipe and Fittings.
19. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
20. ASTM F1473 - Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins.

C. Plastics Pipe Institute (PPI):

1. PPI TR4 - Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings Compound.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1. The Contractor or Supplier shall submit a complete description of and data indicating pipe material used, and pipe accessories and fittings proposed for use to the Engineer for approval at least two weeks prior to installation. Pipe data shall conform to the standards set in Table 334110-A at the end of this Specification.
2. Manufacturer's Certificates:
   a. Certification of the analysis for the HDPE resin.
   b. Certify products meet or exceed specified requirements specified in Table 334110-A at the end of this Specification.
   c. Certifications must be submitted to Engineer for approval at least two weeks prior to installation.
3. Manufacturer's Installation Instructions: Indicate special procedures required to store and install products specified.
4. Submit manufacturer’s product information on the utility location tape to be used.

B. Shop Drawings:

1. Submit shop drawings for HDPE Pipe, fittings, valves, vaults, sizes, locations, and other accessories. Indicate piece numbers and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between piping, and proximate structures. Shop drawings for fabricated fittings shall be submitted to the Engineer for approval at least two weeks prior to fabrication.

C. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet (1:500) and vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

D. Submit information on the proposed detectable underground utility marking tape.

E. Field quality-control reports.

F. Project Record Documents: Record location of pipe runs, connections, and invert elevations via survey information.

G. Submit results of hydrostatic pressure testing for pressurized pipe sections.

H. Submit video survey of pipes.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with these specifications and the CQA Plan.

B. The pipe, outlet structure, and/or fitting manufacturer's production facilities shall be open for inspection by the Owner or his designated agents with a reasonable advanced notice.

C. During inspection, the manufacturer shall demonstrate that it has facilities capable of manufacturing and testing the pipe, manholes, sumps and/or fittings to standards required by this Specification.

D. Pipe which has been tested by the manufacturer and falls outside of the appropriate limits set forth in Table 334110-A contained in this specification will be cause for rejection.

E. The Owner or the specifying Engineer may request certified lab data to verify the physical properties of materials not meeting the requirements of this specification.

PART 2 - PRODUCTS

2.1 HIGH DENSITY POLYETHYLENE (HDPE) PIPING

A. Base Resin (HDPE Material)

1. HDPE material used for the manufacture of HDPE pipe and fittings under this specification shall be produced from approved pipe material base resin that is high density, high molecular weight polyethylene (HDPE) pipe grade resin with the nominal physical properties:
   a. Equivalent to Type III, Category 5, Class C, Grade PE 4710 in accordance with ASTM D1248.
   b. Equivalent to cell classification PE445574C in accordance with ASTM D3350.
   c. As outlined in Table 334110-A at the end of this Specification.
2. The material shall be listed by PPI (Plastics Pipe Institute, a division of the Society of the Plastics Industry) in PPI TR-4 with a 73ºF hydrostatic design basis of 1,600 psi and a 140ºF hydrostatic design basis of 800 psi. The PPI listing shall be in the name of the pipe manufacturer and shall be based on ASTM D2837 testing.
3. The resin shall contain not less than 97% of the base polymer and not less than 2% carbon black as defined in ASTM D1248, Class C to impart maximum weather resistance.

4. The pipe material shall contain no more than 3% carbon black, anti-oxidants, and heat stabilizers combined, and no other additives, fillers or extenders.
5. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same raw material, including both the base resin and the co-extruded resin.

B. Physical Appearance

1. All pipes shall have good appearance qualities.
2. The pipe shall be homogeneous throughout and the surfaces shall be smooth and uniform with no visible defects.
3. The pipes shall be free of visible cracks, holes, voids, nicks, cuts, gouges, scratches, blisters, gels, undispersed ingredients, any signs of contamination by foreign inclusions, or other defects that may affect the wall integrity or the pipe's serviceability.
4. Holes for perforated HDPE pipes shall be cleanly cut, identical in geometry, and evenly spaced.

C. Physical Properties

1. Pipe and fitting dimensions, workmanship, standard dimension ratio (SDR) and corresponding pressure rating shall be in accordance with the requirements of ASTM F714.
2. HDPE piping shall have a Standard Dimension Ratio (SDR) of 17 unless otherwise specified on the Drawings.
3. Pipe supplied under this Specification shall have a nominal OD indicated on the Drawings unless otherwise specified.
4. The chemical and corrosion resistance of the PE pipe and all fittings shall be in keeping with typical properties of high quality polyethylene products currently available through commercial sources and equal to or greater than that of the 60 mil HDPE geomembrane specified.
5. All mechanical fasteners or fittings shall be stainless steel.
6. At a minimum, the pipe material shall meet the properties presented in Table 334110-A at the end of this Specification.

D. Pipe Fittings

1. All fittings specified on the Drawings, or otherwise, needed to make pipe connections (ex: 90º elbow) shall be in accordance with ASTM D2513 and ASTM D3261 and shall be manufactured by injection molding, a combination of extrusion and machining, or fabrication from HDPE pipe conforming to this specification.
2. The fittings shall be fully pressure rated and provide a working pressure equal to that of the pipe with an included 2:1 safety factor.
3. The fittings shall be manufactured from the same base resin type and cell classification as the pipe itself as specified in this Specification. The fittings shall be homogeneous throughout and free from cracks, holes, foreign inclusions, voids, or other injurious defects.
4. Molded socket fittings shall not be used.
5. Pre-fabricated fittings:
   a. Shall not be permitted unless molded fittings are not available from the pipe Manufacturer, and only after obtaining specific approval from the Engineer.
   b. Shall be made using pipe segments meeting all base resin, physical, and property requirements presented in this Specification.

c. All pipe segments in a pre-fabricated fitting shall be pressure rated to exceed by 20 percent of the highest pipe pressure rating to which they are intended to be connected.

E. HDPE Joints

1. The method of joining for high density polyethylene pipe shall be the heat butt fusion method of high density polyethylene pipe per ASTM D2657 and shall be performed in strict accordance with the pipe manufacturer's recommendations, subject to the Engineer's approval. The heat fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer.
2. All joints shall be made by trained technicians qualified by the Manufacturer and using equipment and controlled procedures approved by the Manufacturer.
3. All pipe joints shall be stronger than the pipe itself under both tension and hydrostatic loading conditions.
4. The joints shall be leak-tight, homogeneous and uniform throughout.
5. Butt fusion welds shall exhibit a uniform melt bead. The melt bead shall be removed or reamed from the interior of the pipe prior to placement.
6. Properly executed electrofusion fittings may be used. Extrusion welding or hot gas welding of HDPE shall not be used for pressure pipe applications or fabrications where shear or structural strength is important, as determined by the Engineer. Mechanical joint adapters, flanges, unions, grooved-couplers, transition fittings, and some mechanical couplings may be used to mechanically connect HDPE pipe with approval by the Engineer. Refer to the manufacturer's recommendations.

F. Perforated Pipes

1. The HDPE pipe sections shall be perforated as shown on the Drawings.
2. Perforations shall be cleanly cut, identical in geometry, and evenly spaced.

G. Accessories

1. Valves, vaults, and other accessories as shown on Drawings.

H. Identification

1. The following shall be continuously indent printed on the pipe, or spaced at intervals not exceeding 5 feet:
   a. Name and/or trademark of the pipe manufacturer.
   b. Pipe series designation.
   c. Nominal pipe size.
   d. Standard dimension ratio (SDR).
   e. The letters PE followed by the polyethylene grade per ASTM D1248, followed by the Hydrostatic Design basis in 100's of psi (e.g., PE 4710).
   f. Manufacturing Standard Reference (e.g., ASTM F714-1).
   g. A production code from which the date and place of manufacture can be determined.

2.2 ACCESSORIES

A. Detectable underground utility marking tape.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Packaging, handling, and shipment shall be in accordance with the manufacturer's standards, instructions, and recommendations.

B. Transportation to Site:

1. The manufacturer shall package the pipe, fittings, structures, and/or other miscellaneous HDPE items in a manner designed to deliver it or them to the project neatly, intact, and without physical damage.
2. The transportation carrier shall use appropriate methods and intermittent checks to insure the materials are properly supported, stacked, and restrained during transport such that it is not nicked, gouged, or physically damaged.

C. Storage:

1. Pipe, structures, and other miscellaneous HDPE items shall be stored on clean, level ground to prevent undue scratching or gouging and as needed to protect them from being covered with excessive dirt, water, moisture, and mechanical abrasion.
2. The handling of pipe, structures, and other miscellaneous HDPE items shall be done in such a manner that there is no damage. Nylon slings are often used.
3. If the pipe must be stacked for storage, such stacking shall be done in accordance with the pipe manufacturer's recommendations.
4. Store gaskets for mechanical and push-on joints in cool, dry location out of direct sunlight and not in contact with petroleum products.

D. Care shall be taken to minimize the amount of soil collected inside the pipe, structures, and other miscellaneous HDPE items while handling and installing.

E. The pipe, structures, and other miscellaneous HDPE items shall be handled in such a manner that it is not pulled over sharp objects or cut by chokers or lifting equipment, and care shall be exercised during installation not to damage the pipes and fittings.

F. Any pipe section, structure, fitting, joint or other miscellaneous HDPE items that becomes broken, cracked, crushed, cut, scratched, gouged or otherwise rendered unsuitable, as determined by the Engineer, shall be removed and replaced by the Contractor. Scratches greater than 6 inches in length and gouges exhibiting a depth in excess of 8 percent of the wall thickness of the pipe shall be cause for rejection of pipe or fittings to the extent designated by the Engineer.

G. Fused Pipe Segment Handling:

1. Fused segments of pipe shall be handled so as to avoid damage to the pipe.
2. Chains or cable type chokers must be avoided when lifting fused sections of pipe. Nylon slings are preferred.
3. Spreader bars are recommended when lifting long fused sections.
4. Pipe shall be fused in lengths not to exceed that which can be moved and placed easily and safely, causing no damage to the fused pipe or welds.

3.2 EXAMINATION

A. Verify trench cut or excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on the Drawings.

3.3 PREPARATION

A. Correct over excavation with fill material at no additional cost to the Owner.

B. Remove large stones or other hard matter capable of damaging pipe or impeding consistent backfilling or compaction.

C. Pipe trenching should be conducted in accordance with Section 312005.

3.4 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground infrastructure piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Pipe shall be flushed to remove scraps, shavings, and other deleterious material. Deleterious material shall be removed from the cell area to prevent damage to pumping components.

C. Piping shall be installed to facilitate video inspection. The Contractor shall video survey pipe that is not tested under hydrostatic or air pressure upon completion of pipe installation.

D. Excavate pipe trench (where excavation is required for installation) in accordance with Section 332005.

E. Install pipe, fittings, and accessories in accordance with the Drawings, these Specifications, and the Manufacturer’s recommendations.

F. Route piping in straight line.

G. Pipe sections shall be joined adjacent to the placement area prior to placement.

H. Pipe shall be fused in lengths not to exceed that which can be moved and placed easily and safely, causing no damage to the fused pipe or welds.

I. Pipe will be laid such that the perforations/slots (if applicable) are on the underside of the pipe.

J. Care shall be taken not to drop the pipe while moving it, and to avoid excess stress or strain during installation. When pulling the pipe, either a pulling head or a suitable wraparound sleeve with rubber protective cover shall be used to prevent the pulling cables from damaging the pipe.

K. Pipeline installation and placement of backfill around pipelines shall be performed when the pipe is in a contracted state, i.e., during the cool of the morning, at night, or during periods of over-cast skies.

L. Immediately after placement, the pipe shall be thoroughly and completely embedded, supported, and covered, and the backfill compacted.

M. Refer to Section 312000 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.

N. Install detectable underground utility marking tape continuous over top of pipe outside of the landfill liner limits. Bury marking tape 6 inches below finish grade, above pipe line; coordinate with Sections 312000 and 312005.

O. HDPE pipe shall be joined using butt fusion. All butt fusion welds shall be made as described in ASTM D2657. Electrofusion welding can be used for making pipe welds. Hot air and extrusion welding are not permitted for pipe joining.

P. HDPE force main manifold installation varies along alignment. Refer to Drawings for backfill schedule.

Q. Install leachate force main markers as shown on the Drawings.

R. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

S. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

T. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

U. Place fill to contours and elevations as shown on Drawings with unfrozen materials.

3.5 ERECTION TOLERANCES

A. Lay pipe to alignment and slope gradients noted on Drawings; with maximum variation from indicated slope of 1/8 inch in 10 feet.

B. Maximum variation from intended elevation of culver invert: ½ inch.

C. Maximum offset of pipe from indicated alignment: 1 inch.

D. Maximum variation in profile of structure from Intended Position: ½ percent.

3.6 FIELD QUALITY CONTROL

A. The CQA Engineer will undertake observations and inspections to determine compliance of the materials and work with this Specification.

B. Contractor shall inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

C. Quality control by the CQA Engineer will include testing, monitoring, and/or inspecting:

1. The HDPE pipe and fittings for correct size, SDR rating; workmanship, and fabrication.
2. Damage during installation.
3. The installation, alignment and welding of all pipe, and fittings.
4. Backfilling of pipe.

D. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.

1. Reinspect and repeat procedure until results are satisfactory.

E. Pipe and fittings to be used in a pressurized application shall be hydrostatically tested by the Contractor to the following requirements:

1. 40 psi for 4 hours.

F. Pipe and fittings to be used as the outer pipe in a dual-containment pipe network shall be air tested as approved by the Engineer.

G. The Contractor shall perform camera inspection reports on piping elements within the limit of waste boundary and force main piping elements.

H. Backfill and Compaction Testing: In accordance with Section 312000.

I. When tests indicate Work does not meet specified requirements, remove work, replace and retest.

J. HDPE pipes and other miscellaneous items shall be subject to rejection on account of failure to conform to these Specifications. In addition, individual sections of these items may be rejected because of any of following reasons:

1. Any pipe section, fitting, joint, or outlet structure that becomes broken, cracked, crushed, cut, scratched, gouged or otherwise rendered unsuitable, as determined by the Engineer, shall be removed and replaced by the Contractor.
2. Scratches greater than 6 inches in length and gouges exhibiting a depth in excess of 8 percent of the wall thickness of the pipe, fitting, or outlet structure shall be cause for

rejection of a pipe section, fitting, or outlet structure to the extent designated by the Engineer.

3.7 CLEANING

A. Perform pipe camera inspection, if necessary clean using jet cleaning methods or as approved by the Engineer.

3.8 PROTECTION OF FINISHED WORK

A. Protect pipe, cover, and outlet structures from damage or displacement until backfilling operation is in progress.

B. Care shall be exercised during construction not to damage the pipelines, fittings, and outlet structures.

Table 334110A - HDPE Pipe

Properties	Test Method	Unit	Nominal Value
Material Designation	PPI-TR4		PE 4710
Cell Classification	ASTM D3350		445574C
Material Classification	ASTM D1248		Type III, Category 5, Class C
Density	ASTM D1505		≥ 0.945 g/cc
Melt Index	ASTM D1238 (Condition E)	g/10 min.	<0.1
Carbon Black Content	ASTM D1603	% range	2 to 3
Flexural Modulus	ASTM D790 (2% Secant)	psi	>125,000
Ultimate Tensile Strength	ASTM D638	psi	3,200
Yield Tensile Strength	ASTM D638 (Type IV, 2ipm)[1]	psi	>3,000
Ultimate Elongation at Break	ASTM D638	%	> 750
Yield Elongation	ASTM D638 (Type IV, 2ipm)[1]	%	> 8
Modulus of Elasticity	ASTM D638 (Type IV, 2ipm)[1]	psi	> 100,000
Environmental Stress Crack Resistance	ASTM D1693 (F_0, Condition C)	hrs	> 5,000
Hardness	ASTM D2240	Shore "D"	> 60
Compressive Strength at Yield	ASTM D695	psi	> 1,600
Slow Crack Resistance	ASTM F1473	hours	> 100
Hydrostatic Design Basis at 73.4° F (23° C)	ASTM D2837	psi	> 1,600
Hydrostatic Design Basis at 140° F (60° C)			> 800
Low Temperature Brittleness	ASTM D746	° F (° C)	< -180° (-117°)
Linear Thermal Expansion Coefficient	ASTM D696	in/in/° F	9×10^{-5}

END OF SECTION 334110

Water Quality Monitoring Plan

Dan River Landfill

Duke Energy – Dan River Steam Station

Eden, North Carolina

Amec Foster Wheeler Project No. 7810140065

To:	Duke Energy Carolinas, LLC
Date	8/26/2015
From:	Amec Foster Wheeler

3195 Pine Hall Road
Belews Creek, NC 27009

336-215-4576

August 26, 2015

North Carolina Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
2090 U.S. Highway 70
Swannanoa, North Carolina 28778

Attn: Mr. Larry Frost

Re: Industrial Landfill Permit to Construct Application Submittal
Permit No.: TBD
Dan River Steam Station
Rockingham County
Eden, North Carolina 27009

Dear Mr.Frost,

Attached you will find the Permit to Construct (PTC) Application for the Duke Energy Dan River Steam Station Landfill prepared by Amec Foster Wheeler under the direction of Duke Energy. The PTC Application consists of the Water Quality Monitoring Plan (WQMP), and the Construction Plan Application (CPA) which is submitted as two volumes and provides details on landfill design, operations, closure, and post-closure elements.

The PTC application is being submitted to fulfill the requirements of Title 15A Subchapter 13B of the North Carolina Administrative Code (NCAC) to meet the requirements of Section .0500 for industrial landfills and substantive requirements of Section .1600 for municipal solid waste (MSW) landfills for compliance with Senate Bill 729. Duke Energy requests a 5-Year Solid Waste permit for the Dan River Landfill facility.

Respectfully submitted,

Kimberlee Hutchinson, PE
Environmental Services

Attachments: (2) CPA Hard Copy (Volumes 1 and 2)
(2) CPA Electronic Copy
(2) WQMP Hard Copy
(2) WQMP Electronic Copy

cc (letter only, via e-mail): Ed Mussler, NCDENR
Elizabeth Werner, NCDENR
Henry Taylor, Duke Energy
Ed Sullivan, Duke Energy
Cedric Ruhl, Amec Foster Wheeler

August 26, 2015

Duke Energy
526 South Church Street
Charlotte, North Carolina 28202

Attention: Ms. Kimberlee Hutchinson, P.E.

Subject: Construction Plan Application and Water Quality Monitoring Plan Proposed Dan River Landfill
Duke Energy – Dan River Steam Station
Eden, North Carolina
Amec Foster Wheeler Project No. 7810140065

Dear Ms. Hutchinson:

Amec Foster Wheeler is pleased to provide this Construction Plan Application and Water Quality Monitoring Plan to Duke Energy (Duke) for the proposed Dan River Landfill at Duke's Dan River Steam Station.

The Construction Plan Application is submitted as two volumes and addresses design information required by 15A NCAC 13B .0500 rules. The Water Quality Monitoring Plan is submitted as one volume and addresses monitoring requirements required by 15A NCAC 13B .0500 rules.

The Construction Plan Application and Water Quality Monitoring Plan are being submitted in parallel with on-going activities including collection of monthly water level collection. The additional information including the estimated seasonal high groundwater table will be provided as a revision to these reports at a later date.

Amec Foster Wheeler appreciates the opportunity to provide these reports to Duke. Please contact us at your convenience with questions.

Sincerely,

Amec Foster Wheeler

NORTH CAROLINA PROFESSIONAL SEAL 036330 ENGINEER CEDRIC H. RUHL 8.26.15

NORTH CAROLINA LICENSED SEAL 2203 GEOLOGIST COURTNEY WITHERS MURPHY 08/26/15

Cedric H. Ruhl
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Courtney Murphy
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1 Introduction and Purpose

This document provides the Water Quality Monitoring Plan (WQMP) for the Duke Energy Dan River Steam Station Landfill Development and is intended to satisfy the requirements of North Carolina Administrative Code (NCAC) Title 15A NCAC 13B .0504(1)(g)(iv). The purpose of this document is to establish procedures for leachate monitoring and for monitoring the quality of the groundwater in the shallow unconfined uppermost and lower bedrock aquifer underlying the landfill and surface water adjacent to the new landfill location during operation and post closure periods. The WQMP consists of a series of wells placed upgradient, downgradient, and side-gradient of the Dan River Landfill to monitor both background concentrations of constituents of interest (COIs) potentially associated with coal combustion residuals (CCRs) or coal ash scheduled to be placed in the landfill.

The WQMP is designed to provide information to the North Carolina Department of Environment and Natural Resources (NCDENR) - Solid Waste Section (SWS) and the landfill owner and operations personnel for the purpose of evaluating potential impacts to groundwater and surface water quality prior to, during, and after landfilling operations are completed.

1.1 Project Description

Duke Energy intends to construct a landfill on Dan River Steam Station property to store existing coal combustion residuals (CCRs) currently stored in four units on site. The units consist of the Primary Ash Basin, Secondary Ash Basin, and two unlined ash structural fills (Ash Fills 1 and 2). Electricity production from coal combustion ceased on April 1, 2012 and the coal-fired plant is currently undergoing decommissioning; therefore, no new coal combustion residuals (CCRs) are currently being generated at Dan River Steam Station. A combined cycle plant on station property currently produces electricity from natural gas.

The proposed landfill will be constructed to facilitate placement of ash from existing on-site ash units in a lined facility by August 1, 2019 as required by the North Carolina Coal Ash Management Act of 2014. Prior to construction of the on-site landfill, Duke Energy intends to remove some of the on-site ash by rail to the Maplewood Landfill in Jetersville, Virginia.

1.2 Site Description

The Dan River Steam Station is located at 900 South Edgewood Road in Eden, Rockingham County, North Carolina. The proposed landfill will be located largely within the footprint of existing Ash Fill 1 on the northeastern end of the property and comprise a total area of approximately 23.3 acres and will accept CCR material generated during closure of the existing on-site Primary and Secondary Ash Basins, and Ash Fill 2. The proposed landfill will include a liner system that provides three geosynthetic barrier components (two geomembranes and a geosynthetic clay liner) and a soil barrier component for a total of four barrier components between waste and groundwater. The ash within Ash Fill 1 will be removed prior to construction of the proposed landfill. The proposed landfill will be bound by existing overhead electrical lines to the west and north, rail lines to the east, and a natural gas pipeline to the south.

1.3 Site Geology and Hydrogeology

As described in the respective Hydrogeologic Study prepared by Amec Foster Wheeler, the site is located in the Piedmont Province of North Carolina, and more specifically, lies within a Triassic Period rift basin containing primarily sedimentary rock sequences. Groundwater flow at the site is typical of the Piedmont Province two-part system of regolith and bedrock as described in the site's Hydrogeology Study (Amec Foster Wheeler, July 15, 2015 as amended). Groundwater recharge at the site is primarily derived from infiltration of local precipitation and groundwater levels tend to fluctuate seasonally.

The hydrostratigraphic units encountered at the site during the Hydrogeologic Study field investigations (pre-landfill construction or operation) included soil fill, ash fill, residuum, saprolite, partially weathered rock (PWR), weathered/fractured bedrock, sound bedrock, and minor occurrences of alluvium. Of these

hydrostatigraphic units, groundwater was typically encountered in the PWR and saprolite units; however, some groundwater was encountered within ash near the base of the ash fill unit. It is anticipated that the water level within the ash unit will subside to the underlying saprolite and PWR units once the current ash fill is removed and the area is lined, filled, and capped.

1.4 Well Abandonment

Observation wells and monitoring wells that exist in the vicinity of proposed landfill activities and are not included in the WQMP network, will be decommissioned or abandoned in accordance with 15A NCAC 2C .0113 rules. Well abandonment activities may occur in multiple phases to coordinate with landfill construction activities. Well abandonment methods will be selected according to one (1) of the following scenarios:

- If a well exists within the limit of waste (LOW) of the proposed landfill, it will be properly abandoned by overdrilling methods to remove well materials, and it will then be grouted with a cement-bentonite grout. The bentonite solids content of the grout will be approximately 30% in order to provide a more flexible grout column since extensive excavation of existing overburden material will take place. Tremie pipe will be used to place the grout continuously from the bottom of the borehole upwards. Well surface construction, i.e. concrete pads, protective covers and bollards will be removed.

- If a well exists outside the LOW but within a “cut” area of the grading limits of the proposed landfill, it will be properly abandoned by overdrilling methods to remove well materials, and it will then be grouted with a cement-bentonite grout. The bentonite solids content of the grout will be approximately 30%. Tremie pipe will be used to place the grout continuously from the bottom of the borehole upwards. Well surface construction, i.e. concrete pads, protective covers and bollards will be removed.

- If a well exists outside the LOW but within a “fill” area of the grading limits of the proposed landfill, it may be properly abandoned by in-place methods. No drilling is required for the in-place abandonment method. The well materials remain in-place and a cement-bentonite grout is placed with tremie pipe from the bottom of the well upwards. The bentonite solids content of the grout will be approximately 5%. Well surface construction, i.e. concrete pads, protective covers and bollards will be removed.

- If a well exists outside the LOW and grading limits of the proposed landfill, then such well may be properly abandoned by in-place methods. The bentonite solids content of the grout will be approximately 5%. Well surface construction, i.e. concrete pads, protective covers and bollards will be removed.

Within 30 days of completion of well abandonment activities, Well Abandonment Records (GW-30 forms) will be submitted to the NCDENR. A copy of the NCDENR Well Abandonment Record form has been included in **Appendix II**.

2 Groundwater Monitoring System

2.1 Monitoring Locations

The following section describes the proposed monitoring network for the Dan River Ash Landfill, along with specifications associated with installing, developing, maintaining, and decommissioning facility monitoring wells.

2.1.1 Proposed Monitoring Network

The proposed groundwater monitoring well network for the Dan River Landfill will consist of monitoring well pairs to monitor groundwater quality in the uppermost aquifer and the deeper bedrock aquifer at the site as shown on **Drawing 1**. Specifically, the well network will consist of two (2) upgradient background compliance monitoring well pairs (BW-1S/D and BW-2S/D), one (1) side-gradient well pair (CW-8S/D), and seven (7) downgradient well pairs (CW-1S/D, CW-2S/D, CW-3S/D, CW-4S/D, CW-5S/D, CW-6S/D, and CW-7S/D). Four (4) surface water sampling locations (SWS-1 through SWS-4) will also be established. Surface water sampling location SWS-1 is intended to serve as a background surface water location. The well and surface water sampling locations have been selected based on the potentiometric contours that currently represent site conditions. The general groundwater flow was observed to be from north to south towards the Dan River; however, localized shallow groundwater flow discharges radially from near the center of the site towards ephemeral or seasonal streams to the east and west of the proposed landfill footprint as shown on **Drawing 1**. Surface water flow follows topography and generally reflects surface water runoff as a result of rainfall and recharge events as well as groundwater discharge.

The 10 groundwater monitoring well locations were chosen based on horizontal location in reference to surface drainage features, geologic conditions, groundwater flow directions, current property boundary and landfill features and limits.

2.1.1.1 Proposed Existing Monitoring Well Locations (Observation Wells to be Converted to Monitoring Wells)

Of the 10 proposed groundwater monitoring well pairs, one (1) well pair consists of observation wells installed previously during the site's Hydrogeologic Study. These wells were constructed in accordance with North Carolina Well Construction Standards (15A NCAC 2C .0108) and also the North Carolina Water Quality Monitoring Guidance Document for Solid Waste Facilities. **Table 1** documents the labeling conversions between prior observation wells and proposed monitoring wells.

2.1.1.2 Proposed Newly Installed Monitoring Well Locations

Of the 10 proposed groundwater monitoring well pairs, nine (9) well pairs will be newly installed (CW-1S/D through CW-8S/D and BW-2S/D) at locations depicted on **Drawings 1** and **2**. The new monitoring well pairs will consist of a Type II well to monitor the uppermost aquifer and a Type III well to monitor the deeper bedrock aquifer and be constructed in accordance with North Carolina Well Construction Standards (15A NCAC 2C .0108) and also the North Carolina Water Quality Monitoring Guidance Document for Solid Waste Facilities. Monitoring well construction and installation details are provided below in Section 2.2 and typical Type II and Type III well diagrams have been included as **Figures 1** and **2**.

2.2 Monitoring Well Construction and Installation

Each new monitoring well location will be constructed as Type II and Type III well pairs in accordance with the North Carolina Well Construction Standards (15A NCAC 2C .0108) and the requirements of the North Carolina Water Quality Monitoring Guidance Document for Solid Waste Facilities. A North Carolina Licensed Well Driller will drill the boreholes and construct the monitoring wells. A North Carolina Licensed Geologist will oversee drilling and well installation activities for the monitoring wells. Downhole drill tooling will be steam cleaned between each well location. Typical Type II and Type III monitoring well construction details that are described in the following sections are shown on **Figures 1** and **2**.

Well construction details for the existing observation wells to be converted into monitoring wells are shown in **Table 1**, and respective boring and well logs have been provided in **Appendix I**. Well construction details for newly installed wells will be added to **Table 1** and respective logs added to **Appendix I** upon completion.

New wells will be located by a Professional Land Survey licensed in the state of North Carolina. Well locations will be surveyed to within 0.01 feet of horizontal and vertical. Within 30 days of completion of well installation activities, a boring log, well construction log, groundwater monitoring network map, well

installation certificate, and survey data will be submitted to NCDENR. A copy of the NCDENR Well Construction Record form has been included in **Appendix II**.

2.2.1 Type II (Uppermost Aquifer) Monitoring Wells

For Type II wells, the wells will be installed in the unconsolidated (regolith) material of the uppermost aquifer and boreholes advanced using 4.25-inch I.D. hollow-stem augers and Standard Penetration Test (SPT) sampling every five (5) feet until boring termination depth.

Type II wells will consist of 2-inch Schedule 40 PVC casing and screen. Screens will be prepacked, 0.010-inch machine-slotted, will be approximately 15 feet in length, and located where estimated long-term seasonal high water table is slightly below the top of the screened interval. If however, groundwater is less than five (5) feet below land surface, the top of the screen will be placed at a depth of five (5) feet below land surface to allow adequate seal and grout. Specifically, prepacked screens will consist of environmental grade sand housed in a stainless steel wire mesh cylinder around the PVC machine-slotted screen. A 20/40 sand and wire mesh size is anticipated for site conditions; however, field conditions will determine if a different size is needed to best fit the formation.

The annular space between the borehole wall and well pipe (including the prepacked screen section) from the bottom of the borehole up to approximately two (2) feet above the top of the screen will consist of environmental grade silica sand properly sized to the formation material and screen. A one (1) to 2-foot pelletized or granular bentonite seal will be placed above the filter pack and hydrated. The remainder of the annular space will be filled with a cement/bentonite grout from the top of bentonite seal to near ground surface.

2.2.2 Type III (Deeper Aquifer) Monitoring Wells

For Type III wells, the wells will be installed in bedrock (weathered/fractured bedrock unit or sound bedrock unit) of the deeper aquifer. Type III well boreholes will be advanced through the regolith using 8.25-inch I.D. hollow-steam augers and SPT sampling every five (5) feet until auger refusal depth.

Type III wells will consist of 6-inch Schedule 40 PVC outer casing that is seated slightly into the top of bedrock and grouted into place. Outer casing grout will be allowed to cure a minimum of 48 hours prior to remaining work being performed on the well. Next, Type III well boreholes will be advanced inside and below the outer casing using HQ coring techniques (approximate 3.7-inch diameter corehole). Screens will be prepacked, 0.010-inch machine-slotted, and approximately (five) 5 feet in length. Type III screens will be placed to intersect water-bearing fractures within the bedrock unit and will have a vertical separation distance of approximately 15 to 20 feet from its corresponding Type II well screen (distance from bottom of Type II screen to top of Type III screen at a well pair location). Specifically, prepacked screens will consist of environmental grade sand housed in a stainless steel wire mesh cylinder around the PVC machine-slotted screen. A 20/40 sand and wire mesh size is anticipated for site conditions; however, field conditions will determine if a different size is needed to best fit the formation.

The annular space between the corehole wall and well pipe (including the prepacked screen) from the bottom of the corehole up to approximately two (2) feet above the top of the screen will consist of environmental grade silica sand properly sized to the formation material and screen. A one (1) to 2-foot pelletized or granular bentonite seal will be placed above the filter pack and hydrated. The remainder of the annular space will be filled with a cement/bentonite grout from the top of bentonite seal to near ground surface.

2.2.3 Surface Finish (Type II and Type III Monitoring Wells)

A 4-inch by 4-inch square steel or aluminum protective casing with a locking cap will be placed over the well riser pipe, extending approximately 3.5 feet above the ground surface. The protective casing will be seated into place with a 2-foot by 2-foot square concrete pad. The protective casing will also be painted and provided a permanent well tag with the following information displayed:

- Well ID number;
- Driller registration number;
- Date of well installation;
- Total depth of well;
- Depth of screen interval;
- Depth of filter pack, seal, and grout intervals;
- Depth to groundwater following well completion; and
- Warning stating well is not for water supply and that groundwater may contain hazardous materials.

2.2.4 Well Protection

Each monitoring well will be guarded against potential damage caused by normal site activities such as vehicle and equipment operation. The anticipated protective measures to be installed are steel bollards. Bollards or other protective measures selected will be located just off the edge of the well pads at each of the four (4) corners unless protection is provided by other means such as woods, buildings, or other structures/features. Well pairs may "share" a side of protective measures if horizontal spacing between wells is sufficiently narrow to prevent vehicle and/or equipment access between wells. Bollard installation as a protective measure is shown on **Figures 1** and **2**.

2.2.5 Surveying

A North Carolina Registered Land Surveyor will locate each well for State Plane coordinates, ground surface elevation at the base of the well, and the top of the PVC inner well casing elevation. The survey data will be referenced to a site benchmark for horizontal control. Well locations will be surveyed to within 0.01 feet of horizontal and vertical.

2.3 Monitoring Well Development

Following well installation, each monitoring well will be developed to reduce clay, silt, sand, and other fines which may have been introduced into the well or filter pack during installation. Well development will be performed using a pump, disposable bailer, or other approved method. Turbidity will be monitored during development using a field turbidity meter. Well development will continue until turbidity has been reduced to a goal of below 10 Nephelometric Turbidity Units (NTU). If a well has not reached turbidity less than 10 NTU after five (5) to 10 well volumes have been removed, the well will be allowed to sit for approximately 24 hours, then a second attempt to reach below 10 NTU will be made. If a second attempt does not reach turbidity levels below 10 NTU, the well will be allowed to sit an additional 24 hours, and a third attempt will be performed. If after three (3) attempts the well remains above 10 NTU, then NCDENR-SWS will be notified and supplied well construction and development records to determine if the turbidity is an artifact of the geologic formation in which the well is screened.

2.4 Monitoring Well In-Situ Permeability Testing

No sooner than 24 hours following well development, each newly installed monitoring well be slug tested to calculate hydraulic conductivity at the well location. The hydraulic conductivity values will be used in conjunction with assumed effective porosity and horizontal groundwater gradients to estimate groundwater flow rates each monitoring event.

2.5 Monitoring Well Maintenance

The wells and surrounding area will be maintained to provide adequate access for sampling activities, which could include items such as vegetation control or access road maintenance. Each monitoring well will be accessible by at least a four-wheel drive vehicle. Surface water run-on controls such as diversion berms or channels may need to be provided to inhibit erosion or deposition at the well or damage to concrete well pads.

In addition to access, routine maintenance of monitoring wells could include repair or replacement of well tags, locks, well caps, concrete pads, or protective covers.

3 Groundwater Monitoring Program

Groundwater will be sampled and analyzed on a semi-annual basis. Constituents to be analyzed along with their respective analytical method and regulatory standards are listed in **Table 2**. Groundwater sample results will be compared to the 15A NCAC 2L .0202 (2L Standards) as well as the NCDENR-SWS Groundwater Protection Standards (where established). In addition, temperature, pH, specific conductivity, dissolved oxygen (DO), oxidation reduction potential (ORP), and turbidity will be measured and recorded for each sample.

3.1 Equipment Calibration

A multi-parameter water quality meter will be used to measure the field parameters listed above in Section 3. Instrument calibration should be conducted at the start and end of each day, with calibration reference standards selected to bracket anticipated site groundwater conditions.

3.2 Sampling

Prior to the initial sampling event, each monitoring well will be fitted with a dedicated stainless steel bladder pump and polyethylene tubing suitable for low-flow purging and sampling techniques described in Sections 3.2.2 and 3.2.3 below. If possible, the pump intake will be placed at least two (2) feet above the bottom of the well to reduce chances of mobilization of particulates present in bottom of well. The following sections detail activities associated with low-flow purging and sampling.

3.2.1 Decontamination of Field Sampling Equipment

Prior to the initial sampling event, each dedicated bladder pump will be properly cleaned and rinsed with distilled and a phosphate and borax free detergent prior to installing in the well unless certified as decontaminated from the supplier. Tubing used for air intake and water discharge connections will be new certified-clean supplied directly from factory packaging.

During the initial and subsequent sampling events, the water level probe will be cleaned and rinsed with distilled or deionized water prior to measuring the water level in each monitoring well.

3.2.2 Well Purging Methods

3.2.2.1 Low-Flow Method

The total well depth will be recorded prior to installation of the dedicated pump and confirmed when the pump is removed for inspection or repair. Prior to purging, the initial static water level and total well depth for each well will be recorded. The volume of water held by the well pump and tubing will be calculated, as well as the total water volume in the well. Pumping rates and flow rates will be adjusted such that drawdown is no more than 0.3 feet, if possible. Pumping rates should range between 100 milliliters per min (mL/min) and 500 mL/min. Once an acceptable pumping rate and flow rate is determined for each well, the indicator parameters listed below will be measured with a multi-parameter water quality meter and flow-through cell, with the exception of turbidity, which will be measured with a separate meter. The parameters (along with discharge rate and depth to water) will be recorded over time, with the frequency of the measurements based on the time required to completely evacuate one (1) volume of the flow-through cell (typically five (5) minute increments) until stabilization within a certain range is reached over three (3) consecutive readings. The critical indicator parameters will be pH, specific conductivity, dissolved oxygen, and turbidity. Each indicator parameter and their respective stabilization criteria is listed as follows:

- pH ± 0.1 standard units;

- specific conductivity ± 5 percent in microsemens per centimeter (µS/cm);
- dissolved oxygen (DO) ± 0.2 milligrams per liter (mg/L) or 10% saturation;
- turbidity less than 10 NTUs;
- temperature (recorded but not considered a purge stabilization parameter); and
- oxidation reduction potential (ORP) (recorded but not considered a purge stabilization parameter).

As listed above, the optimal samples will be obtained at a turbidity of 10 NTU or less. If turbidity levels are slightly above 10 NTU, but trending downward, purging shall continue. If turbidity readings are greater than 10 NTU and have stabilized to within 10% during three (3) consecutive readings, attempts should be made to contact the project manager prior to collecting the groundwater sample. If turbidity readings are greater than 10 NTU and are not stable, the project manager should be contacted and well sampling shall be based upon stabilization of more critical indicator parameter (such as DO) without attainment of the targeted turbidity.

If after five (5) well volumes or two (2) hours of purging (whichever is achieved first), critical indicator parameters have not stabilized, purging will be discontinued and samples collected. Efforts used towards stabilization of the parameters (such as modified pumping rates) will be documented.

3.2.2.2 Volume-Averaging Method

There may be instances in which a well has very slow recharge rates, draw down excessively at the minimum pumping rate of 100 mL/min, or require a higher pumping rate (greater than 500 mL/min) to maintain purging. In such cases, typical low-flow purging and sampling methods are not appropriate, and the volume-averaging method will be used. For the volume-averaging method, well volumes (i.e. water column volumes) will be calculated and three (3) to five (5) well volumes removed. Although indicator parameter stabilization is not required for the volume-averaging method, the parameters (as well as discharge rate and depth to water) will still be measured and recorded as follows:

- Initially at the start of purging;
- After each well volume is purged; and
- Just before purge completion.

The removal of three (3) to five (5) well volumes may not be practical in wells with slow recovery rates. If a well is purged near dryness at a rate of less than 0.5 gallons per minute (gpm), the well shall be allowed to completely recover prior to sampling. A two (2) hour limit may be exceeded to allow for sufficient recovery, but samples should be collected within 24 hours of purge completion.

3.2.3 Sample Collection

For each monitoring well location, water will be transferred directly from the pump tubing prior to entry the flow-through cell into the laboratory provided, pre-preserved containers. The sample bottles will be held such that the sample liquid is allowed to run gently down the side of the bottle to reduce turbulence. The container for metals will be filled first, followed by the containers for general chemistry parameters.

3.2.4 Sample Labels

Sample labels shall be placed on each sample bottle and remain legible even if wet. The sample labels should contain at a minimum, the following information:

- Site name;
- Sample ID;
- Well ID;
- Sample date and time;
- Name of sampling personnel;
- Constituents to be analyzed; and
- Preservative (if applicable).

3.2.5 Sample Preservation and Handling

Upon containerizing groundwater samples, the samples will be packed into pre-chilled, ice-filled coolers and either hand-delivered or shipped overnight by a commercial carrier to a NC certified laboratory for analysis. Sample preservation methods will be used to retard biological action and hydrolysis, as well as to reduce sorption effects. These methods will include chemical preservation, cooling/refrigeration at 4º C, and protection from light.
Precautions will be taken to reduce movement of samples during transport, including packing the bottles securely in the cooler. A laboratory provided temperature blank will also be included in the cooler. Sample coolers should be sealed shut with sturdy tape and tamper seals placed across the cooler opening.

3.2.6 Chain-of-Custody Program

Properly documented sample chain-of-custody is an essential element of data integrity. Correctly performed custody procedures inhibit the potential for sample tampering to occur. Custody procedures will trace the handling of each sample during the collection process, through analysis, until final turnover for both laboratory and field samples obtained. Chain-of-custody forms are typically provided by the laboratory and should be completed by qualified sampling staff and laboratory employees. A manually-prepared chain-of-custody record will be initiated at the time of sample kit preparation by the laboratory and will remain with the sample kit throughout sample collection, transport, and analysis. Information the chain-of-custody record may document includes:

- Client name, contact, phone number and address;
- Client project name;
- Sampler(s) name and signature;
- Name and signature of person involved in chain of possession;
- Inclusive dates of possession;
- Sample ID, number, matrix, type (grab or composite);
- Date and time of collection;
- Number and type of containers and preservative; and
- Analysis method.

Chain-of-custody records will be prepared by the field sampling personnel and sample numbers and chain numbers also documented in the field books.

3.2.7 Field Logbook

Each field crew conducting sampling activities shall maintain a field logbook to document the activities conducted by the field crew for each day throughout the course of the field sampling event. At a minimum, the following information shall be recorded in the field logbook:

- Name and location of the site;
- Pre-Job Safety Brief;
- Date(s) of sample event;
- Name(s) and affiliation(s) of the field sampling crew;
- Time of arrival to the site;
- Weather conditions (including changes throughout the day);
- Pertinent field observations;
- Equipment calibration information;
- Static water level measurements;
- Date and time of well purging;
- Purge volume;
- Time of sample collection;

- Numbers and types of samples collected, sample identification numbers, and preservatives used;
- A description of sampling methodology and quality control samples (field blanks, duplicates, etc.);
- Water quality indicator parameter readings with time stamp;
- Sample Chain of Custody reference number and cross reference to the sample form data;
- Physical description and picture or sketch of the sample collection location(s) if unusual;
- Record of daily phone calls and/or contact with individuals at the site;
- Documentation of equipment decontamination activities; and
- Description of deviations from the Work Plan.

Field documentation is a crucial element of field activities and, therefore, field crew members should strictly adhere to logbook entry protocol. Key procedures of field documentation are provided below:

- Logbook should be bound and weather-resistant;
- Consecutively number each page of the logbook;
- Make entries into the logbook in chronological order so that a time notation introduces each entry;
- Use only indelible ink for logbook entries;
- Record data directly and legibly in the field logbook;
- Line out errors in the logbook (a single line strike-through) and initial and date the correction;
- Avoid leaving blank line(s) between logbook entries. Cross out blank spaces that exist with a single line and initial and date the cross out; and
- Sign and date each page of the logbook (field team member responsible for keeping the logbook).

3.3 Analytical Procedures

A North Carolina certified laboratory will analyze the groundwater samples for the constituents listed in **Table 2**. Analysis will be performed in accordance with Environmental Protection Agency (EPA) Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW 846), which are also listed in **Table 2**. Alternate SW 846 methods may be used if they have the same or lower reporting limit. The laboratory must report a detection of any requested constituent even if it is below the Solid Waste Section Limit (SWSL); however, such concentration will be reported with a qualifier (“J” flag). The laboratory must include an electronic data deliverable (EDD) spreadsheet with the full laboratory analytical report.

3.4 Quality Assurance and Quality Control Program

Quality Assurance/Quality Control samples will be collected during field activities. Temperature blanks will be provided by the laboratory in the sample coolers. Temperature blanks will be used to check the temperature of the samples upon receipt of the cooler to the laboratory. At least one (1) field duplicate sample will be prepared. A field duplicate is a duplicate sample prepared at an identical sample location, collected at the same time, in the same container type, containing equal portions of sample medium, preserved in the same way, and analyzed by the same laboratory as a measure of control. A field blank may also be collected and analyzed during each monitoring event. A field blank is a sample prepared in the field and exposed to the sampling environment. A field blank may be prepared by filling appropriate laboratory bottles with deionized water.

Field QA/QC samples (except for the temperature blank) will be analyzed for the same constituents as shown in **Table 2**. Concentrations of any constituents found in the blanks will be used to qualify the analytical data. Any compound detected in a sample, which was also detected in any associated blank, will be qualified with a “B” flag.

4 Surface Water Monitoring

Water samples will be collected from four (4) surface water locations on a semi-annual basis as shown on **Drawing 1**. Surface water samples will be collected by directly filling laboratory containers with stream

discharge water. Surface water samples will be subjected to the same sample handling, preservation, chain of custody, labeling, and field logging techniques as groundwater samples described in above sections. Surface water samples will be analyzed for the same constituents as groundwater samples (**Table 2**), and will be compared to respective Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of North Carolina as defined in 15A NCAC 2B .0200 (2B Standards).

5 Leachate Monitoring

Leachate will be monitored at the landfill facility on a semi-annual basis. A composite, untreated leachate sample will be collected at a location to be determined pending the final leachate force main design for the facility. The leachate sample will be analyzed for the constituents listed in **Table 2**, and field indicator parameters of pH, temperature, and specific conductivity recorded. The leachate sample analysis will be included in semi-annual reporting, but will not be compared to any water quality standards.

6 Data Evaluation and Reporting

The following sections describe anticipated deliverables in regards to this WQMP.

6.1 Well Abandonment Record Submittal

As mentioned above in Section 1.4, within 30 days of completion of well abandonment activities, Well Abandonment Records (GW-30 forms) will be submitted to the NCDENR. A copy of the NCDENR GW-30 Well Abandonment Record form (version dated August 2013) has been included in **Appendix II**.

6.2 Well Construction Record Submittal

As mentioned above in Section 2.2, within 30 days of completion of well installation activities, Well Construction Records (GW-1b Forms) will be submitted to the NCDENR. A copy of the NCDENR GW-1b Well Construction Record form (version dated August 2013) has been included in **Appendix II**.

6.3 Monitoring Well Installation Report

Following completion of well installation related field activities, a Monitoring Well Installation Report will be prepared that will include information regarding the newly installed wells such as:

- a description of field activities;
- a table summarizing monitoring well construction details;
- boring and well logs;
- well development notes;
- slug test data;
- soil laboratory data; and
- effective porosity estimates.

6.4 WQMP Update

Information obtained from monitoring well installation activities and reported in the Monitoring Well Installation Report (described above in Section 6.3), will be included in an update to this WQMP. The WQMP Update may also address comments (if any) received from the NCDENR-SWS on this original WQMP.

6.5 Semi-Annual Monitoring Reports

Groundwater, surface water, and leachate monitoring events and respective reporting will occur on a semi-annual basis. The actual months of the semi-annual events will be determined sometime after a Permit to Operate is received. Semi-Annual Monitoring Reports will be submitted within 120 days of each sampling event. Each semi-annual report will be submitted to the NCDENR-SWS via electronic

document submittal as described in the NCDENR Memorandum titled Groundwater, Surface Water, Soil, Sediment, and Landfill Gas Electronic Document Submittal dated November 5, 2014. A copy of the November 5, 2014 Memorandum has been included in **Appendix III**. Each Semi-Annual Monitoring Report will be accompanied by an NCDENR-SWS Environmental Monitoring Reporting (EMR) Form which will be signed and sealed by a North Carolina Licensed Geologist. A copy of the EMR Form has been included in **Appendix IV**. Details of the minimum each monitoring report should include are listed in the November 5, 2015 NCDENR Memorandum and summarized below:

- Copies of laboratory reports;
- Copies of sampling logs;
- Table of monitoring well detections and exceedances;
- Table of field parameters;
- Electronic Data Deliverable (EDD) spreadsheet;
- Monitoring well construction table;
- Groundwater level table with flow rates;
- Monitoring well location figure; and
- Groundwater flow map.

7 References

The references cited below were used in the preparation of this WQMP, and may or may not be referenced in above text.

- Amec Foster Wheeler, July 2015. *Hydrogeology Study, Duke Energy Dan River Steam Station*, Project Number 7810.14.0065.

- Duke Energy, June 2015. *Low Flow Sampling Plan - Duke Energy Facilities – Ash Basin Groundwater Assessment Program, North Carolina*.

- North Carolina Department of Environment and Natural Resources, Division of Waste Management, Solid Waste Section, 2014. *Groundwater, Surface Water, Soil, Sediment, and Landfill Gas Electronic Document Submittal*, memorandum dated November 5, 2014.

- United States Environmental Protection Agency, June 1997. *SW-846 Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Final Update III.

- United States Environmental Protection Agency, 1996. *Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells*, Revision 2.

TABLES

TABLE 1 - WELL CONSTRUCTION SUMMARY
WATER QUALITY MONITORING PLAN
DAN RIVER LANDFILL
Amec Foster Wheeler Project No. 7810.14.0065

WELL ID	Well Origin	Date Installed	Survey				Outer Casing			Sch. 40 PVC Inner Casing		Screen			Static Water Level* (ft-bgs)	Total Well Depth (ft-bgs)	Predominate Hydrostratigraphic Unit of Saturated Screened Interval
			Northing	Easting	Ground Surface Elev. (ft-MSL)	TOC Elev. (ft-MSL)	Material	Dia. (in)	Interval (ft-bgs)	Dia. (in)	Interval (ft-bgs)	Material	Dia. (in)	Interval (ft-bgs)			
BW-1S	converted from OW-417S	4/1/2015	1000389.941	1788347.324	594.15	597.68	N/A	N/A	N/A	2	+3.52 to 18.7	Sch. 40 machine-slot PVC	2	18.7 to 33.7	21.45	34.0	Saprolite
BW-1D	converted from OW-417D	4/14/2015	1000386.138	1788350.651	594.18	597.58	Sch. 40 PVC	6	0 to 33	2	+3.41 to 42.4	Sch. 40 machine-slot PVC	2	42.4 to 47.4	17.87	47.7	Bedrock
BW-2S	new well	TBD	TBD	TBD	TBD	TBD	N/A	N/A	N/A	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	TBD
BW-2D	new well	TBD	TBD	TBD	TBD	TBD	Sch. 40 PVC	6	TBD	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	Bedrock
CW-1S	new well	TBD	TBD	TBD	TBD	TBD	N/A	N/A	N/A	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	TBD
CW-1D	new well	TBD	TBD	TBD	TBD	TBD	Sch. 40 PVC	6	TBD	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	Bedrock
CW-2S	new well	TBD	TBD	TBD	TBD	TBD	N/A	N/A	N/A	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	TBD
CW-2D	new well	TBD	TBD	TBD	TBD	TBD	Sch. 40 PVC	6	TBD	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	Bedrock
CW-3S	new well	TBD	TBD	TBD	TBD	TBD	N/A	N/A	N/A	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	TBD
CW-3D	new well	TBD	TBD	TBD	TBD	TBD	Sch. 40 PVC	6	TBD	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	Bedrock
CW-4S	new well	TBD	TBD	TBD	TBD	TBD	N/A	N/A	N/A	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	TBD
CW-4D	new well	TBD	TBD	TBD	TBD	TBD	Sch. 40 PVC	6	TBD	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	Bedrock
CW-5S	new well	TBD	TBD	TBD	TBD	TBD	N/A	N/A	N/A	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	TBD
CW-5D	new well	TBD	TBD	TBD	TBD	TBD	Sch. 40 PVC	6	TBD	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	Bedrock
CW-6S	new well	TBD	TBD	TBD	TBD	TBD	N/A	N/A	N/A	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	TBD
CW-6D	new well	TBD	TBD	TBD	TBD	TBD	Sch. 40 PVC	6	TBD	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	Bedrock
CW-7S	new well	TBD	TBD	TBD	TBD	TBD	N/A	N/A	N/A	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	TBD
CW-7D	new well	TBD	TBD	TBD	TBD	TBD	Sch. 40 PVC	6	TBD	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	Bedrock
CW-8S	new well	TBD	TBD	TBD	TBD	TBD	N/A	N/A	N/A	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	TBD
CW-8D	new well	TBD	TBD	TBD	TBD	TBD	Sch. 40 PVC	6	TBD	2	TBD	Sch. 40 machine-slot PVC; prepacked 20/40 sand & wire mesh	2	TBD	TBD	TBD	Bedrock

Notes:

BW = background well for water quality monitoring plan
CW = compliance well for water quality monitoring plan
OW = observation well from site hydrogeologic study
TBD = to be determined
Dia. = diameter
in = inches

ft-MSL = feet relative to Mean Sea Level
ft-bgs = feet below ground surface
"+" = denotes above ground surface
Sch. = Schedule
PVC = polyvinylchloride
N/A = not applicable

* Water levels measured on June 29, 2015 unless otherwise noted.
Saprolite = unconsolidated product of weathered bedrock that usually retains some physical characteristics of the parent bedrock.
PWR = partially weathered rock (Saprolite and weathered rock with Standard Penetration Resistance of N>100 and/or rock core recovery <50%.
Bedrock = rock below auger drill refusal depth; i.e. material that could not be penetrated with hollow-stem augers

TABLE 2 - CONSTITUENTS, ANALYTICAL METHODS, & REGULATORY STANDARDS SUMMARY
WATER QUALITY MONITORING PLAN
DAN RIVER LANDFILL
Amec Foster Wheeler Project No. 7810.14.0065

CONSTITUENT	ANALYTICAL METHODS	NCDENER-SWS GWP STANDARDS (µg/L)	15A NCAC 2L STANDARDS FOR GROUNDWATER (µg/L)	15A NCAC 2B STANDARDS FOR SURFACE WATER (µg/L)
Arsenic, Total	EPA 200.8 OR 6020	NE	10	50
Barium, Total	EPA 6010	NE	700	NE
Boron	EPA 6010	NE	700	NE
Cadmium, Total	EPA 200.8 OR 6020	NE	2	2
Chloride	EPA 300.0	NE	250 mg/L	230 mg/L
Chromium, Total	EPA 6010	NE	10	50
Copper, Total	EPA 6010	NE	1 mg/L	7
Fluoride	EPA 300.0	NE	2 mg/L	1.8
Iron, Total	EPA 6010	NE	300	1 mg/L
Lead, Total	EPA 200.8 OR 6020	NE	15	25
Manganese, Total	EPA 6010	NE	50	NE
Mercury, Total	EPA 7470	NE	1	0.012
Nickel, Total	EPA 6010	NE	100	88
Nitrate as Nitrogen	EPA 300.0	NE	10,000	NE
pH	Field	NE	6.5*-8.5*	6.0-9.0
Selenium, Total	EPA 200.8 OR 6020	NE	20	5
Silver, Total	EPA 6010	NE	20	0.06
Sulfate	EPA 300.0	NE	250 mg/L	NE
Total Dissolved Solids (TDS)	SM2540C	NE	500 mg/L	NE
Zinc, Total	EPA 6010	NE	1000	50

Notes:

Total = total recoverable metals

NCDENR-SWS GWP= North Carolina Department of Environment and Natural Resources - Solid Waste Section, Groundwater Protection Standards (effective June 13, 2011)

15A NCAC 2L = North Carolina Groundwater Quality Standards (effective April 1, 2013)

15A NCAC 2B = North Carolina and Environmental Protection Agency (EPA) Surface Water Quality Standards listed under Freshwater Aquatic Life (applicable to Class C streams as those found on-site); (effective May 15, 2013)

µg/L = micrograms per liter

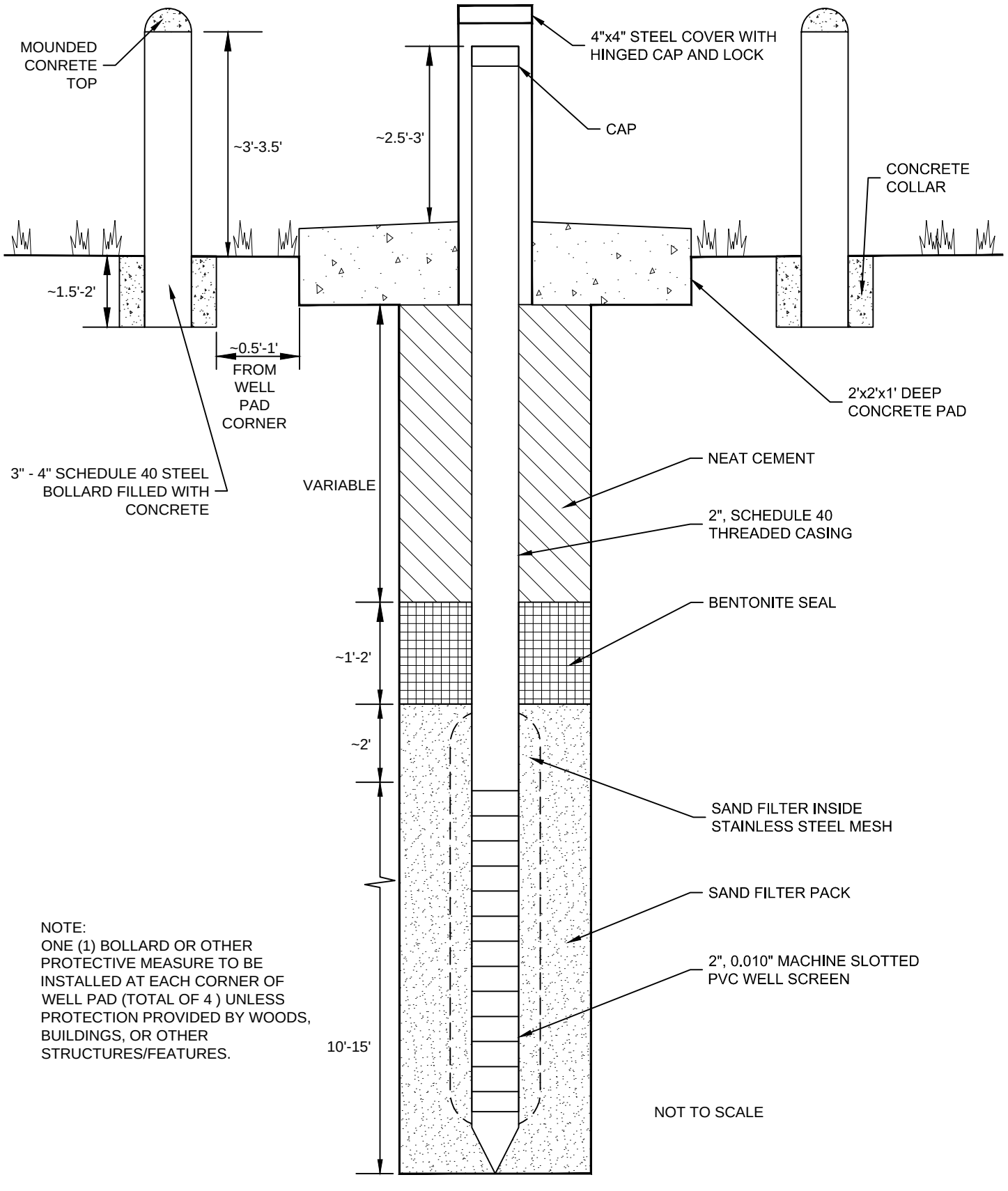
mg/L = milligrams per liter

Values listed under 2L and 2B Standards are in µg/L unless otherwise noted.

NE = not established

* While there is not an established pH range listed under the 15A NCAC 2L Standards, the range listed in table is representative of most natural groundwater in the Piedmont Province of North Carolina

FIGURES

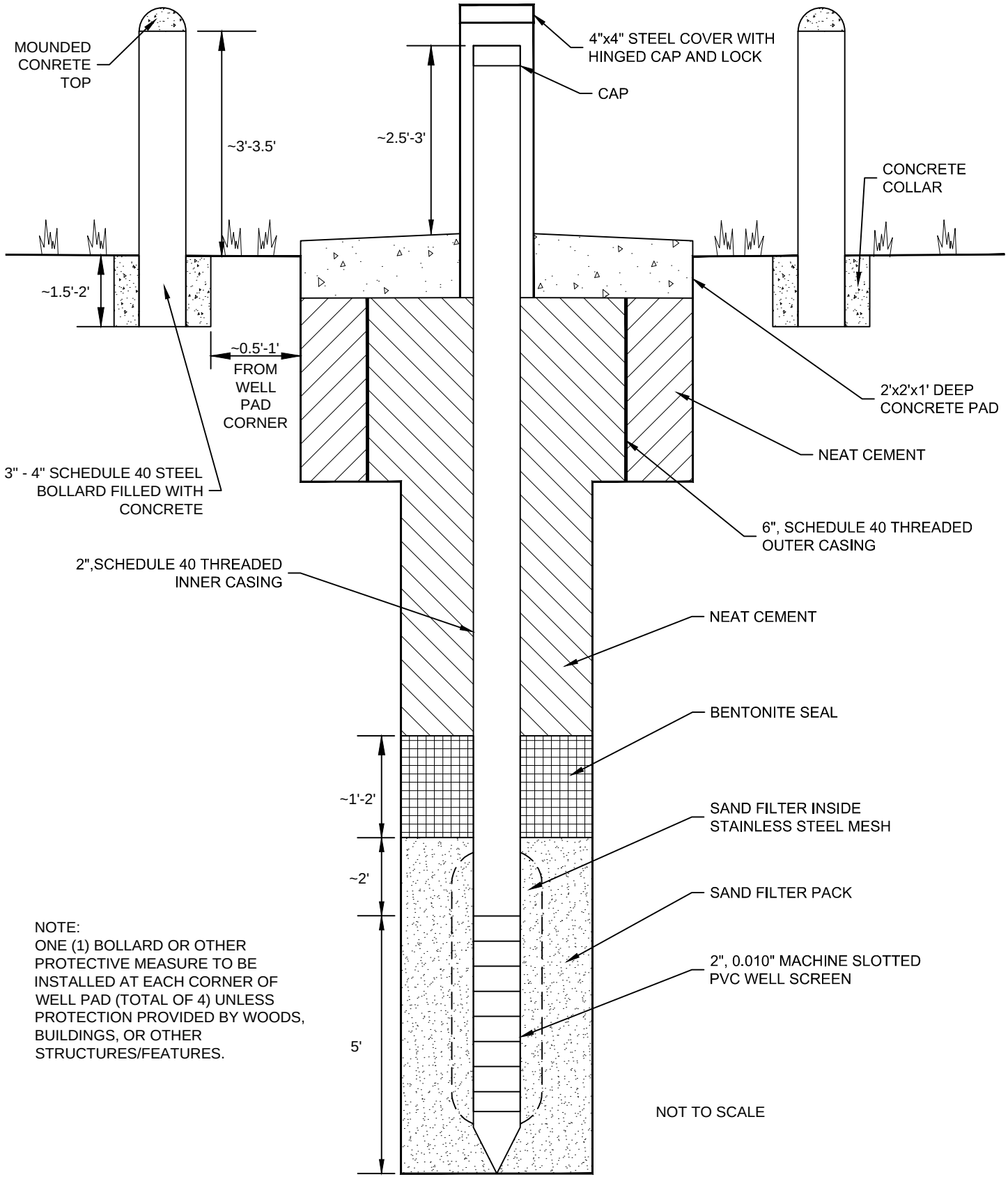


amec foster wheeler

TYPICAL TYPE II MONITORING WELL w/PREPACKED SCREEN AND PROTECTION

PREPARED BY:	DATE:	CHECKED BY:	DATE:	JOB NUMBER:	FIGURE:
LDD	08/17/2015	CWM	07/27/2015	7810-14-0065.05.504	1

\\Clt1-fs1\cad\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\WQMP\xMonitoring Well Details.dwg – Figure 1 – Aug. 25, 2015 12:31pm – cedric.ruhl



NOTE:
ONE (1) BOLLARD OR OTHER PROTECTIVE MEASURE TO BE INSTALLED AT EACH CORNER OF WELL PAD (TOTAL OF 4) UNLESS PROTECTION PROVIDED BY WOODS, BUILDINGS, OR OTHER STRUCTURES/FEATURES.

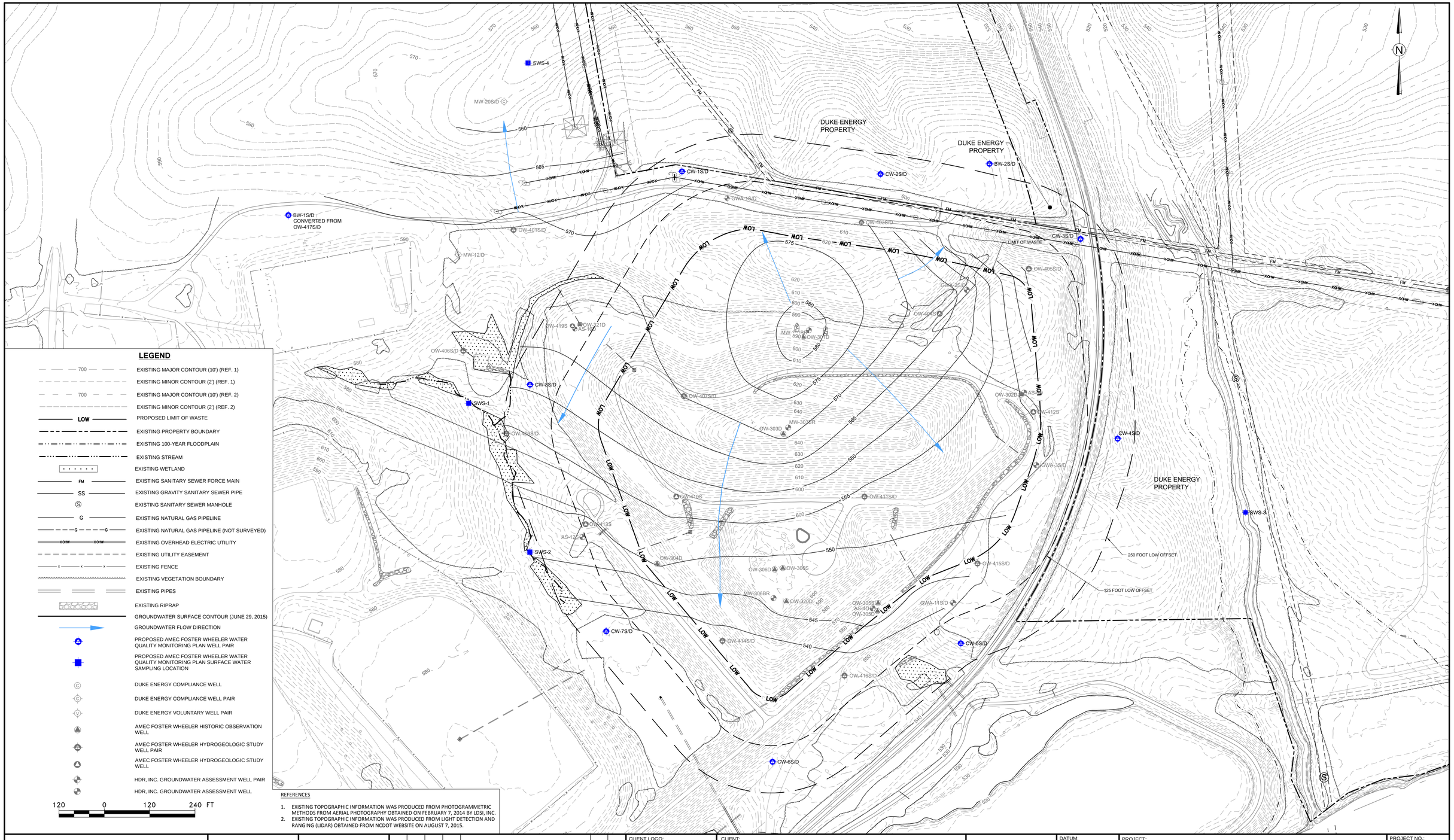
amec foster wheeler

TYPICAL TYPE III MONITORING WELL w/ PREPACKED SCREEN AND PROTECTION

PREPARED BY:	DATE:	CHECKED BY:	DATE:	JOB NUMBER:	FIGURE:
LDD	08/17/2015	CWM	07/27/2015	7810-14-0065.05.504	2

\\Clt1-fs1\cad\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\WQMP\xMonitoring Well Details.dwg – Figure 2 – Aug. 25, 2015 12:32pm – cedric.ruhl

DRAWINGS



LEGEND

- EXISTING MAJOR CONTOUR (10') (REF. 1)
- EXISTING MINOR CONTOUR (2') (REF. 1)
- EXISTING MAJOR CONTOUR (10') (REF. 2)
- EXISTING MINOR CONTOUR (2') (REF. 2)
- PROPOSED LIMIT OF WASTE
- EXISTING PROPERTY BOUNDARY
- EXISTING 100-YEAR FLOODPLAIN
- EXISTING STREAM
- EXISTING WETLAND
- EXISTING SANITARY SEWER FORCE MAIN
- EXISTING GRAVITY SANITARY SEWER PIPE
- EXISTING SANITARY SEWER MANHOLE
- EXISTING NATURAL GAS PIPELINE
- EXISTING NATURAL GAS PIPELINE (NOT SURVEYED)
- EXISTING OVERHEAD ELECTRIC UTILITY
- EXISTING UTILITY EASEMENT
- EXISTING FENCE
- EXISTING VEGETATION BOUNDARY
- EXISTING PIPES
- EXISTING RIPRAP
- GROUNDWATER SURFACE CONTOUR (JUNE 29, 2015)
- GROUNDWATER FLOW DIRECTION
- PROPOSED AMEC FOSTER WHEELER WATER QUALITY MONITORING PLAN WELL PAIR
- PROPOSED AMEC FOSTER WHEELER WATER QUALITY MONITORING PLAN SURFACE WATER SAMPLING LOCATION
- DUKE ENERGY COMPLIANCE WELL
- DUKE ENERGY COMPLIANCE WELL PAIR
- DUKE ENERGY VOLUNTARY WELL PAIR
- AMEC FOSTER WHEELER HISTORIC OBSERVATION WELL
- AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY WELL PAIR
- AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY WELL
- HDR, INC. GROUNDWATER ASSESSMENT WELL PAIR
- HDR, INC. GROUNDWATER ASSESSMENT WELL

120 0 120 240 FT

REFERENCES

1. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON FEBRUARY 7, 2014 BY LDSI, INC.
2. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM LIGHT DETECTION AND RANGING (LIDAR) OBTAINED FROM NCDOT WEBSITE ON AUGUST 7, 2015.

PRELIMINARY
NOT FOR CONSTRUCTION

NORTH CAROLINA LICENSED GEOLOGIST SEAL 0203 CHRISTOPHER WITHERS MURPHY 08/26/15

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	ENG.	APPR.
0	26	08	2015	SUBMITTED FOR PERMIT REVIEW	CHR	CWM

CLIENT LOGO: DUKE ENERGY.

CLIENT: DUKE ENERGY CAROLINAS, LLC
EDEN, NORTH CAROLINA

Amec Foster Wheeler Environment & Infrastructure, Inc.
2801 YORKMONT ROAD, SUITE 100
CHARLOTTE, NC 28208
TEL: (704) 357-8600 FAX: (704) 357-8638
LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

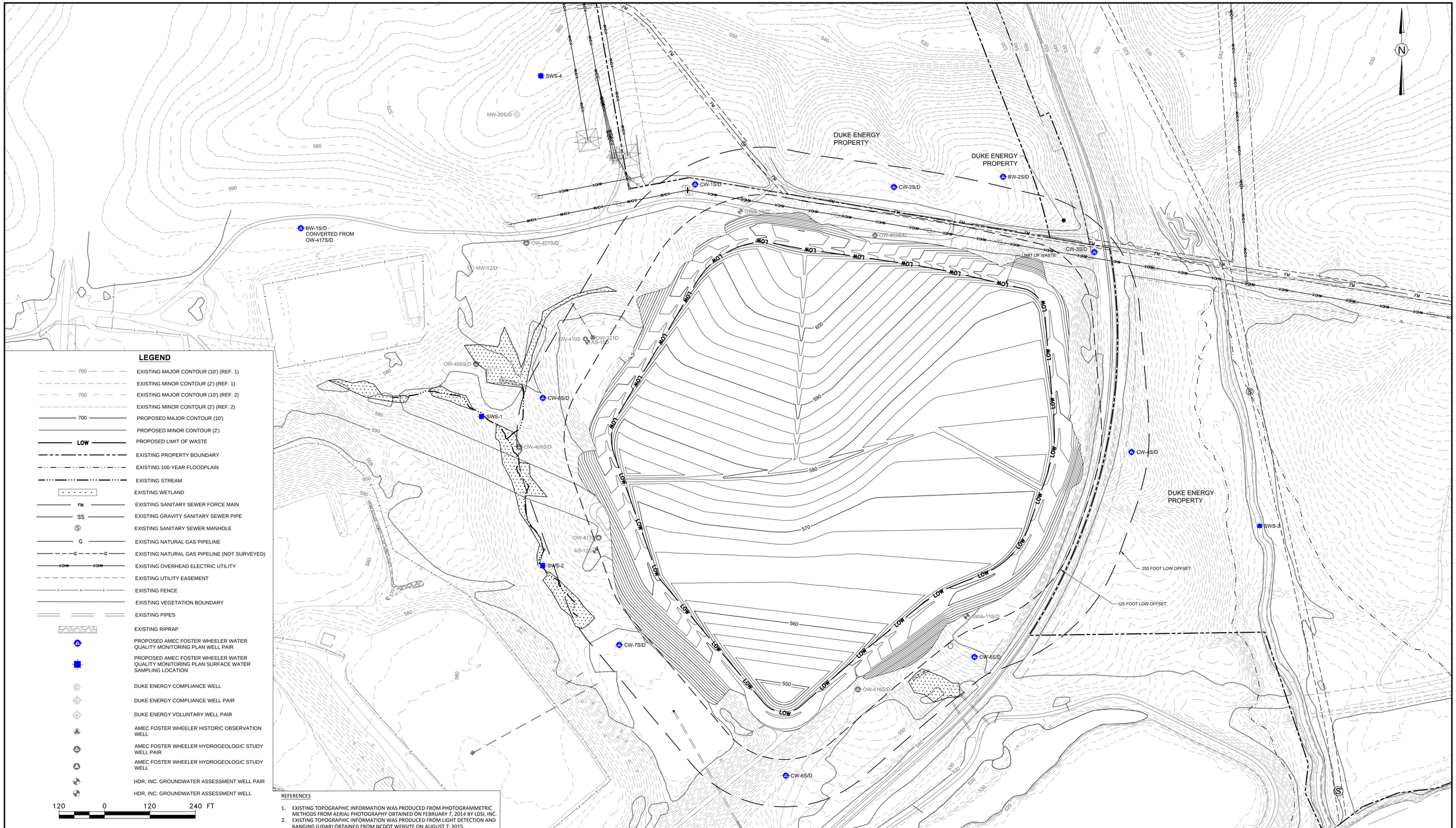
DATUM:	---
PROJECTION:	---
DRAWN BY:	CSJ
REVIEWED BY:	CWM
SCALE:	AS SHOWN

PROJECT: DAN RIVER LANDFILL
WATER QUALITY MONITORING PLAN

TITLE: PROPOSED MONITORING LOCATIONS
GROUNDWATER CONTOURS

PROJECT NO.: 7810-14-0065
REVISION NO.: 0
DATE: 8/26/2015
DRAWING NO.: 1

Plotted By:Jordon, Chris Sheet Set:WQMP Layout:1 PROPOSED MONITORING LOCATIONS GROUNDWATER CONTOURS August 25, 2015 01:43:26pm Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\WQMP\1 PROPOSED MONITORING WELLS EXISTING GRADES.dwg



LEGEND

- EXISTING MAJOR CONTOUR (10') (REF. 1)
- EXISTING MINOR CONTOUR (2') (REF. 1)
- EXISTING MAJOR CONTOUR (10') (REF. 2)
- EXISTING MINOR CONTOUR (2') (REF. 2)
- PROPOSED MAJOR CONTOUR (10')
- PROPOSED MINOR CONTOUR (2')
- PROPOSED LIMIT OF WASTE
- EXISTING PROPERTY BOUNDARY
- EXISTING 100-YEAR FLOODPLAIN
- EXISTING STREAM
- EXISTING WETLAND
- EXISTING SANITARY SEWER FORCE MAIN
- EXISTING GRAVITY SANITARY SEWER PIPE
- EXISTING SANITARY SEWER MANHOLE
- EXISTING NATURAL GAS PIPELINE
- EXISTING NATURAL GAS PIPELINE (NOT SURVEYED)
- EXISTING OVERHEAD ELECTRIC UTILITY
- EXISTING UTILITY EASEMENT
- EXISTING FENCE
- EXISTING VEGETATION BOUNDARY
- EXISTING PIPES
- EXISTING RIPRAP
- PROPOSED AMEC FOSTER WHEELER WATER QUALITY MONITORING PLAN WELL PAIR
- PROPOSED AMEC FOSTER WHEELER WATER QUALITY MONITORING PLAN SURFACE WATER SAMPLING LOCATION
- DUKE ENERGY COMPLIANCE WELL
- DUKE ENERGY COMPLIANCE WELL PAIR
- DUKE ENERGY VOLUNTARY WELL PAIR
- AMEC FOSTER WHEELER HISTORIC OBSERVATION WELL
- AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY WELL PAIR
- AMEC FOSTER WHEELER HYDROGEOLOGIC STUDY WELL
- HDR, INC. GROUNDWATER ASSESSMENT WELL PAIR
- HDR, INC. GROUNDWATER ASSESSMENT WELL

120 0 120 240 FT

REFERENCES

1. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON FEBRUARY 7, 2014 BY LDSI, INC.
2. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM LIGHT DETECTION AND RANGING (LIDAR) OBTAINED FROM NCDOT WEBSITE ON AUGUST 7, 2015.

PRELIMINARY
NOT FOR CONSTRUCTION

NORTH CAROLINA LICENSED GEOLOGIST SEAL 2203 CHARLEY WITHERS MURPHY

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	ENG.	APPR.
0	26	08	2015	SUBMITTED FOR PERMIT REVIEW	CHR	CWM

CLIENT LOGO: DUKE ENERGY.

CLIENT: DUKE ENERGY CAROLINAS, LLC
EDEN, NORTH CAROLINA

Amec Foster Wheeler Environment & Infrastructure, Inc.
2801 YORKMONT ROAD, SUITE 100
CHARLOTTE, NC 28208
TEL: (704) 357-8600 FAX: (704) 357-8638
LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247

amec foster wheeler

DATUM: ---
PROJECTION: ---
DRAWN BY: CSJ
REVIEWED BY: CWM
SCALE: AS SHOWN

PROJECT: DAN RIVER LANDFILL
WATER QUALITY MONITORING PLAN

TITLE: PROPOSED MONITORING LOCATIONS
TOP OF PROTECTIVE COVER

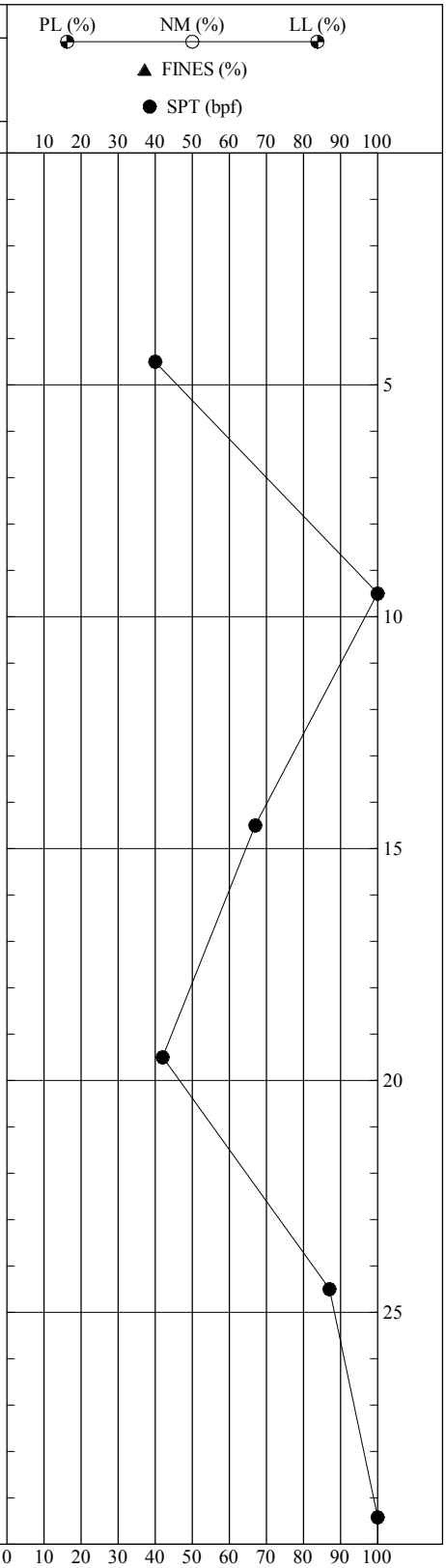
PROJECT NO.: 7810-14-0065
REVISION NO. 0
DATE: 8/26/2015
DRAWING NO. 2

Plotted By:Jordan, Chris Sheet Set:WQMP Layout:2 PROPOSED MONITORING LOCATIONS TOP OF PROTECTIVE COVER August 26, 2015 10:40:30am Q:\Duke\DanRiver\7810140065_ABSAT Dan River Off Site LF\Plansheets\WQMP\2 PROPOSED MONITORING LOCATIONS TOP OF PROTECTIVE COVER.dwg

APPENDIX I

Boring and Well Logs

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	(Rec") N-COUNT or Rec%/RQD% 6"- 6"- 6"- 6"
0	SAPROLITE: Yellow (10YR 7/8), Hard, Elastic SILT with Sand (MH) with Rock Fragments, Low Plasticity, Dry		594.2			
				SS-1		(18) 8-11-29
5			589.2			
	PARTIALLY WEATHERED ROCK: Brown-Yellow (10YR 6/6), Very Dense, Silty Fine to Medium SAND (SM), Non-Plastic, Dry			SS-2		(13.2) 15-42-50/5
10			584.2			
	SAPROLITE: Brown-Yellow (10YR 6/6), Very Hard, Sandy Lean CLAY (CL) with Rock Fragments, Low Plasticity, Dry to Moist			SS-3		(14.4) 12-32-35
15			579.2			
	SAPROLITE: Dark Gray-Brown (10YR 4/2), Dense, Silty Fine SAND (SM), Non-Plastic, Moist			SS-4		(18) 10-16-26
20			574.2			
	SAPROLITE: Yellow-Tan (10YR 6/6), Very Dense, Clayey SAND (SC), Low Plasticity, Moist			SS-5		(13.2) 7-37-50
25			569.2			
	PARTIALLY WEATHERED ROCK: When Sampled Becomes Gray (7.5YR 6/1), Very Dense, Silty Fine SAND (SM) with Rock Fragments, Non-Plastic, Dry to Moist			SS-6		(9.6) 25-50/5
30			564.2			



DUKE ABSAT GEOTECHNICAL BORING LOG DR ONSITE LANDFILL BORING LOGS 7810140065.GPJ AMEC DUKE ABSAT.GDT 7/6/15

CONTRACTOR:	SAEDACCO
LOGGED BY:	L. Eaves
EQUIPMENT:	CME-550
DRILL METHOD:	4.25 HSA
HOLE DIAMETER:	7"
CLOSURE METHOD:	Type II Observation Well Installed
REMARKS:	Located northwest of Ash Fill 1; Water level = 21.78 feet bgs on May 27, 2015

REVIEWED BY: _____

GEOTECHNICAL BORING RECORD

PROJECT NAME: Dan River On-Site Landfill
PROJECT NO.: 7810-14-0065 **START DATE:** 4/1/2015
COORD N: 1000390 **COMP. DATE:** 4/1/2015
COORD E: 1788347 **Page** 1 **of** 2
LOCATION: Eden, North Carolina

BORING NO.: OW-417S

amec foster wheeler

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	(Rec") N-COUNT or Rec%/RQD% 6"- 6"- 6"- 6"	PL (%) NM (%) LL (%) ▲ FINES (%) ● SPT (bpf) 10 20 30 40 50 60 70 80 90 100
30	PARTIALLY WEATHERED ROCK: When Sampled Becomes Gray (7.5YR 6/1), Very Dense, Silty Fine SAND (SM) with Rock Fragments, Non-Plastic, Dry to Moist		564.2	SS-7	⊠	(5) 50/5	●
	Auger Refusal at 34 ft bgs						
35			559.2				
40			554.2				
45			549.2				
50			544.2				
55			539.2				
60			534.2				

0 10 20 30 40 50 60 70 80 90 100

DUKE ABSAT GEOTECHNICAL BORING LOG DR ONSITE LANDFILL BORING LOGS 7810140065.GPJ AMEC DUKE ABSAT.GDT 7/6/15

CONTRACTOR:	SAEDACCO
LOGGED BY:	L. Eaves
EQUIPMENT:	CME-550
DRILL METHOD:	4.25 HSA
HOLE DIAMETER:	7"
CLOSURE METHOD:	Type II Observation Well Installed
REMARKS:	Located northwest of Ash Fill 1; Water level = 21.78 feet bgs on May 27, 2015

REVIEWED BY: _____

GEOTECHNICAL BORING RECORD

PROJECT NAME: Dan River On-Site Landfill
PROJECT NO.: 7810-14-0065 **START DATE:** 4/1/2015
COORD N: 1000390 **COMP. DATE:** 4/1/2015
COORD E: 1788347 **Page** 2 **of** 2
LOCATION: Eden, North Carolina

BORING NO.: OW-417S

amec foster wheeler

WELL CONSTRUCTION REPORT

WELL ID: **OW-417 S**

PROJECT:	Dan River Landfill
PROJECT NO:	7810-14-0065
PROJECT LOCATION:	Dan River Steam Station; Eden, North Carolina

DRILLING CONTRACTOR:	**SAEDACCO**	WATER LEVEL:	**21.78 ft BGS on 5/27/2015**
DRILLING METHOD:	**4.25" HSA**	LATITUDE:	**36.4964**
DATE COMPLETED:	**4/1/2015**	LONGITUDE:	**-79.7200**
LOGGED BY:	**L. Eaves**	GS ELEVATION:	**594.15 feet**
Cave-In Below Well:	**None**	TOC ELEVATION:	**597.68 feet**
(not depicted)		DATUM:	**Mean Sea Level (MSL)**

Depth (ft-bgs)	WELL DIAGRAM	Elev (ft-MSL)	WELL CONSTRUCTION DETAILS
+3.52		597.68 TOC	PROTECTIVE CASING:
0		594.15 GS	Diameter: 4-inch x 4-inch square Type: Steel Stickup Interval: +4 to 2 feet bgs
			OUTER CASING: Diameter: Not Applicable Type: Not Applicable Interval: Not Applicable
			INNER CASING: Diameter: 2-inch Type: Sch. 40 PVC Interval: +3.52 to 18.7 feet bgs
15.0		579.15	
			SCREEN: Diameter: 2-inch Type: Sch. 40 PVC Interval: 18.7 to 33.7 feet bgs
17.0		577.15	
18.7		575.45	
			FILTER PACK: Type: #2 Silica Sand Interval: 17 to 34 feet bgs
			SEAL: Type: Bentonite Interval: 15 to 17 feet bgs
			GROUT: Type: Neat Cement Interval: 0 to 15 feet bgs
33.7		560.45	
34.0	End Cap	560.15	

NOTES: GS=ground surface; TOC=top of inner PVC casing; bgs=below ground surface

Not to Scale

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES (Rec") N-COUNT or Rec%/RQD% 6"- 6"- 6"- 6"	PL (%) NM (%) LL (%) ▲ FINES (%) ● SPT (bpf) 10 20 30 40 50 60 70 80 90 100
0	SAPROLITE: Yellow (10YR 7/8), Hard, Elastic SILT with Sand (MH) with Rock Fragments, Low Plasticity, Dry		594.2	UD-1		(20.4)	
5			589.2				
	PARTIALLY WEATHERED ROCK: Brown-Yellow (10YR 6/6), Very Dense, Silty Fine to Medium SAND (SM), Non-Plastic, Dry						
10			584.2				
	SAPROLITE: Brown-Yellow (10YR 6/6), Very Hard, Sandy Lean CLAY (CL) with Rock Fragments, Low Plasticity, Dry to Moist						
15			579.2				
	SAPROLITE: Dark Gray-Brown (10YR 4/2), Dense, Silty Fine SAND (SM), Non-Plastic, Moist						
20			574.2				
	SAPROLITE: Yellow-Tan (10YR 6/6), Very Dense, Clayey SAND (SC), Low Plasticity, Moist						
25			569.2				
	PARTIALLY WEATHERED ROCK: When Sampled Becomes Gray (7.5YR 6/1), Very Dense, Silty Fine SAND (SM) with Rock Fragments, Non-Plastic, Dry to Moist						
30			564.2				

DUKE ABSAT GEOTECHNICAL BORING LOG DR ONSITE LANDFILL BORING LOGS 7810140065.GPJ AMEC DUKE ABSAT.GDT 7/6/15

CONTRACTOR:	SAEDACCO
LOGGED BY:	M. Flanik
EQUIPMENT:	CME-550
DRILL METHOD:	4.25 / 8.25 HSA; 5 7/8 RC; NQ2 CORE
HOLE DIAMETER:	12" to 6" to 3"
CLOSURE METHOD:	Type III Observation Well Installed
REMARKS:	Located northwest of Ash Fill 1; Water level = 18.05 feet bgs on May 27, 2015

REVIEWED BY: _____

GEOTECHNICAL BORING RECORD

PROJECT NAME: Dan River On-Site Landfill
PROJECT NO.: 7810-14-0065 **START DATE:** 4/2/2015
COORD N: 1000386 **COMP. DATE:** 4/2/2015
COORD E: 1788351 **Page** 1 **of** 2
LOCATION: Eden, North Carolina

BORING NO.: OW-417D

amec foster wheeler

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	(Rec") N-COUNT or Rec%/RQD% 6"- 6"- 6"- 6"	PL (%) NM (%) LL (%) ▲ FINES (%) ● SPT (bpf) 10 20 30 40 50 60 70 80 90 100
30	PARTIALLY WEATHERED ROCK: When Sampled Becomes Gray (7.5YR 6/1), Very Dense, Silty Fine SAND (SM) with Rock Fragments, Non-Plastic, Dry to Moist **Auger Refusal at 33 ft bgs; Begin 5 7/8" Roller Cone**		564.2				
	WEATHERED / FRACTURED ROCK: (No Samples Obtained); **Roller Cone Refusal at 33.5 ft bgs; Begin NQ2 Core**						
35	WEATHERED / FRACTURED ROCK: Fine-Grained GRAYWACKE, Intensely Fractured, Horizontal, Low, and High Angle Fractures, Moderate to Slight Staining		559.2	CORE-1		74/0	
	WEATHERED / FRACTURED ROCK: Fine-Grained GRAYWACKE, Moderately Fractured, Horizontal, Low, and High Angle Fractures, No Staining						
40			554.2	CORE-2		100/24	
45			549.2	CORE-3		100/48	
	Boring Terminated at 48.5 ft bgs **Soil Lithologic Descriptions Obtained From OW-417S Boring**						
50			544.2				
55			539.2				
60			534.2				

0 10 20 30 40 50 60 70 80 90 100

DUKE ABSAT GEOTECHNICAL BORING LOG DR ONSITE LANDFILL BORING LOGS 7810140065.GPJ AMEC DUKE ABSAT.GDT 7/6/15

CONTRACTOR:	SAEDACCO
LOGGED BY:	M. Flanik
EQUIPMENT:	CME-550
DRILL METHOD:	4.25 / 8.25 HSA; 5 7/8 RC; NQ2 CORE
HOLE DIAMETER:	12" to 6" to 3"
CLOSURE METHOD:	Type III Observation Well Installed
REMARKS:	Located northwest of Ash Fill 1; Water level = 18.05 feet bgs on May 27, 2015

REVIEWED BY: _____

GEOTECHNICAL BORING RECORD

PROJECT NAME: Dan River On-Site Landfill
PROJECT NO.: 7810-14-0065 **START DATE:** 4/2/2015
COORD N: 1000386 **COMP. DATE:** 4/2/2015
COORD E: 1788351 **Page 2 of 2**
LOCATION: Eden, North Carolina

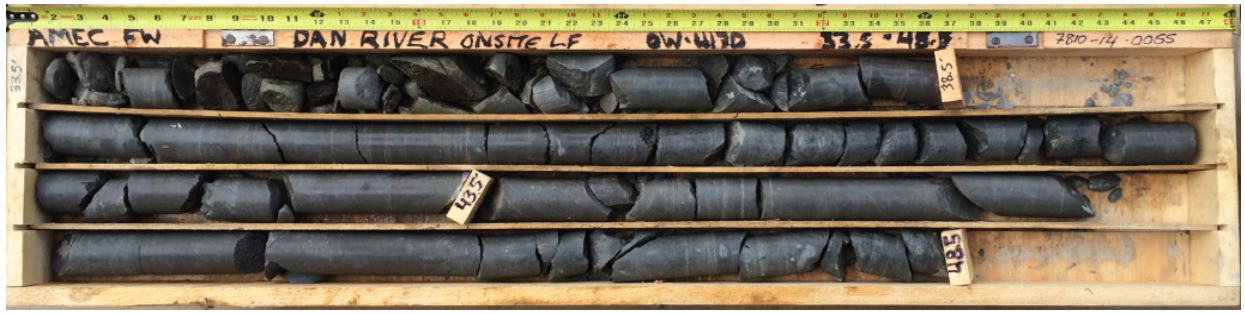
BORING NO.: OW-417D

amec foster wheeler

PROJECT:	DAN RIVER LANDFILL DAN RIVER STEAM STATION, Eden, NC Amec Foster Wheeler Project No. 7810-14-0065	ROCK CORE PHOTO LOG:	OW-417D

CLIENT:	**Duke Energy**	AUGER REFUSAL DEPTH:	**33.0**	**ft bgs**		LATITUDE:	**36.4964**
DATE DRILLED:	**4/14-15/2015**	ROLLER CONE REFUSAL DEPTH:	**33.5**	**ft bgs**		LONGITUDE:	**-79.7200**
DRILL RIG:	**Diedrich D-50 Turbo**	CORING TERMINATION DEPTH:	**48.5**	**ft bgs**		GROUND ELEVATION:	**594.18**
DRILLER:	**Richy Lemire**	WATER LEVEL:	**19.30 ft bgs on 4/30/15**			NOTES: Type III Monitoring Well Installed to 47.7 ft bgs with 5-ft screen 42.4-47.4 ft bgs.	
LOGGED BY:	**Rodney Clark**						
CORE SIZE:	**NQ2**						

CORE BOX #: 1 of 1
TOP OF BOX: 33.5 ft bgs
BOTTOM OF BOX: 48.5 ft bgs



DESCRIPTION:

33.5 to 38.5 ft bgs: **WEATHERED / FRACTURED ROCK**: Fine-Grained **GRAYWACKE**, Intensely Fractured, Horizontal, Low, and High Angle Fractures, Moderate to Slight Staining

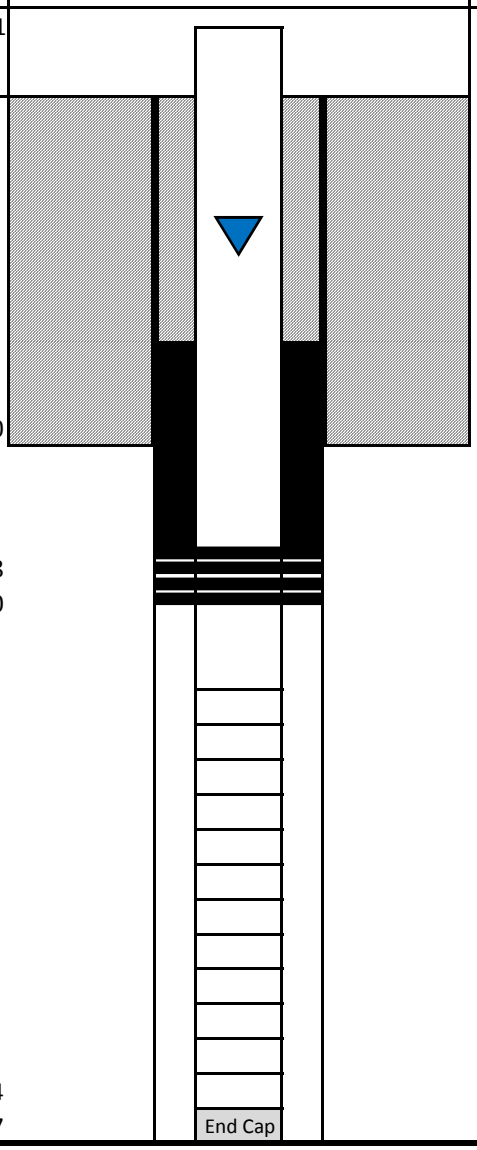
38.5 to 48.5 ft bgs: **WEATHERED / FRACTURED ROCK**: Fine-Grained **GRAYWACKE**, Moderately Fractured, Horizontal, Low, and High Angle Fractures, No Staining

WELL CONSTRUCTION REPORT

WELL ID: **OW-417 D**

PROJECT:	Dan River Landfill
PROJECT NO:	7810-14-0065
PROJECT LOCATION:	Dan River Steam Station; Eden, North Carolina

DRILLING CONTRACTOR:	**SAEDACCO**	WATER LEVEL:	**18.05 ft BGS on 5/27/2015**
DRILLING METHOD:	**8.25"HSA/NQ2 core**	LATITUDE:	**36.4964**
DATE COMPLETED:	**4/14/2015**	LONGITUDE:	**-79.7200**
LOGGED BY:	**Flanik/Clark**	GS ELEVATION:	**594.18 feet**
Cave-In Below Well:	**47.7-48.5 ft bgs**	TOC ELEVATION:	**597.58 feet**
(not depicted)		DATUM:	**Mean Sea Level (MSL)**

Depth (ft-bgs)	WELL DIAGRAM	Elev (ft-MSL)	WELL CONSTRUCTION DETAILS
+3.41		597.58 TOC	PROTECTIVE CASING: Diameter: 4-inch x 4-inch square; Type: Steel Stickup; Interval: +4 to 2 feet bgs
0		594.18 GS	OUTER CASING: Diameter: 6-inch; Type: Sch. 40 PVC; Interval: 0 to 33 feet bgs
31.5		562.68	INNER CASING: Diameter: 2-inch; Type: Sch. 40 PVC; Interval: +3.41 to 42.4 feet bgs
33.0		561.18	
41.8		552.38	SCREEN: Diameter: 2-inch; Type: Sch. 40 PVC; Interval: 42.4 to 47.4 feet bgs
42.0		552.18	
42.4		551.78	FILTER PACK: Type: Not Applicable; Interval: Not Applicable
			SEAL: Type: Bentonite & K-Packer; Interval: 31.5 to 42 feet bgs
			GROUT: Type: Neat Cement; Interval: 0 to 31.5 feet bgs
47.4		546.78	
47.7	End Cap	546.48	

NOTES: GS=ground surface; TOC=top of inner PVC casing; bgs=below ground surface

Not to Scale

APPENDIX II

NCDENR Well Abandonment Record and Well Construction Record Forms

WELL ABANDONMENT RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

_____
Well Contractor Name (or well owner personally abandoning well on his/her property)

_____
NC Well Contractor Certification Number

_____
Company Name

2. Well Construction Permit #: _____
List all applicable well permits (i.e. County, State, Variance, Injection, etc.) if known

3. Well use (check well use):

Water Supply Well:	
☐Agricultural	☐Municipal/Public
☐Geothermal (Heating/Cooling Supply)	☐Residential Water Supply (single)
☐Industrial/Commercial	☐Residential Water Supply (shared)
☐Irrigation	
Non-Water Supply Well:	
☐Monitoring	☐Recovery
Injection Well:	
☐Aquifer Recharge	☐Groundwater Remediation
☐Aquifer Storage and Recovery	☐Salinity Barrier
☐Aquifer Test	☐Stormwater Drainage
☐Experimental Technology	☐Subsidence Control
☐Geothermal (Closed Loop)	☐Tracer
☐Geothermal (Heating/Cooling Return)	☐Other (explain under 7g)

4. Date well(s) abandoned: _____

5a. Well location:

_____ _____
Facility/Owner Name Facility ID# (if applicable)

_____
Physical Address, City, and Zip

_____ _____
County Parcel Identification No. (PIN)

5b. Latitude and longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

_____ **N** _____**W**

CONSTRUCTION DETAILS OF WELL(S) BEING ABANDONED
*Attach well construction record(s) if available. For multiple injection or non-water supply wells **ONLY** with the same construction/abandonment, you can submit one form.*

6a. Well ID#: _____

6b. Total well depth: _____**(ft.)**

6c. Borehole diameter: _____**(in.)**

6d. Water level below ground surface: _____**(ft.)**

6e. Outer casing length (if known): _____**(ft.)**

6f. Inner casing/tubing length (if known): _____**(ft.)**

6g. Screen length (if known): _____**(ft.)**

For Internal Use ONLY:

WELL ABANDONMENT DETAILS

7a. Number of wells being abandoned: _____
*For multiple injection or non-water supply wells **ONLY** with the same construction/abandonment, you can submit one form.*

7b. Approximate volume of water remaining in well(s): _____**(gal.)**

FOR WATER SUPPLY WELLS ONLY:

7c. Type of disinfectant used: _____

7d. Amount of disinfectant used: _____

7e. Sealing materials used (check all that apply):

☐ Neat Cement Grout	☐ Bentonite Chips or Pellets
☐ Sand Cement Grout	☐ Dry Clay
☐ Concrete Grout	☐ Drill Cuttings
☐ Specialty Grout	☐ Gravel
☐ Bentonite Slurry	☐ Other (explain under 7g)

7f. For each material selected above, provide amount of materials used:

_____ _____

_____ _____

7g. Provide a brief description of the abandonment procedure:

_____

_____

_____

_____

8. Certification:

_____ _____
Signature of Certified Well Contractor or Well Owner Date

By signing this form, I hereby certify that the well(s) was (were) abandoned in accordance with 15A NCAC 02C .0100 or 2C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

9. Site diagram or additional well details:
You may use the back of this page to provide additional well site details or well abandonment details. You may also attach additional pages if necessary.

SUBMITTAL INSTRUCTIONS

10a. For All Wells: Submit this form within 30 days of completion of well abandonment to the following:

Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

10b. For Injection Wells: In addition to sending the form to the address in 10a above, also submit one copy of this form within 30 days of completion of well abandonment to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

10c. For Water Supply & Injection Wells: In addition to sending the form to the address(es) above, also submit one copy of this form within 30 days of completion of well abandonment to the county health department of the county where abandoned.

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

Well Contractor Name

NC Well Contractor Certification Number

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☐Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: _____ **Well ID#**_____

5a. Well Location:

Facility/Owner Name Facility ID# (if applicable)

Physical Address, City, and Zip

County Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

_____ **N** _____**W**

6. Is (are) the well(s): ☑**Permanent** **or** ☐**Temporary**

7. Is this a repair to an existing well: ☐**Yes** **or** ☐**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: _____

*For multiple injection or non-water supply wells **ONLY** with the **same construction**, you can submit one form.*

9. Total well depth below land surface: _____**(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: _____ **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: _____ **(in.)**

12. Well construction method: _____

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
ft.	ft.	
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
ft.	ft.	in.			
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
ft.	ft.		
ft.	ft.		
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
ft.	ft.		
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

22. Certification:

Signature of Certified Well Contractor Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:
You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:
Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.

APPENDIX III

NCDENR Memorandum: Groundwater, Surface Water, Soil, Sediment, and Landfill Gas Electronic Document Submittal November 5, 2014

North Carolina Department of Environment and Natural Resources
Division of Waste Management

Pat McCrory
Governor

John E. Skvarla, III
Secretary

November 5, 2014

MEMORANDUM

To: **Solid Waste Directors, Public Works Directors, Landfill Operators, and Landfill Owners**

From: **Solid Waste Section**

Re: **Groundwater, Surface Water, Soil, Sediment, and Landfill Gas Electronic Document Submittal**

The Solid Waste Section is continuing its efforts to improve efficiencies in document management. All groundwater, surface water, soil, sediment, and landfill gas documents submitted to the Solid Waste Section are stored electronically and are made readily available for the public to view on our webpage. Please remember that hard copies/paper copies are not required, and should not be submitted. The submittal of these electronic documents following a consistent electronic document protocol will also assist us in our review. Please follow these procedures when submitting all groundwater, surface water, soil, sediment, and landfill gas documents to the Solid Waste Section.

Submittal Method and Formatting

- All files must be in portable document format (pdf) except for Electronic Data Deliverables (EDDs) unless otherwise specified by the Solid Waste Section. All pdf files should meet these requirements:
    - Optical Characteristic Recognition (OCR) applied;
    - Minimum of 300 dpi;
    - Free of password protections and/or encryptions (applies to EDDs as well);
    - Optimized to reduce file size; and
    - Please begin using the following naming convention when submitting all electronic files: Permit Number (00-00)_Date of Document (YYYYMMDD). For example: 00-00_20140101.
- Please submit all files via email or by file transfer protocol (FTP) via email to the appropriate Hydrogeologist unless otherwise specified by the Solid Waste Section. If the electronic file is greater than 20 MB, please submit the file via FTP or on a CD. If submitting a CD, please mail the CD to the appropriate Hydrogeologist. The CD should be labeled with the facility name, permit number, county, name of document, date of monitoring event (if applicable), and the date of document.
- Please be sure a signed Environmental Monitoring Data Form is submitted as part of the electronic file for all water quality and landfill gas documents (monitoring, alternate source demonstration, assessment, investigation, corrective action). This completed form should be the first page of the document before the cover/title page and should not be submitted as an individual file. Blank forms can be downloaded at http://www.wastenotnc.org/swhome/EnvMonitoring/NCEnvMonRptForm.pdf

Monitoring Data

Monitoring data documents may include any or all of the following: 1) groundwater and surface water monitoring; 2) soil and sediment, and 3) landfill gas monitoring. In addition to the above procedures, at a minimum, please include the following:

Groundwater and Surface Water Monitoring

- A copy of the laboratory report(s).
- A copy of the sampling log(s).
- A separate table of detections and exceedances for each monitoring location.

1646 Mail Service Center, Raleigh, North Carolina 27699-1646
Phone: 919-707-8200

2090 US Highway 70, Swannanoa, North Carolina 28778-82111
Phone: 828-296-4500

http://portal.ncdenr.org/web/wm/
An Equal Opportunity / Affirmative Action Employer

    - All analytical results should be reported in micrograms per liter (ug/L) except for field parameters and specific Monitored Natural Attenuation (MNA) parameters.
    - Please also include the laboratory's method detection limit (MDL) in ug/L, the Solid Waste Section Limit (SWSL) in ug/L, the appropriate NC regulatory standard in ug/L (2L, 2B, GWPS, IMAC), and the Federal Maximum Contaminant Level (MCL) in ug/L.
    - Please **BOLD** each exceedance result.
- A separate table of field parameters for each monitoring location.
- An Electronic Data Deliverable (EDD) spreadsheet for each monitoring event submitted in the correct format. All analytical results should be reported in micrograms per liter (ug/L) except for field parameters and specific Monitored Natural Attenuation (MNA) parameters. The blank EDD template can be downloaded at http://www.wastenotnc.org/swhome/enviro_monitoring.asp. Please pay attention to the formats within the spreadsheet. Any EDD received that is not formatted correctly will be emailed back to be resubmitted via email within five (5) days.
- A separate groundwater monitoring well construction table.
    - Please also include the date the well was drilled, well diameter, total well depth, depth to top of screened interval (in feet), screened interval (in feet), geology of screened interval, TOC elevation, ground elevation, groundwater elevation, GPS coordinates (latitude and longitude), and depth to water (in feet).
- A separate groundwater table with groundwater flow rate(s).
- A recent facility figure that includes labeled groundwater and surface water monitoring locations.
- A groundwater flow map with an arrow(s) indicating flow direction(s), including date the measurements were taken.

Soil and Sediment Sampling

- A copy of the laboratory report(s).
- A copy of the sampling log(s).
- A separate table of detections and exceedances for each sampling location.
    - Please also include the results in micrograms per liter (ug/L), the laboratory's method detection limit (MDL) in ug/L, and the appropriate NC regulatory standard (PSRG) in ug/L.
    - Please **BOLD** each exceedance result.
- A separate table of soil and/or sediment characteristics.
- A recent facility figure that includes labeled sampling locations.

Landfill Gas Monitoring

- A blank Landfill Gas Monitoring Data Form can be found within the *Landfill Gas Monitoring Guidance* document and can be downloaded at http://portal.ncdenr.org/c/document_library/get_file?uuid=da699f7e-8c13-4249-9012-16af8aefdc7b&groupId=38361.
- A separate table of landfill gas detections and exceedances for each monitoring location. Please **BOLD** each exceedance result.
- A recent facility figure that includes labeled landfill gas monitoring locations (both permanent and temporary).

If you have any questions or concerns regarding electronic submittals, please feel free to contact the Hydrogeologist overseeing your facility. The Solid Waste Section greatly appreciates your assistance on this matter. Working together, we can continue to provide excellent customer service to you and to the public.

- Jackie Drummond, Asheville Regional Office, 828-296-4706, jaclynne.drummond@ncdenr.gov
- Ervin Lane, Raleigh Central Office, 919-707-8288, ervin.lane@ncdenr.gov
- Elizabeth Werner, Raleigh Central Office, 919-707-8253, elizabeth.werner@ncdenr.gov
- Christine Ritter, Raleigh Central Office, 919-707-8254, christine.ritter@ncdenr.gov
- Perry Sugg, Raleigh Central Office, 919-707-8258, perry.sugg@ncdenr.gov

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Phone: 828-296-4500
http://portal.ncdenr.org/web/wm/
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APPENDIX IV

NCDENR Environmental Monitoring Reporting Form

DENR USE ONLY: ☐ Paper Report ☐ Electronic Data - Email CD (data loaded: Yes / No) Doc/Event #:

NC DENR
Division of Waste Management - Solid Waste

Environmental Monitoring Reporting Form

Notice: This form and any information attached to it are "Public Records" as defined in NC General Statute 132-1. As such, these documents are available for inspection and examination by any person upon request (NC General Statute 132-6).

Instructions:

- **Prepare one form for each individually monitored unit.**
- **Please type or print legibly.**
- Attach a notification table with values that attain or exceed NC 2L groundwater standards or NC 2B surface water standards. The notification must include a preliminary analysis of the cause and significance of each value. (e.g. naturally occurring, off-site source, pre-existing condition, etc.).
- Attach a notification table of any groundwater or surface water values that equal or exceed the reporting limits.
- Attach a notification table of any methane gas values that attain or exceed explosive gas levels. This includes any structures on or nearby the facility (NCAC 13B .1629 (4)(a)(i).
- Send the original signed and sealed form, any tables, and Electronic Data Deliverable to: Compliance Unit, NCDENR-DWM, Solid Waste Section, 1646 Mail Service Center, Raleigh, NC 27699-1646.

Solid Waste Monitoring Data Submittal Information

Name of entity submitting data (laboratory, consultant, facility owner):

Contact for questions about data formatting. Include data preparer's name, telephone number and E-mail address:

Name: _____ Phone: _____

E-mail: _____

Facility name:	Facility Address:	Facility Permit #	NC Landfill Rule: (.0500 or .1600)	Actual sampling dates (e.g., October 20-24, 2006)

Environmental Status: (Check all that apply)

☐ Initial/Background Monitoring ☐ Detection Monitoring ☐ Assessment Monitoring ☐ Corrective Action

Type of data submitted: (Check all that apply)

☐ Groundwater monitoring data from monitoring wells
☐ Groundwater monitoring data from private water supply wells
☐ Leachate monitoring data
☐ Surface water monitoring data
☐ Methane gas monitoring data
☐ Corrective action data (specify) _____
☐ Other(specify) _____

Notification attached?

☐ No. No groundwater or surface water standards were exceeded.
☐ Yes, a notification of values exceeding a groundwater or surface water standard is attached. It includes a list of groundwater and surface water monitoring points, dates, analytical values, NC 2L groundwater standard, NC 2B surface water standard or NC Solid Waste GWPS and preliminary analysis of the cause and significance of any concentration.
☐ Yes, a notification of values exceeding an explosive methane gas limit is attached. It includes the methane monitoring points, dates, sample values and explosive methane gas limits.

Certification

To the best of my knowledge, the information reported and statements made on this data submittal and attachments are true and correct. Furthermore, I have attached complete notification of any sampling values meeting or exceeding groundwater standards or explosive gas levels, and a preliminary analysis of the cause and significance of concentrations exceeding groundwater standards. I am aware that there are significant penalties for making any false statement, representation, or certification including the possibility of a fine and imprisonment.

Facility Representative Name (Print) Title (Area Code) Telephone Number

Affix NC Licensed/ Professional Geologist Seal

Signature Date

Facility Representative Address

NC PE Firm License Number (if applicable effective May 1, 2009)

Revised 6/2009